

Introducing Protection Action Theory:

**An exploration of the factors that
influence household emergency
preparedness in Ireland**

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Introducing Protection Action Theory: An exploration of the factors that influence household emergency preparedness in Ireland

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of PhD is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed

A handwritten signature in black ink, appearing to read 'G. Brown', written in a cursive style.

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Dedication

This dedication is for my parents, Mary and David, whose endless support and unwavering belief in me have been my foundation.

This achievement is as much yours as it is mine.

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Introducing Protection Action Theory: An exploration of the factors that influence household emergency preparedness in Ireland

Gavin David Brown

Abstract

This thesis examines the factors that influence household emergency preparedness in Ireland. Its structure is underpinned by research papers exploring the multifaceted dimensions influencing household preparedness.

Paper 1 (Chapter 2) evaluates how gender affects risk perception, revealing that women frequently view involuntary risks as more probable and severe than men. Paper 2 (Chapter 3) analyses perceived versus actual household preparedness, investigating the impact of expertise, coping appraisal, and experience. Paper 3 (Chapter 4) delves into the challenges first responders faced during the COVID-19 outbreak in Ireland. Notably, concerns for family safety significantly swayed protective behaviours, prompting some to modify family interactions or initiate actions like decontamination. Paper 4 (Chapter 5) employs an expanded PMT framework to explore fire safety in apartments. Aside from the coping appraisal of households, no factors predicted the adoption of all of the fire safety measures, emphasising the importance of tailoring preparedness campaigns by action type. Paper 5 (Chapter 6) explores PMT in relation to severe weather. While high threat and coping appraisals typically prompt protective actions, this study highlights that low confidence in the warning system can lead to non-protective responses. Paper 6 (Chapter 7) investigates the relationship between nurses' perceived and actual household emergency preparedness while also examining the key factors expected to influence both aspects of preparedness. Chapter 8 concludes by proposing a new model, Protection Action Theory (PAT), which is informed by the previous papers within this thesis. The PAT model examines household preparedness actions immediately before and following a severe weather emergency. A notable contribution of this research is conceptualising and testing the post-event coping assessment and its linkage to preparedness actions. The results show that where households rate their post-event coping assessments as relatively low during a weather-related emergency, they are more inclined to take additional preparedness measures afterwards.

1. Chapter One – Introduction

1.1 Background & Research Question

The COVID-19 global pandemic highlighted vulnerabilities in emergency preparedness across all nations and prompted a renewed emphasis on building resilience at a national level in Ireland. While traditionally considered a low risk country, Ireland has experienced the impacts of severe weather events, transport incidents, animal health emergencies, food contamination, and major fires such as that which engulfed the Stardust nightclub. While there is a clear need for national and even international policies to drive preparedness, resilience must be built from the micro to the macro level. Household emergency preparedness is a crucial aspect of building national resilience. Research indicates that a deeper understanding of the factors that influence behaviour regarding household emergency preparedness can be used as the basis of initiatives and policies to drive resilience and enhance preparedness (Paton, 2003; McNeill *et al.*, 2013). According to Norris *et al.* (2008), success in achieving resilience to emergencies depends on a collective response and the preparedness of individual households.

Promoting individual and household emergency preparedness within the context of Ireland's low-risk profile poses a set of challenges. In Ireland, unlike regions affected by emergencies such as an earthquake, household emergency preparedness has generally adopted an all-hazard approach. This is reflected in the national “Be Winter Ready” and “Be Summer Ready” campaigns aimed at encouraging individuals, households, and communities to prepare for seasonal risks. These campaigns, led by the Office of Emergency Planning (OEP), raise awareness of the risks citizens will face and encourage planning and mitigation to reduce the risk to individuals and their homes.

Persuading individuals and households of the necessity for emergency preparedness hinges on understanding the factors that encourage them to take action. This study sets out to answer the following research question:

What are the factors that influence household emergency preparedness in Ireland?

1.2 Literature Review

The first step in answering this question involved identifying and analysing the key factors which emerged as being significant in studies conducted into emergency preparedness for a wide range of risks and in other geographic contexts. The literature review also encompassed the findings of papers covering the factors that influence risk perception, which in turn drives emergency preparedness action. This literature review established a theoretical framework that provided a blueprint for the six papers that form the main body of this thesis and ultimately allow for the answering of the research question.

Based on the PRISM methodology, a Systematic Literature Review (SLR) was deployed to identify the factors that influenced perceived and actual household preparedness (see Section 3.2 for an overview of the SLR). The SLR encompassed 69 research papers. Considering that some papers employed multiple models to explore the relationship between various factors and household preparedness, the count of models that tested these relationships was reported instead of the number of papers. This approach was chosen to offer a more precise depiction of the findings within the literature. The SLR examines household preparedness before moving to an identification of the factors that were found to influence emergency preparedness.

1.2.2 Perceived & Actual Household Preparedness

Household preparedness is assessed based on a measure of actual and/or perceived preparedness. Determining actual preparedness, an objective measure, involves determining if respondents have undertaken one or more measures to prepare for an emergency (Kyne *et al.*, 2020). This can involve a single binary measure, such as inquiring whether respondents have a 72-hour emergency kit (Annis, Jacoby, and De Mers, 2016), or using a checklist of several preparedness measures. Some studies compile these measures into a scale (Nguyen *et al.*, 2006; Wood *et al.*, 2012; Bodas *et al.*, 2015 & 2018; Espina & Teng-calleja, 2015; Henly-Shepard *et al.*, 2015; Baytiyeh & Naja, 2016; DeYoung & Peters, 2016; Ejeta *et al.*, 2016; Mabuku *et al.*, 2018; Wei, Sim, & Han, 2019; DeYoung *et al.*, 2019), while others report each measure separately (Basolo *et al.*, 2009; Basolo, Steinberg, and Gant, 2017; Knuth *et al.*, 2017; Hung, 2019; Annis, Jacoby, and De Mers, 2016).

Perceived preparedness is a subjective assessment based on how prepared respondents feel (Kyne *et al.*, 2020). As with actual, some studies used binary measures for perceived preparedness (Basolo *et al.*, 2009; Henly-Shepard *et al.*, 2015; Cope *et al.*, 2018); for example, Cope *et al.* (2018) asked respondents if they felt prepared to deal successfully with a serious threat. Other studies utilised ordinal scales, varying from three-point scales (DeBastiani *et al.*, 2015; Basolo, Steinberg, and Gant, 2017; Kirschenbaum, Rapaport, and Canetti, 2017), to four or five-point scales (Bradford *et al.*, 2012; Donahue, Eckel, and Wilson, 2014; Han *et al.*, 2017), to measuring preparedness as a percentage (Adame and Miller, 2016; Ranjbar *et al.*, 2018; Oriangi *et al.*, 2019). For example, Adame and Miller (Adame and Miller, 2016) asked respondents how prepared they felt for a flood on a 1 to 100 point scale.

1.2.1 Socio-demographic Factors

This section examines the effects of socio-demographic variables on household preparedness. First, for models where perceived preparedness was the dependent variable (19 models - see Table 1.1), and then the models where actual preparedness was the dependent variable (84 models – see Table 1.2).

Table 1.1 Perceived Preparedness (19 Models)

	Gender (Female)	Age	Children	Income	Race	Owens Home	Household Size	Years of Residence	Urbanicity	Education	Employed
Significant & Positive	10.5% (2n)	15.8% (3n)	0% (0n)	5.3% (1n)	10.5% (2n)	10.5% (2n)	0% (0n)	0% (0n)	0% (0n)	5.3% (1n)	0% (0n)
Significant & Negative	10.5% (2n)	21.1% (4n)	0% (0n)	0% (0n)	0% (0n)	0% (0n)	5.3% (1n)	15.8% (3n)	0% (0n)	10.5% (2n)	5.3% (1n)
Not Significant	63.2% (12n)	36.8% (7n)	26.3% (5n)	31.6% (6n)	31.6% (6n)	21.1% (4n)	5.3% (1n)	5.3% (1n)	0% (0n)	36.8% (7n)	5.3% (1n)
Did Not Test/Report	15.8% (3n)	26.3% (5n)	73.7% (14n)	63.2% (12n)	57.9% (11n)	68.4% (13n)	89.5% (17n)	78.9% (15n)	100% (19n)	47.4% (9n)	89.5% (17n)

Within the models examining perceived preparedness (Table 1.1), several socio-demographic variables emerged as significant explanatory variables. Where significant, income (Oriangi *et al.*, 2019), race (Donahue, Eckel and Wilson, 2014; DeBastiani *et al.*, 2015) and owning a home (Donahue, Eckel and Wilson, 2014; Cope *et al.*, 2018) were found to have a positive effect on perceived preparedness, while household size (Oriangi *et al.*, 2019), years of residence (Henly-Shepard *et al.*, 2015) and being employed (Cope *et al.*, 2018) were all negatively associated with perceived preparedness.

In the case of the explanatory variables age, education and gender, the relationship with perceived preparedness was not consistent across studies. Where significant, some studies found age (DeBastiani *et al.*, 2015; Basolo, Steinberg and Gant, 2017; Kruger *et al.*, 2018) had a positive and significant effect on perceived preparedness, while others reported a negative effect (Kirschenbaum, Rapaport and Canetti, 2017; Cope *et al.*, 2018). Similarly depending on the study, education (Kruger *et al.*, 2018) and gender (Kirschenbaum, Rapaport and Canetti, 2017), being female, were estimated to have positive and significant effects on perceived preparedness, as well as negative and significant effects on education (DeBastiani *et al.*, 2015; Cope *et al.*, 2018) and gender (female) (Bradford *et al.*, 2012; DeBastiani *et al.*, 2015)). Having children in the home (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Cope *et al.*, 2018; Kruger *et al.*, 2018) was not found to have a significant relationship with perceived preparedness. The review revealed that urbanicity was never included in a perceived preparedness model or study.

Table 1.2 Actual Preparedness (84 Models)

	Gender (Female)	Age	Children	Income	Race	Owns Home	Household Size	Years of Residence	Urbanicity	Education	Employed
Significant & Positive	7.1% (6n)	14.3% (12n)	10.7% (9n)	6% (5n)	0% (0n)	8.3% (7n)	6% (5n)	1.2% (1n)	0% (0n)	15.5% (13n)	0% (0n)
Significant & Negative	13.1% (11n)	1.2% (1n)	1.2% (1n)	1.2% (1n)	2.4% (2n)	2.4% (2n)	3.6% (3n)	1.2% (1n)	1.2% (1n)	2.4% (2n)	1.2% (1n)
Not Significant	39.3% (33n)	35.7% (30n)	33.3% (28n)	21.4% (18n)	14.3% (12n)	16.7% (14n)	13.1% (11n)	7.1% (6n)	3.6% (3n)	26.2% (22n)	10.7% (9n)
Did Not Test/ Report	40.5% (34n)	48.8% (41n)	54.8% (46n)	71.4% (60n)	83.3% (70n)	72.6% (61n)	77.4% (65n)	90.5% (76n)	95.2% (80n)	56% (47n)	88.1% (74n)

In models using actual preparedness as the dependent variable (Table 1.2), there was mixed evidence about its relationship with the socio-demographic variables examined. Where significant, age was predominantly found to have a positive relationship (Ablah, Konda and Kelley, 2009; Basolo *et al.*, 2009; McNeill *et al.*, 2013; Tomio *et al.*, 2014; Bodas *et al.*, 2015; DeBastiani *et al.*, 2015; Hoffmann and Muttarak, 2017; Knuth *et al.*, 2017; Donner and Lavariega-Montforti, 2018), although one study found a negative significant association (Muttarak and Pothisiri, 2013). A positive and significant relationship between households with children and actual preparedness was more frequently reported (Basolo *et al.*, 2009; Rebmann *et al.*, 2013; Basolo, Steinberg and Gant, 2017; Hoffmann and Muttarak, 2017; Knuth *et al.*, 2017; Xu *et al.*, 2018) than a negative and significant relationship (Muttarak and Pothisiri, 2013). A similar pattern was evident for high education levels, with more studies reporting a positive and significant relationship (Muttarak and Pothisiri, 2013; Tomio *et al.*, 2014; Annis, Jacoby and De Mers, 2016; Hoffmann and Muttarak, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Xu *et al.*, 2018; Wei, Sim and Han, 2019) than a negative and significant relationship (DeBastiani *et al.*, 2015; Chen *et al.*, 2019). Higher incomes were more often positively and significantly associated with actual preparedness (Ablah, Konda and Kelley, 2009; Annis, Jacoby and De Mers, 2016; Donner and Lavariega-Montforti, 2018; Xu *et al.*, 2018; Chen *et al.*, 2019) than negatively and significantly associated (Xu *et al.*, 2018).

The estimated impact of gender (female) varied across studies and where significant, some studies reported a positive and significant relationship (Kirschenbaum, 2006; Tomio *et al.*, 2014; Hoffmann and Muttarak, 2017; Kelly and Ronan, 2018; Xu *et al.*, 2018), while others were negative and significant (Basolo *et al.*, 2009; McNeill *et al.*, 2013; Rebmann *et al.*, 2013; DeBastiani *et al.*, 2015; Annis, Jacoby and De Mers, 2016; Basolo, Steinberg and Gant, 2017; Knuth *et al.*, 2017; Bodas *et al.*, 2018; Ranjbar *et al.*, 2018). Likewise, the

results for factors associated with the home, such as household size, owning a home and years at address were mixed, sometimes estimated as positive and significant (owning a home (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Knuth *et al.*, 2017); household size (Knuth *et al.*, 2017; Xu *et al.*, 2018); years of residence (Hoffmann and Muttarak, 2017)) and other times negative and significant (owning a home (Oral *et al.*, 2015; Hung, 2019); household size (Hoffmann and Muttarak, 2017; Xu *et al.*, 2018); years of residence (Henly-Shepard *et al.*, 2015)). Being employed (Ablah, Konda and Kelley, 2009), urbanicity (Wei, Sim and Han, 2019), and race (DeBastiani *et al.*, 2015; Basolo, Steinberg and Gant, 2017) were never found to have a positive and significant relationship with actual preparedness.

The literature reviews undertaken by Levac *et al.* (Levac, Toal-Sullivan and O'Sullivan, 2012) and Kohn *et al.* (Kohn *et al.*, 2012) supported the results of this SLR, suggesting that the effects of socio-demographic factors differ between studies. Study design, context (location and the risks analysed) and the specific preparedness measures used may explain the variation in findings.

1.2.3 Experience & Exposure to Emergencies

Within the SLR, exposure to emergencies was included in 53 out of the 104 models predicting household preparedness. Of these, 32 showed that exposure to emergencies had a non-significant relationship to household preparedness. Of the remaining models, the majority reported a significant positive relationship between exposure to emergencies and preparedness, for example (Muttarak and Pothisiri, 2013; Donahue, Eckel and Wilson, 2014; Espina and Teng-calleja, 2015; Henly-Shepard *et al.*, 2015; Hoffmann and Muttarak, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Knuth *et al.*, 2017; Donner and

Lavariega-Montforti, 2018; Xu *et al.*, 2018; Chen *et al.*, 2019). Only Oral *et al.* (2015) found that exposure to earthquakes had a negative effect on actual household preparedness.

A more detailed examination of the models from the SLR revealed that the significance of exposure to emergencies would frequently change from significant and positive to non-significant, depending on the preparedness measure. For example, Basolo *et al.* (2017) found that exposure to hurricanes only significantly and positively impacted having a family emergency plan, but not other preparedness measures (for example, having sandbags on-site) or perceived preparedness. Kirschenbaum *et al.* (2017) similarly found that exposure to earthquakes positively and significantly affected actual household preparedness but not perceived preparedness.

1.2.4 Expertise

In the SLR, expertise was identified as an under explored factor in household preparedness studies. Only eight models across six papers incorporated expertise into their analyses. Tej *et al.* (2014) and Cope *et al.* (2018) observed that professional background, e.g., whether individuals worked in the oil industry, significantly influenced awareness and actions related to preparedness.

Chan *et al.* (2019) and Rebmann *et al.* (2013) studied the impact of specialist training on preparedness. Their research identified that recent disaster training (within the past 1-2 years) markedly improved household preparedness levels. Also linked to training, Landahl and Cox (2009) found that while 65.9% of Homeland Security organizations offered general disaster preparedness training to their staff, only 29.1% had implemented training strategies focused on encouraging family or household disaster preparedness among their employees.

Studies by Knuth *et al.* (2017) and Corwin *et al.* (2017) investigated the impact of expertise on preparedness yielding inconsistent results. Corwin *et al.* (2017) reported no statistically significant difference in elements of preparedness (planning and supplies) between experts and non-experts. However, experts were statistically more likely to have taken preparedness actions (buying insurance, sourcing information on local volcanic risk, undertaking a first aid course, or identifying who in the neighbourhood required additional assistance) and exhibited a higher average preparedness score than non-experts. Knuth *et al.* (2017) found that experts, particularly those in the civil defence and medical sectors, were more inclined to consider acquiring a fire blanket despite not owning one. This intention to improve preparedness did not extend to other preparedness measures, such as purchasing a fire extinguisher or first aid kit, where no significant differences were observed.

1.2.5 Risk Rating & Risk Perception

The SLR highlighted two common approaches to measuring risk within the household preparedness research. The first was risk rating i.e., likelihood (probability) (Prati, Pietrantoni and Zani, 2011; Bourque *et al.*, 2013; McNeill *et al.*, 2013; Donahue, Eckel and Wilson, 2014; Han *et al.*, 2017; Kerstholt, Duijnhoven and Paton, 2017; Knuth *et al.*, 2017; Stumpf *et al.*, 2017; Xu *et al.*, 2018; Mabuku *et al.*, 2018; Wirtz, Rohrbeck and Burns, 2019; Wei, Sim and Han, 2019) and impact (consequence/severity) (Prati, Pietrantoni and Zani, 2011; McNeill *et al.*, 2013; Jassempour *et al.*, 2014; Bodas *et al.*, 2015; Ejeta *et al.*, 2016; Han *et al.*, 2017; Kerstholt, Duijnhoven and Paton, 2017; Xu *et al.*, 2018; Ranjbar *et al.*, 2018; Wei, Sim and Han, 2019; Wirtz, Rohrbeck and Burns, 2019).

The second was the concept of risk perception (Kirschenbaum, 2005; Espina and Teng-calleja, 2015; DeYoung and Peters, 2016; Basolo, Steinberg and Gant, 2017; Wei and

Lindell, 2017; Cope *et al.*, 2018; DeYoung *et al.*, 2019), which in addition to measures for likelihood and impact included, for example, measures of worry (Prati, Pietrantonio and Zani, 2011; Mabuku *et al.*, 2018; Xu *et al.*, 2018) or anxiety (Wei, Sim and Han, 2019; Wirtz, Rohrbeck and Burns, 2019), dread (Basolo *et al.*, 2009). The SLR included 52 models (of 104) that did not measure risk perception.

Overall, 29 models contained at least one significant risk measure. In most cases it was positively related to preparedness (Prati, Pietrantonio and Zani, 2011; Espina and Teng-calleja, 2015; DeYoung and Peters, 2016; Basolo, Steinberg and Gant, 2017; Han *et al.*, 2017; Kerstholt, Duijnhoven and Paton, 2017; Cope *et al.*, 2018; DeYoung *et al.*, 2019) suggesting that a higher risk rating was associated with higher levels of preparedness. However, some instances of a negative relationship with preparedness were identified (Bodas *et al.* 2015; Wei *et al.* 2019).

1.3 Protection Motivation Theory (PMT)

The SLR identified several theoretical frameworks that could help explain household preparedness. A more targeted search using the keywords (preparedness AND ("protection motivation" OR PADM OR PMT) AND "risk perception") identified 61 papers focused on household preparedness. Among these, PMT was the most applied theory, cited in 21 studies. Protective Action Decision Model (PADM) was utilised in 10 papers and 21 papers did not align with any specific theory. The remaining studies employed alternative theories, such as communication models, critical thinking cycles.

PMT was first formulated by Rogers in 1975 as a framework to describe the effects of fear appeals on motivations to follow health advice (Rogers, 1975). Through subsequent updates, which enabled its application to a wider variety of contexts, PMT suggested that when a risk is perceived, two independent appraisal processes occur that shape protection

motivation. The first is a threat appraisal, which is followed by a coping appraisal (Maddux 1993; Milne *et al.* 2000; Rogers 1983; Maddux and Rogers 1983; Rogers and Prentice-Dunn 1997). Together, these determine whether sufficient motivation to adopt risk-reducing behaviours exists (Rogers and Prentice Dunn, 1997; Norman, Boer and Seydel, 2005). This PMT model is presented in Figure 1.1.

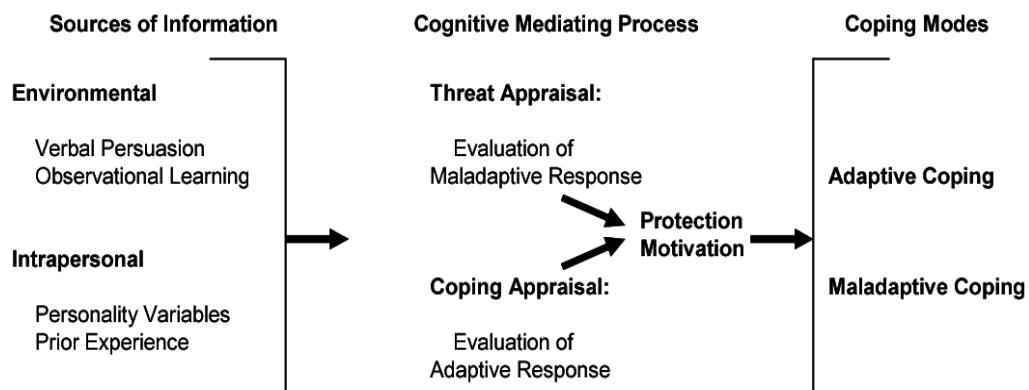


Figure 1.1 Overall Model of PMT (Rogers and Prentice-Dunn 1997, p.114)

The threat appraisal process involves individuals assessing the perceived likelihood and impact of a risk (Bubeck *et al.*, 2013; Grothmann & Reusswig, 2006):

- Likelihood: Expresses uncertainty and is the same as probability (SRA 2018).
- Impact: “The effects that the consequences have on specified values (such as human life and health, environment and economic assets)” (SRA, 2018, p.6).

PMT often associates fear with the threat appraisal process, either as a direct component (Dittrich *et al.*, 2016; Babicky and Seebauer, 2019) or as an indirect factor potentially leading to avoidance rather than protective motivation (Rogers & Prentice Dunn, 1997). Although fear is a typical measure in PMT studies (Grothmann and Reusswig, 2006; Dittrich *et al.*, 2016; McCaughey *et al.*, 2017), the concept of worry is also prevalent within the household preparedness literature (Babicky and Seebauer, 2019; Heidenreich, Masson and Bamberg, 2020; Hudson, Hagedoorn and Bubeck, 2020; Odidi *et al.*, 2020; Hu *et al.*,

2021; Scovell *et al.*, 2021). Despite their relatedness, fear and worry can be defined differently (Barlow 2002): fear being most related to an imminent risk, a perceived certain threat which triggers a fight-or-flight response, whereas worry involves apprehension about a potential threat and can prompt preparation and preparedness (Barlow, 2002; Zinbarg *et al.*, 2006).

The coping appraisal evaluates the ability to mitigate a threat through risk reduction and preparedness actions (Rogers and Prentice Dunn, 1997; Norman, Boer and Seydel, 2005).

It is comprised of three factors:

- Self-efficacy: Confidence in successfully performing a recommended risk reduction behaviour;
- Response efficacy: Belief in the effectiveness of a specific risk reduction behaviour in mitigating the risk;
- Response costs: Perceived costs, such as time and financial expenditure, associated with adopting the risk reduction behaviour.

In essence, those with a high coping appraisal believe they can complete the preparedness action, the action will be effective, and the benefits outweigh the costs associated with the protective action.

Beyond its established efficacy in health research as an explanatory model for health-related decision-making (Floyd, *et al.* 2000; Milne, *et al.* 2000), PMT has gained widespread use in explaining how threat and coping appraisals drive motivation to undertake household emergency preparedness and is summarised in Figure 1.2 (Seebauer and Babicky, 2020; Jansen, Snijders and Willemsen, 2021). It has been applied in many

contexts including to examine the factors that influence preparedness behaviour in socio-natural risk¹ contexts (Mulilis and Lipa, 1990; Grothmann and Reusswig, 2006).

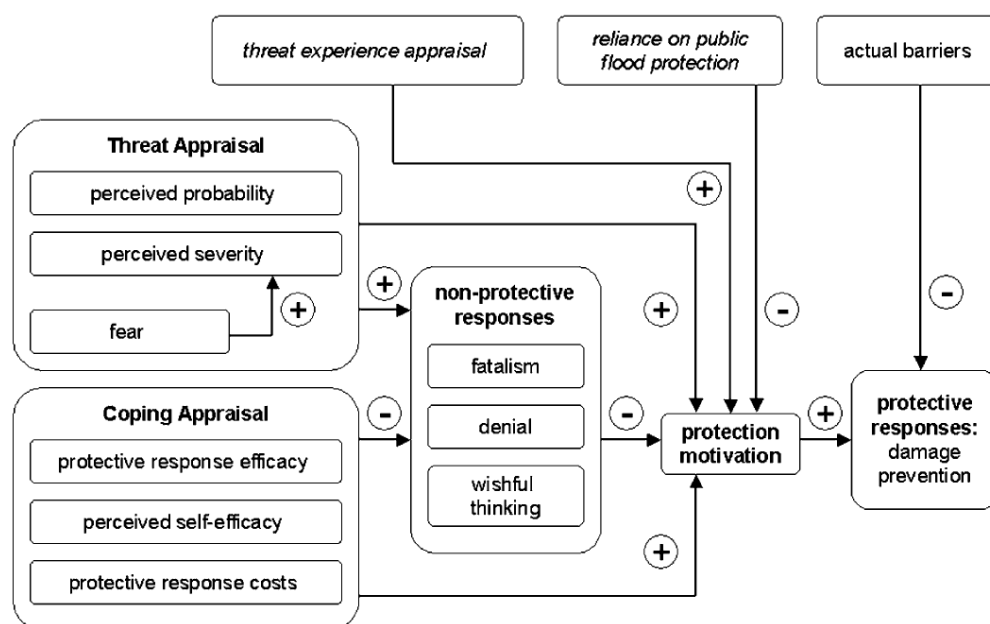


Figure 1.2 Explanatory factors for PMT² (Grothmann and Reusswig 2006, p.105)

Within the PMT literature, findings on the predictive effectiveness of the threat appraisal on household preparedness are inconsistent (Bubeck, Botzen and Aerts, 2012; Poussin, Botzen and Aerts, 2014; Dittrich *et al.*, 2016; Tang and Feng, 2018; Babcicky and Seebauer, 2019; Twerefou *et al.*, 2019; Weyrich, Mondino, *et al.*, 2020). Dittrich *et al.* (2016) suggested that the significance of threat appraisal depends on the specific preparedness measure being examined. Weyrich, *et al.* (2020) found that higher perceived severity (impact) of a flood positively affected emergency preparedness actions (e.g., having emergency plans), while increased perceived vulnerability (likelihood) positively affected structural and avoidance measures (e.g., use of water-resistant materials and

¹ Socio-natural risks arise from the interaction between social systems and natural hazards and acknowledge that disasters are not purely natural. These risks encompass a wide range of events such as storms and floods, where the impact on humans is significantly shaped by societal factors including urbanization, environmental management, social inequalities, and preparedness levels.

² Note: + = positive association; - = negative association.

raising appliances above flood levels). Babicky and Seebauer (2019) found that high levels of fear alone prompted respondents to establish emergency plans, while low-risk perception was associated with higher levels of non-protective responses.

PMT studies consistently show a positive association between high coping appraisal (or its sub-components, high self-efficacy and/or high response efficacy) and protective motivation or action (Grothmann and Reusswig, 2006; Martin, Bender and Raish, 2007; Bubeck *et al.*, 2013; Poussin, Botzen and Aerts, 2014; Gebrehiwot and van der Veen, 2015; Babicky and Seebauer, 2019; Weyrich, Scolobig, *et al.*, 2020). For instance, Grothmann and Reusswig (2006) found coping appraisal explained more variance in protective responses (2–21%) than threat appraisal (3–6%). Similarly, Poussin *et al.* (2014) concluded that coping appraisal had a greater influence on preparedness action than threat appraisal.

PMT has been used extensively to study preparedness for severe weather, including flooding, drought, heatwaves, cold temperatures, and tropical cyclones. Many of these PMT studies focus on respondents' perceived level of threat and perceived ability to cope, with data collected before the event occurred. For example, in Gumasing *et al.* (2022), data was collected two days before a cyclone made landfall. Where data was gathered after the event, the timing of data collection, sometimes occurring a year or more after the event, has potential implications (Bubeck *et al.*, 2018; Schlef *et al.*, 2018; Hudson, Hagedoorn and Bubeck, 2020; Seebauer and Babicky, 2020; Tabe-Ojong, Boakye and Muliro, 2020; Williams, Arguillas and Arguillas, 2020; Dillenardt, Hudson and Thieken, 2021; Mondal, Murayama and Nishikizawa, 2021). For example, this delay could influence respondents' perceptions of their coping abilities and, consequently, may lead to conclusions different from those of the data collected shortly after the event. There is a concern that memories may fade, perceptions may change due to subsequent experiences or information, and the immediate reactions and adaptations made could be underreported, overreported, or

misrepresented. Only a few PMT studies have focused on collecting data in the immediate aftermath of a severe weather emergency (Botzen *et al.*, 2019; Weyrich, Mondino, *et al.*, 2020; Kurata *et al.*, 2022). Within these studies, there was little emphasis on examining preparedness actions taken following, and in response to the event, and no emphasis on respondents' coping assessment. This highlights a gap in the literature. Understanding post-emergency coping assessments and how these influence preparedness actions following emergency events could provide valuable insights into designing more effective preparedness campaigns and interventions.

1.3.1 PMT Comparison

In addition to PMT, the Health Belief Model (HBM), the Trans-Theoretical Model (TTM), and Protective Action Decision Model (PADM) have been used to study variations in preparedness levels (Paton 2019).

Paton (2019) notes that each theory captures various combinations of factors that account for whether preparedness action is taken or not. In the context of this research, given its use within the household preparedness literature to explain decision-making processes in relation to a range of long-term potential environmental risks (Lindell and Perry 2012), PADM was considered as an alternative lens through which household preparedness could be studied. Figure 1.3 provides an overview of PADM.

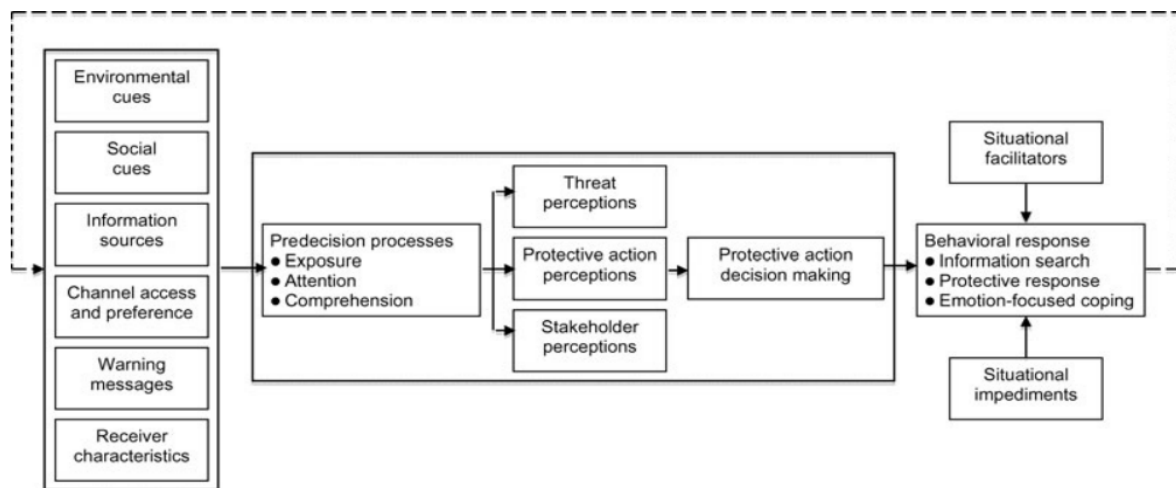


Figure 1.3 Information flow in the PADM (Lindell and Perry 2012, p.617).

Both PMT and PADM include the perception of the threat and the efficacy of response, emphasising the role cognitive processes play in decision-making. They also both consider the role of external factors, such as cues and messages, in shaping individuals' responses. Finally, they both acknowledge that individuals engage in information processing, risk-benefit evaluation, and the delicate balancing of costs versus benefits before deciding on protective actions.

However, PADM does not incorporate the concept of self-efficacy. Lindell and Perry (2012) and Floyd *et al.* (2000) considered this a significant gap, pointing out that many behavioural theories neglected self-efficacy as a component of protective motivation. The literature review revealed that self-efficacy has consistently been identified as a vital factor influencing household emergency preparedness. Its absence from PADM was the primary motivator for the selection of PMT over PADM as the overarching theoretical model for this thesis. Furthermore, the widespread use of PMT across various contexts and its extensive testing since 1975 made the case for PMT even more compelling.

1.4 Theoretical Framework & Link to Papers

Drawing on the literature reviews reported in Sections 1.2 and 1.3, a wide range of factors likely to influence household emergency preparedness were identified. These included gender, age, presence of children in the household, income, race, home ownership, household size, length of residence, education level, employment status, exposure to emergencies, worry, risk rating (likelihood and impact), coping appraisal (which included self-efficacy), and non-protective responses. In addition, expertise and urbanicity were highlighted as being under explored factors in the literature, pointing to gaps in the understanding of their effects on household emergency preparedness.

The results for factors such as gender and the presence of children in the home were inconsistent between studies, suggesting a need for additional investigation. These variations underscored the importance of examining how each factor, both individually and in combination, influence household emergency preparedness.

This PhD is completed using the “by publication” rather than the traditional “by monograph” approach. It includes six published papers, presented in Chapters 2 to 7. Table 1.3 outlines within which chapter each key factor from the literature review is analysed with a view to answering the research question: What are the factors that influence household emergency preparedness in Ireland? The papers are presented chronologically, by date of publication, given that the insights from each published paper, combined with peer review, informed subsequent research.

Table 1.3 Mapping of Factors from Theoretical Framework to Chapter/Paper

	Chapter 2 (Paper 1)	Chapter 3: (Paper 2)	Chapter 4: (Paper 3)	Chapter 5: (Paper 4)	Chapter 6: (Paper 5)	Chapter 7: (Paper 6)	Chapter 8: (Conclusion)
Gender	✓	✓		✓		✓	✓
Age	✓	✓		✓		✓	✓
Presence of Children	✓	✓	✓	✓		✓	✓
Income	✓	✓		✓		✓	✓
Race				✓			✓
Home Ownership	✓	✓		✓		✓	✓
Household Size		✓				✓	✓
Length of Residence	✓	✓				✓	✓
Urbanicity	✓	✓		✓	✓	✓	✓
Education Level	✓	✓		✓			
Employment Status			✓		✓	✓	✓
Expertise		✓	✓		✓	✓	✓
Exposure to Emergencies	✓	✓	✓	✓		✓	✓
Worry			✓	✓	✓		✓
Risk Rating	✓	✓		✓		✓	✓
Coping Appraisal		✓	✓	✓	✓	✓	✓
Non-protective Responses	✓			✓	✓		✓

1.5 Setting Research Papers in the Context of the Literature

The final two sections of Chapter 1 set out how the papers relate to the existing literature reported in Sections 1.2 and 1.3, the scope and objectives of each paper, and how they come together to form a narrative and provide an answer to the overarching research question. Finally, an overview of the methodological approach to this thesis is provided.

1.5.1 Paper 1: The impact of gender on risk perception: Implications for EU member states' national risk assessment processes

Paper 1 analyses the influence of gender on the perceived risk posed by 17 involuntary risks drawn from the Irish National Risk Matrix. Gender was recognised as a factor that influenced risk perception, which in turn drives emergency preparedness. However, the literature review revealed inconsistencies in results regarding its impact on risk assessment.

This difference was attributed to varied contexts and the types of risks examined (Sullivan-Wiley and Gianotti, 2017; Finucane *et al.*, 2000; Flynn *et al.*, 1994). To address this gap, Paper 1 explored the influence of gender on risk perception across a broad range of risks within a single sample. The findings revealed that gender significantly influenced the likelihood score for 15 risks, the impact score for 10 risks, and the overall risk rating for 14 risks, with females generally perceiving higher levels of risk than males. One notable exception was the impact score for fire, where males reported a higher impact rating than females. The theoretical contribution of this research is that it confirms, within one location and across a wide range of risks, that gender impacts risk perception. This study further extends knowledge by documenting how such effects vary significantly depending on the specific risk involved.

1.5.2 Paper 2: The influence of expertise on perceived and actual household disaster preparedness

Following the exploration of the influence of gender on risk perception, the narrative shifted towards expertise and its role in influencing household emergency preparedness. Here, experts were defined as individuals in the emergency services, defence forces, disaster/crisis management or health services. Paper 2 began by examining the alignment between perceived and actual household emergency preparedness before moving on to explore the influence of individuals' emergency management expertise on their preparedness levels.

The results revealed that although a positive correlation existed between perceived and actual preparedness for all participants, this alignment did not differ significantly between experts and non-experts. This novel contribution showed that emergency response expertise

does not enhance the accuracy of an individual's self-assess household emergency preparedness.

Secondly, expertise had a positive, significant effect on both perceived and actual preparedness. Experts' homes showed significantly higher levels of actual preparedness, highlighting the practical impact of their professional expertise on emergency preparedness. This finding confounded a prior finding that "response professionals largely mirror laypeople in terms of their household preparedness levels" (Corwin *et al.*, 2018, p.13).

Finally, Paper 2 shed light on other key factors that influenced perceived and actual preparedness. The findings extended knowledge by presenting new evidence on the different predictors of perceived and actual preparedness. For instance, the results showed that living in a town or city, and owning your home, both had a significant and positive relationship with actual preparedness. However, these factors were non-significant in the perceived preparedness model. Similarly, as the number of children in a household increased, the level of perceived preparedness decreased, but the level of actual preparedness was not impacted. These findings provide further insights into building an understanding of the factors that influence household preparedness.

1.5.3 Paper 3: Voices from the frontline: a review of EMS first responders' experience of COVID-19 in Ireland

Paper 3 continued the theme of expertise and delved into the complex challenges encountered by Emergency Medical Services (EMS) first responders during the initial COVID-19 lockdown in Ireland, shedding light on the personal and professional challenges faced during this unprecedented period. The research findings provided evidence-based recommendations aimed at bolstering the preparedness of EMS personnel for subsequent

waves of the pandemic and future public health emergencies. Key among these were the calls for adequate personal protective equipment (PPE), robust mental health services, and clear, effective communication strategies—all deemed essential for enhancing the resilience and operational effectiveness of these first responders.

Central to the research question, Paper 3 revealed how a positive coping appraisal helped EMS first responders navigate the risks posed by COVID-19 by adapting their professional behaviours to safeguard their families. These changes included altering family interactions and implementing precautionary measures like decontamination prior to engaging with family members. The research also captured high levels of worry among respondents in relation to contracting COVID-19 and transmitting the virus to their loved ones, particularly children and older people.

Reflecting on the theoretical framework drawn from Sections 1.2 and 1.3, the findings also extend knowledge of how the factors in PMT may interact to motivate preparedness. The study emphasised the impact of having children in the home on experts' risk rating and how worry and coping appraisals drove emergency preparedness measures. These findings highlight how the dynamic between individual and familial traits, coping appraisals, and worry extend understanding of the factors influencing emergency preparedness in a high-risk context.

1.5.4 Paper 4: Fire safety protection motivation and preparedness in Irish apartments: a post-Grenfell analysis

Built on insights from Paper 2 which highlighted the positive impact of city living on actual household preparedness without a corresponding increase in perceived preparedness, Paper 4 advanced understanding of the factors that shaped household emergency preparedness in urban settings. By applying Protection Motivation Theory (PMT) to fire safety in apartment

dwelling, a previously underexplored area within PMT research, the paper explored fire risk and household preparedness.

Extending PMT's application, Paper 4 introduced personal responsibility as a novel influence on both perceived and actual household preparedness for fire-related risks. Although the literature had emphasised the importance of taking personal responsibility for protective actions against fire risks, this aspect had not been examined within a PMT framework.

Contributing to the overarching research question, the study found that the determinants of household emergency preparedness (both perceived and actual) varied across different safety measures. For instance, while higher levels of worry prompted more frequent smoke alarm testing, they reduced compliance with evacuation protocols. The presence of children in an apartment was linked to an increased frequency of smoke detector testing, offering insights into the motivations behind specific preparedness behaviours. Moreover, the research challenged assumptions about the impact of ownership status on fire safety actions, revealing no significant differences in preparedness between apartment renters and owners. Finally, perceived personal responsibility was correlated positively with perceived preparedness and the presence of fire extinguishers or fire blankets, yet no significant relationship was found with awareness of fire plans, appropriate fire alarm response behaviour, or smoke detector testing.

The findings in Paper 4 amplified the complex nature of emergency preparedness within the urban context, specifically regarding fire safety in apartment buildings. By highlighting the role of, for example, perceived personal responsibility, alongside the influence of worry and the presence of children, this paper offered valuable insights for policymakers and

emergency managers seeking to enhance fire safety preparedness and response strategies in apartment buildings.

1.5.5 Paper 5: Weathering the Storm: Developing a user-centric weather forecast and warning system for Ireland

As the thesis evolved, the role of worry and the factors which influence worry, emerged as an increasingly important factor influencing household emergency preparedness in Ireland. This led to Paper 5, which explored the importance of weather forecasts and warning systems for the general public and professionals, such as farmers. Mileti and Sorensen (1990) described the warning-response process, highlighting the vital influence of warning effectiveness in prompting action; while incorrectly issued warnings, such as false alarms, could detrimentally affect individuals' reactions to subsequent warnings (Meyer and Kunreuther, 2017).

The results published in Paper 5 revealed that despite widespread confidence in the National Meteorological and Hydrological Service (NMHS) and the Irish weather warning system, there was criticism around the frequency with which yellow warnings were issued. Through focus group discussions, the study uncovered empirical evidence that the issuance of red warnings significantly heightened threat appraisal, specifically worry, urging participants to adopt protective measures. In line with PMT, the research also explored non-protective responses, revealing that diminished perceptions of warning credibility, eroded by previous over-warnings (the cry wolf effect) for events that failed to occur, lowered threat appraisal, evidenced by a lack of worry, and led to non-protective behaviours. The literature review demonstrated that coping appraisal was more influential than threat appraisal, however, Paper 5 demonstrated the influence of threat appraisal in the context of

severe weather. The high-level red warnings were acknowledged as the triggering of a strong sense of urgency which drove individuals to engage in preparedness actions.

Through Paper 5, the thesis significantly added to the understanding of how severe weather warnings (a high risk rating) influence the relationship between threat appraisal, worry, and protective actions.

1.5.6 Paper 6: An assessment of nurses' perceived and actual household emergency preparedness

Paper 6, the final publication within the thesis, explored the relationship between nurses' perceived and actual household emergency preparedness, while also examining the key factors expected to influence both aspects of preparedness. The study revealed a direct correlation between perceived and actual preparedness among nurses, finding that a one-point increment in actual preparedness led to a 15.8 percentage point increase in the likelihood that nurses felt prepared.

The paper analysed the impact of PMT-related factors, such as self-efficacy, exposure to previous emergencies, and risk rating, on nurses' emergency preparedness. Confounding prior results, as reported in Papers 2 and 4 and the literature more generally, self-efficacy was only marginally significant for perceived preparedness and not significantly associated with actual preparedness. The presence of children in the home was linked to a significant reduction in perceived preparedness, with no significant impact on actual preparedness. Residing in a city setting, as opposed to a rural one, was significantly associated with a decrease in both perceived and actual preparedness levels among nurses. These results contribute to the body of knowledge on emergency preparedness, underscore the value of considering a wide range of socio-demographic factors within studies of household emergency preparedness, and inform the response to the overall research question.

1.6 Setting the Research Context of Emergency Management in Ireland

Emergency management in Ireland operates on two distinct planes to ensure both strategic and operational implementation (McMullan 2010). This dual approach allows for coordinated planning, response, and recovery mechanisms, addressing a broad spectrum of potential emergencies and ensuring effective coordination of resources (McMullan 2010). From a strategic perspective, this involves formulating high-level policies and systems to guide emergency management activities at a governmental level. Activities include assessing and mitigating national risks, communicating risk and preparedness-related guidance, and providing structures for inter-departmental coordination and communication across various government entities (SEM 2017; McMullan *et al.* 2024). From the operational perspective, implementation focuses on assessing and mitigating regional risks, responding to emergencies, and managing recovery efforts (McMullan 2010). This involves a multi-agency approach to planning, coordination, response, and recovery (MEM 2006).

1.6.1 Strategic Level

At the strategic level, the Strategic Emergency Management National Structures and Framework (SEM) was prepared by the Office of Emergency Planning (OEP) within the Department of Defence. The SEM (2017) provides top-level policy direction, coordination, and oversight of emergency management activities across all Government Departments and public authorities, ensuring a cohesive and effective emergency management strategy. The SEM identifies 50 different emergency types and outlines the roles and responsibilities of various government departments.

Key components of the SEM (2017) include:

- **National-Level Coordination:** The SEM emphasises managing emergencies locally whenever possible. The National Emergency Coordination Group (NECG) coordinates efforts when a national-level response is warranted. The NECG is activated by the OEP when requested by the relevant Lead Government Department (LGD). For example, the Department of Housing, Local Government, and Heritage is the LGD for Severe Weather.
- **Government Task Force on Emergency Planning:** Chaired by the Minister for Defence, this task force includes senior representatives from all government departments and key agencies such as the Health Service Executive and An Garda Síochána. It oversees and coordinates emergency management policies and activities at the national level.

The Office of Emergency Planning (OEP), a joint Civil and Military Office within the Department of Defence, supports the Minister for Defence in overseeing national emergency management. Its key responsibilities include managing and operating the National Emergency Coordination Centre, ensuring readiness and facilitating its use by Lead Government Departments (LGDs) for emergency response activities (SEM 2017). The OEP helps identify and address capability gaps in Government Departments and Agencies, coordinates and facilitates emergency management training and education, and offers advice and assistance in preparing emergency plans and conducting exercises (SEM 2017). Additionally, the OEP prepares the National Risk Assessment for Ireland in collaboration with relevant Government Departments and engages with the European Union on related reviews (SEM 2017).

The National Risk Assessment (NRA) complements these efforts by comprehensively evaluating the key risks facing Ireland. It identifies and assesses risks from the natural, technological, civil, and transportation domains, drawing risk-based information from MEM regions, government departments and agencies. The NRA ensures compliance with EU standards, plots relative risk, and helps prioritise risk mitigation efforts. The latest NRA highlights:

- Risk Identification and Evaluation: Assessing the likelihood and impact of 22 key risks to inform government decisions on resource allocation.
- Public Awareness and Participation: Enhancing communication about risks through public participation, such as the Household Emergency Preparedness Survey conducted by Dublin City University (NRA 2023; McMullan *et al.* 2024).

1.6.2 Operational Level

At an operational level, the National Directorate for Fire and Emergency Management (NDFEM), which sits within the Department of Housing, Local Government, and Heritage, oversees the coordination of regional emergency management. This operational focus is underpinned by the Framework for Major Emergency Management (MEM 2006), which coordinates the Principal Response Agencies (PRAs) in preparing for and responding to major emergencies. The PRAs consist of An Garda Síochána (AGS), the Irish policing service, the Health Service Executive (HSE), and the Local Authorities. In addition, the roles of the Principal Emergency Services (PES), An Garda Síochána, the Ambulance Service, the Fire Service and the Irish Coast Guard, are set out with the MEM framework.

1.7 Methodological Approach

This research utilised a mix of quantitative and qualitative methodologies to answer the research question. This section provides a brief outline of the methodological approach and the general trajectory of the research; for a visual summary, see Figure 1.4. Specific methodological choices regarding each paper are discussed within the relevant chapter.

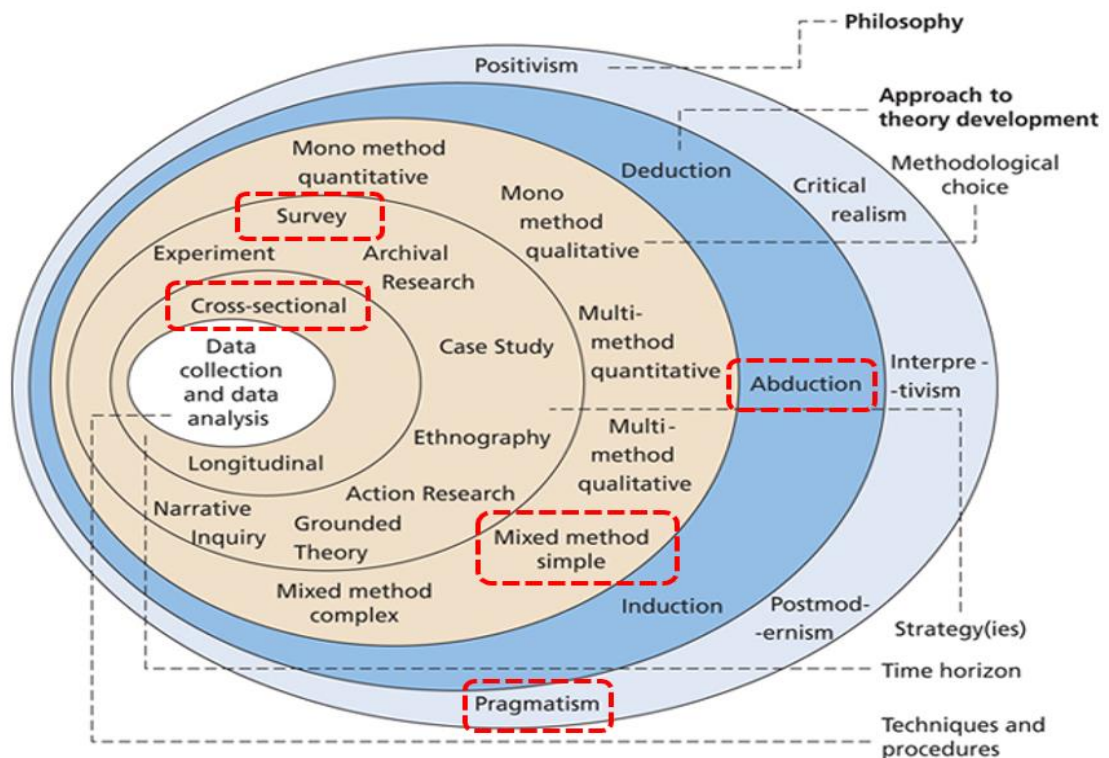


Figure 1.4 The ‘research onion’ (Saunders, Lewis and Thornhill 2020 p.128)

This thesis was built upon a philosophy of pragmatism adopting a flexible stance and the methodologies required to meet the objectives of each paper and the overarching research question (Morgan, 2014; Saunders, Lewis, and Thornhill 2020). Rather than focus on a subjective or an objective view of reality, pragmatism employs a reflexive process and focuses on problem-solving by emphasising the implications of research (Saunders, Lewis, and Thornhill 2020; Morgan, 2014). The adoption of this pragmatic stance was influenced by two key characteristics of the study (Saunders, Lewis, and Thornhill 2020):

1. This thesis's approach was both exploratory and confirmatory, bringing together qualitative insights and quantitative hypothesised relationships. Pragmatism provided a foundation that accommodated this mixed methods approach and helped ensure a thorough understanding that neither qualitative nor quantitative methods could achieve in isolation.
2. The study's evolutionary nature—where concepts were continuously refined based on new insights—resonated with the iterative essence of pragmatism, offering the needed adaptability. This iterative process is vital for responding to emerging insights and adapting the research trajectory in order to answer the research question.

Transitioning to the next phase of the ‘research onion’, this study’s overarching approach to theory development was abduction. This approach allowed for the movement back and forth between data and theory, blending deductive and inductive processes. While deduction commenced with theory to deduce specific conclusions from the data, and induction built theory from particular observations, abduction allowed for the generation of new hypotheses rooted in observations and existing theories (Suddaby 2006; Saunders, Lewis, and Thornhill 2020). This abductive approach was vital as it allowed for findings to be integrated into subsequent research papers and for the continued refinement of the data analysis techniques.

Next, this thesis used a multiphase mixed methods framework, where quantitative and qualitative data collection and analysis occurred in staggered phases (Clark and Ivankova 2015). The various chapters of this thesis illustrate the application of this approach, showcasing how different datasets contribute to a layered understanding of the research question. This multiphase approach not only enriches the research findings but also reinforces the pragmatic approach to answering the research question.

This thesis used a survey design, also referred to as a cross-sectional design, as its primary research approach to address the research question (Seale, 2018; Saunders, Lewis & Thornhill, 2020). The independence of samples across different data collection periods highlights the cross-sectional nature of this research, purposely chosen to examine specific dimensions of this research while facilitating comparisons and contrasts that contributed to answering the overall research question.

The data collection and analysis methods employed in the research papers are detailed within individual chapters and are summarised in Table 1.4. The design of the survey and focus group questions was informed by:

1. Conducting the SLR:

- The SLR was used to identify key papers, including those by Grothmann and Reusswig (2006), Bubeck et al. (2013), Poussin et al. (2014), and Dittrich et al. (2016), which were used to inform the initial design of the questions.
- Grey literature such as materials from the American Red Cross (2016a), FEMA (2016), and the Office of Emergency Planning (2016) was also included to capture a wider range of preparedness measures.
- The SLR was periodically updated to incorporate the latest research and findings.

2. Extracting and Synthesising Relevant Points:

- Thematic analysis was conducted to identify recurring themes, patterns, and gaps in the literature, which guided the question development.
- Studies such as that by Poussin et al. (2014), which provided a comprehensive supplementary data file, were used to better inform the exact wording of the questions.

3. Collaborating:

- Having identified key measures and potential questions related to PMT from the SLR these were edited for the Irish context.
- The supervisory panel was involved in reviewing the survey design to bring diverse perspectives and expertise into the question design.

4. Pilot Testing:

- To test the survey questions a pilot test on each bank of survey questions was carried out ensuring they were comprehensible and valid across different subgroups.
- Quantitative and qualitative methods were combined in the pilot testing phase to gain deeper insights into the respondents' understanding and interpretation of the questions.

5. Finalising the Survey:

- Once feedback was received, the final sets of questions were inputted into Qualtrics to facilitate data collection.

This approach ensured that the survey questions were grounded in theoretical and practical frameworks, enhancing their overall relevance and accuracy.

Papers 1 and 2 utilised a questionnaire to survey 2,000 households. The survey was initially pilot tested with 20 emergency management professionals. They completed the questionnaire and then participated in a semi-structured focus group to provide feedback. Additional feedback was collected via email from those unable to attend in person. The survey was then shared with a small sample of the public to finalise the questionnaire before a wider release. These individuals also provided their feedback via email. The data for Paper 3 was collected using a questionnaire from 815 EMS first responders during the first phases of the COVID-19 pandemic. The survey was pilot tested with EMS first responders and emergency management students who were studying on the MSc in Emergency Management at DCU (MSEM Students). Feedback was collected through a focus group with the students. Paper 4 surveyed apartment dwellers in Dublin and collected data from 455 homes. Similarly to the earlier studies, this was pilot tested with MSEM students and some households (specifically apartment dwellers). Again, feedback was collected via an in-class discussion with the students along with written feedback collected via email from households. The dataset for Paper 5, also utilised for the overall conclusion, was obtained using a survey methodology and encompasses responses from 4,451 households across

Ireland as well as qualitative data from 8 focus groups. The survey's pilot test was conducted with MSEM students and general households to gather feedback on the flow and design of the questions. This was repeated with a different group of MSEM students to test the flow of the focus group questions during the next phase of data collection. Finally, Paper 6, targeted at registered nurses, gathered responses from 557 respondents using an online questionnaire. The questionnaire was based on the one used in Paper 1 and 2 and was subsequently piloted tested with a small number of nurses prior to releasing online. A link was sent via email for them to review the questionnaire and provide written feedback.

This research complies with the University's research ethics policy, and all aspects of this work received ethical approval from DCU. Copies of the approval notifications are included in Appendix Chapter 1.

Table 1.4 Data Collection and Analysis Overview by Paper

Data Collection	Chapter 2 (Paper 1)	Chapter 3 (Paper 2)	Chapter 4 (Paper 3)	Chapter 5 (Paper 4)	Chapter 6 (Paper 5)	Chapter 7 (Paper 6)	Chapter 8 (Conclusion)
Survey – Quantitative Data	✓	✓	✓	✓	✓	✓	✓
Survey – Qualitative Data			✓		✓		✓
Focus Groups					✓		
Sample Size	2000		815	455	4451	557	4451
Pilot Testing	First with those working in emergency management and then households		EMS & MSEM Students	Households & MSEM Students	Households & MSEM Students	Nurses	Households & MSEM Students
Data Analysis							
Descriptive/Summary Statistics	✓	✓	✓	✓	✓	✓	✓
Group Comparison Tests: e.g. Mann-Whitney U Test		✓			✓		
Association and Correlation Analyses	✓	✓		✓	✓	✓	
Regression: OLS	✓	✓		✓		✓	✓
Regression: Ordered Probit	✓	✓				✓	✓
Regression: Probit				✓			✓
Content Analysis			✓				✓
Thematic Analysis					✓		

2. Chapter Two – Paper 1

The impact of gender on risk perception: implications for EU Member States' National Risk Assessment processes.

Brown, G.D., Largey, A. and McMullan, C., 2021. The impact of gender on risk perception: Implications for EU member states' national risk assessment processes.

International Journal of Disaster Risk Reduction, 63, p.102452.

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2.0 Abstract

This study examined the influence of gender on individual risk perception. The analysis covered 17 involuntary risks and examined the effects of gender on three dimensions - likelihood, impact and overall risk rating. The results showed that while the magnitude and significance of the gender coefficients varied by risk, a general pattern was apparent: females judged involuntary risks as being more likely, having a greater impact, or having a higher overall risk rating than their male counterparts. The impact rating for Fire was the one significant exception to this pattern. These findings highlight how the composition of National Risk Assessment (NRA) focus groups may impact the outputs from Ireland's NRA process and the importance of EU Member States ensuring gender representation within NRA focus groups.

2.1 Introduction

Member States of the EU are required to submit national, or appropriate sub-national level, risk assessments (NRA), every three years. Guidelines on the content, methodology and structure of the NRAs were made available to support Member States (Commission Staff Working Paper, 2010), but under Article 6 (1313/2013/EU), each Member State was free

to develop and refine the methodology underpinning the preparation of their NRA. This fluidity meant that “varying assessment methodologies and processes exist across Participating States” (Commission Staff Working Paper, 2017, p.50). However, common elements were identified across many member states; with multi-stakeholder working groups often being used to rate the likelihood and impact of national-level risks (Commission Staff Working Paper, 2017).

While the EU guidelines offered no guidance on the composition of such multi-stakeholder working groups, ISO IEC 31010 (2019), on risk assessment techniques, emphasised the importance of considering human aspects such as socioeconomic position, ethnicity, culture and gender when conducting risk assessments. Similarly, research on individual risk perception revealed that variables such as “gender, age, and educational attainment are often (though not consistently) found to be mediating factors in risk perception” (Sullivan-Wiley and Gianotti, 2017, p.139). Notwithstanding this lack of consistency, many studies of risk perception have suggested that gender can play a significant role, and studies showed that females tended to rate risk higher than males (Finucane *et al.*, 2000; Gustafson, 1998; Chauvin, 2018). The review by Chauvin highlighted that for a wide range of risks “from flood to earthquakes, from nuclear technology to environmental pollution, and from pesticides in food to cardiovascular disease” individual risk perception was impacted by gender (Chauvin, 2018, p.41). These differing perceptions of risk can impact how risk information is interpreted and output from the process are used (ISO 31010, 2019).

Considering this research, a lack of gender diversity within multi-stakeholder focus groups could have an adverse impact on the quality of output from a country’s NRA process. This topic required further research as not all studies showed gender to be significant (Sullivan-Wiley and Gianotti, 2017; Wachinger *et al.*, 2013), and the results differed depending on

the context, study and country, and risk type. For example, Lindell and Hwang (2008) in the United States and Kellens *et al.* (2011) in Belgium established that gender was a significant factor in flood risk perception. In contrast, the studies by Plapp (2001) in Germany, and Burningham *et al.* (2008) in England and Wales, found gender was not a significant factor in predicting flood risk perception. These contradictory findings raised the possibility that differences in research design, sampling, or additional less examined factors such as societal culture had an impact on the results. Therefore, in the context of NRAs, where multi-stakeholder focus groups were used to assess risk, it was unclear if a lack of gender diversity would influence the risk assessment process in each country. Although a vast body of literature on risk and gender existed, only a few studies examined the influence of gender systematically over a wide range of involuntary risks (Olofsson and Rashid, 2011; Finucane *et al.*, 2000; Flynn *et al.*, 1994). As a result, less is known about how the impact of gender varied by risk within one country and, more specifically, regarding risks drawn from NRAs. Studies involving NRAs across Europe (Vlek, 2013; Bossong and Hegemann, 2016; Lin 2018; Girgin *et al.*, 2019; Tómasson and Karlsson, 2020) focused on the methodologies deployed but did not examine the influence of gender. This paper fills this gap by examining the impact of gender on the assessment of 17 involuntary NRA risks by the Irish public. The impact of gender on likelihood, impact and overall risk rating was examined. It identified the risks which females rated as being more likely, or more impactful than males and ascertained whether females rated specific risks more highly than males. We revealed the influence that gender-biased multi-stakeholder focus groups might have on Ireland's NRA by pinpointing these effects.

The remainder of this paper is structured as follows: Section 1.1 provides an overview of the Irish NRA. Section 1.2 presents a literature review on the influence of gender on risk perception, drawing attention to studies that examined a wide range of risks and

differentiate between involuntary and voluntary risk. Section 2 introduces the methodology and defines the control variables. Section 3 provides the results of the analysis. Section 4 summarizes the study and illustrates how these findings could impact the Irish NRA.

2.1.1 National Risk Assessments: Policy & Practice

“A number of high profile crises and disasters have driven the EU to increase cooperation among its member states in the area of civil protection and to enhance its capacity to conduct civil protection operations in Europe and around the world” (Parker *et al.*, 2019, p.1313). An important aspect of this enhancement of civil protection across member states is the completion of NRAs and the subsequent sharing of outputs from these assessments with international and national stakeholders. The completion of coordinated NRAs should strengthen emergency management practice and increases EU and national resilience (Poljanšek *et al.* 2019). “The ability to analyse different types of information from diverse stakeholders is among the core challenges that risk analysts in any domain may confront” (Trimintzios and Gavrilă 2013, p.2). Depending on a country’s risk profile and data availability, several assessment methods may be leveraged, including focus groups and expert panels (Trimintzios and Gavrilă, 2013), i.e. multi-stakeholder working groups (Commission Staff Working Paper, 2017).

Many NRAs, such as those submitted by Belgium (2018), Denmark (2018), Finland (2018), Germany (2011), Ireland (2017), Lithuania (2015), Netherlands (2019), and Sweden (2012), referred to the contribution made by some form of multi-stakeholder working groups. For example, in Sweden (2012), workshops with relevant stakeholders from various state agencies and different levels of society were used to contribute to the final NRA. Notably, despite the influence which gender may have, the publicly available NRAs

mentioned above provided no information on the characteristics of those participating in the multi-stakeholder working groups.

In Ireland, the first NRA process completed in 2012 and those undertaken in 2017 and 2020 involved Government departments, state agencies, and each of the emergency management regions providing a list of risks that could trigger a national-level emergency. The NRA working group, comprising staff from the Office of Emergency Planning and academic experts, collated these risks into a consolidated list of risks. Once approved by the Government taskforce, in line with EU guidance on multi-stakeholder working groups, expert focus groups comprising of individuals with the appropriate combination of experience and knowledge came together to determine reasonable worse case scenarios and then assess the risk posed by each of the risks on the consolidated list of risks. The participants first assessed the likelihood of each risk occurring, followed by the potential impact. The focus groups were replicated to maximise the reliability and validity of the risk assessments. After completing several focus groups, the working group combined the results to form the Irish NRA. While the 2017 process was robust and in line with EU guidance, gender representation and diversity within each focus group was not reported. By examining the influence of gender on likelihood, impact and overall risk rating, this paper illustrates how a lack of gender representation and diversity within the NRA process could influence the outputs.

2.1.2 Risk Perception & Gender

Within the risk analysis literature, much attention has been paid to the inconsistency of findings from one study to the next. Differences between the impact of gender on risk perception have been attributed to pan-national variance: cultural, social, or gender equality differences between nations (Boholm, 1998; Olofsson and Rashid, 2011). This socio-

political hypothesis, originally posited by Flynn *et al.* (1994), is described by Chauvin (2018) as the most plausible explanation for the varying impact of gender on risk perception. The hypothesis suggests that “white males see less risk in the world because they create, manage, control, and benefit from so much of it” (Flynn *et al.*, 1994, p.1107). This is, in part, because of the inherently subjective nature of risk perception; where social, cultural and political values, along with psychological factors, can interact and influence an individual’s assessment of risk (Slovic, 2016).

Also, of central importance is whether the risk is voluntary or involuntary because having control over one’s potential risk exposure may influence risk perception (Gardoni and Murphy, 2014). Individuals perceive they have less control over involuntary risks (Starr, 1969; Gardoni and Murphy, 2014) and are “willing to accept ‘voluntary’ risks roughly 1000 times greater than ‘involuntary’ risks” (Starr, 1969, p.1237). This distinction between voluntary and involuntary risks may also result in different criteria being applied when evaluating the level of risk posed (Starr, 1969).

Studies which focused on large numbers of risks tended to include both involuntary and voluntary risks and often merged some risks to form broader constructs (Olofsson and Rashid, 2011; Satterfield *et al.*, 2004; Finucane *et al.* 2000; and Flynn *et al.* 1994). Flynn *et al.* (1994), for example, combined storms and floods, while Olofsson and Rashid (2011) and Satterfield *et al.* (2004) included ‘natural disasters’ as one risk. By exploring a wide range of risks, these studies were able to present risk perception patterns based on gender (Olofsson and Rashid, 2011; Satterfield *et al.*, 2004; Finucane *et al.*, 2000; and Flynn *et al.*, 1994). The Finucane *et al.* (2000) analysis of 19 health risks and eight food-related risks showed that for the entire range of risks white males generally perceived less risk than females and other races, which echoed the findings of Flynn *et al.* (1994). On the other

hand, Olofsson and Rashid's (2011) Swedish study of 17 risks, including smoking, alcohol, climate change and 'natural disasters', found no general differences based on gender. They suggested that in Sweden, this could be accounted for by the relative equality between genders. However, it should be noted that four risks: climate change, 'natural disasters', accidents related to leisure activities, and stress, were significantly impacted by gender. While no concrete conclusion can be drawn from the result, it highlighted that the impact of gender on risk perception might fluctuate depending on the type of risk measured within a country. In other words, among one sample, the relationship between gender and risk rating was not consistent. Further, the combining of a range of risks into one construct (e.g. 'natural disasters') made it difficult to assess the impact of gender for a specific risk such as flooding within the context of the broader risk construct.

Of the studies which included involuntary risks a sizeable portion showed a significant relationship between gender and risk perception (Brody, 1984; Flynn *et al.*, 1994; Finucane *et al.*, 2000; Peacock *et al.*, 2005; Armaş, 2006; Lindell and Hwang, 2008; Kellens *et al.*, 2011; Lujala *et al.*, 2015). For instance, in the early investigation of individuals' risk perceptions towards nuclear plants, Brody (1984) found that females felt less safe and reported a higher degree of dissatisfaction with atomic power due to the associated health risks. However, some studies reported no significant findings between gender and risk perception (Siegrist and Gutscher, 2006; Plapp and Werner, 2006; Whitfield *et al.*, 2009; Akompab *et al.*, 2013; Knuth, *et al.*, 2015).

While inconsistencies in empirical results existed, differences in research design, sampling and choice of control variables made it difficult to compare the published findings accurately. For instance, multiple forms of analysis were used, including structural equation modelling (Whitfield *et al.*, 2009), logistic regression (Akompab *et al.*, 2013; Lujala *et al.*,

2015), and ordinary least squares (OLS) regression (Saleh *et al.*, 2012). In other cases, there were notable differences between the selection of control/explanatory variables for each study. Although demographic factors such as income/economic condition or age were commonly included in such studies on risk (Donner and Rodríguez, 2008; Lindell and Hwang, 2008; Saleh *et al.*, 2012; Lujala *et al.*, 2015), the inclusion of other factors like past experience (Peacock *et al.*, 2005; Lindell and Hwang, 2008), political orientation/ voting behaviours (Saleh *et al.*, 2012; Lujala *et al.*, 2015), years in location (Peacock *et al.*, 2005), and climate-related variables (Saleh *et al.*, 2012; Lujala *et al.*, 2015) was not consistent across all studies. Finally, the involuntary risk constructs also presented a challenge for pattern analysis. Some used broad risk constructs: e.g. technological (which included risks such as radiation and pesticides) and, non-technological risks (which included risks such as extreme weather and crime) (Siegrist *et al.*, 2005), or the risk of climate change using indicators like the impact on oneself; family; plants and animals (Saleh *et al.*, 2012), while other studies focused on a single specific involuntary risk such as volcanic risk perception (Barberi *et al.*, 2008) or earthquakes (Armaş, 2006; Kung and Chen, 2012). Even for the same risk, e.g. earthquakes, differences emerged regarding how risk perception was presented. In some instances, risk perception, as the dependent variable, was reported as one measure (Armaş, 2006). In other cases, multiple dependent variables were used; e.g. Kung and Chen (2012, p.1535) focused on the categories of personal impact and controllability (defined as “a sense of efficacy of self-protection in regard to earthquakes”). Knuth *et al.* (2015, p.597) suggested that an explanation for gender having no significant effect on risk perception could be connected to the dimension of risk measured. For example, they measured likelihood (perceived and objective) and found gender was not a determinant but did not test for a relationship with impact or overall risk rating.

In summary, differences in methods of analysis, control variables, and broad or narrow risk constructs made it difficult to determine whether a pattern exists across involuntary risks. Evidence suggested that gender differences in risk perception can vary by risk, but this required further analysis (Boholm, 1998; Byrnes *et al.*, 1999). As a result, the literature provided limited insights into the influence that gender-biased multi-stakeholder focus groups might have on the Irish NRA. To examine changes in the impact of gender by risk, a wide range of risks was studied, the effect of gender on likelihood, impact and overall risk ratings was identified, and only single or standalone involuntary risks were examined.

2.2 Methods

A questionnaire designed to examine the influence of gender on individuals' rating of involuntary risks was administered online (using Qualtrics software) and in paper format. Participants were members of the general public who could opt-in voluntarily once they had read the plain language statement. To reduce evaluation apprehension participants' anonymity was guaranteed. Twitter and Facebook were used to promote the questionnaire online, and it was also promoted on social media by government and public agencies, such as the Met Éireann (the national meteorological service), County Councils, the Office of Emergency Planning, and Dublin Fire Brigade. Each questionnaire took approximately 20 minutes to complete, and all data was collected within 2016.

The analysis included data from 1977 respondents, of whom 59.1% identified as female, and was carried out using the statistical software package STATA (StataCorp; Release 14.2/SE). The sociodemographic characteristics of those surveyed matched the Irish census data closely. The Central Statistics Office, Ireland (CSO, 2016a) data shows for adults (aged 20 years and over), there are slightly more females than males in Ireland (4.9%), giving a 4.2 percentage point (pp) difference between our data and the national census data.

Household income (66.8% earn less than €70,000) and homeownership (77.8%) were also reasonably representative of the national data (67.6% homeownership; income: 62.6% had a gross income of less than €60,000) (CSO, 2016b; CSO 2016c). However, there was under-representation (19.9 percentage points) from respondents in the 55 or over age range (CSO, 2016d). Finally, as the latest CSO (2016e) data shows that the ethnicity of Ireland is predominately white (92.4%) this factor was not measured.

The cross-sectional questionnaire was developed for an Irish context and was informed by both government and academic questionnaires (FEMA, 2014; Grothmann, and Reusswig, 2006; Terpstra and Lindell, 2013). To help ensure accuracy and validity, the questionnaire was pilot tested on specialists in emergency management and members of the general public.

As preliminary tests for association between females and each of the likelihood, impact and risk rating variables Goodman and Kruskal's Gamma statistic were computed. The outputs are provided in Supplementary Table 1 in the Appendix. Polychoric correlations for likelihood and impact measures are provided in Supplementary Table 2 in the Appendix.

Ordered probit analysis with marginal effect calculations and OLS regression were used to estimate the impact of gender on the three distinct components of 17 involuntary risks (likelihood, impact and risk rating). These 17 risks were drawn from the 29 risks assessed as part of the 2017 Irish NRA process (see McMullan *et al.* 2018). Including natural, technological and civil risks allowed us to explore differences in perception for risks from the same category, for example, floods and storms. It should be noted that although the term "natural" is used in the NRA, the term socio-natural is preferred as it allows for the intersection between natural hazards and human activity; risk and emergencies are rarely, if ever, totally natural events. The 12 excluded risks were less relevant to household settings

and covered five transportation risks (Aviation, Maritime, Road, Rail, Transport Hubs), Crowd and Public Safety, Industrial and Hazmat Incidents, Tsunami, Space Weather and Volcanic Ash. Using 17 risks drawn from the NRA allowed us to assess the most credible risks for an Irish context, and compare the findings with the output from the NRA.

To isolate the effect of gender on respondents' perception of risk, control variables (discussed below) were selected and used consistently throughout all 51 regressions. This resulted in the following general form for each of the preparedness variables:

$$\begin{aligned} &\textit{dependent variable} \\ &= f[\textit{gender, socio-demographics, risk exposures, household preparedness, non} \\ &\quad \textit{protective responses}] \end{aligned}$$

Before beginning the analysis, variance inflation factor (VIF) values were used to check for multicollinearity. A VIF score of five or above indicates multicollinearity. The results show VIF scores within acceptable limits (O'Brien, 2007) having a maximum VIF of 2.27 and a mean VIF of 1.39.

Only the regression coefficients and marginal effects of the independent variable gender (female) are reported. See supplementary Tables 3-5 in the Appendix for three examples of the complete regression outputs, along with the regression outputs in table format. Marginal effects provided an additional illustration of the impact of gender on risk, quantifying the effect in probability terms. For each risk, we outlined the difference in probability of particular responses for females compared to males. These were computed with all other explanatory variables (see Table 2.1) set to their mean scores. By showing the extent to which the impact of gender was dispersed across each point on the scale (likelihood and impact) for the 17 risks, our research expanded and deepened the work of Kung and Chen (2012) and others while allowing us to determine the importance of gender representation in the NRA assessment process.

2.2.1 Variable Definitions - Dependent Variables

While there are many definitions of risk, most incorporate three common facets: the source of the risk, the likelihood (uncertainty), and the impact (consequence). The ISO (31000, 2018: 3.1) definition states: ‘Risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood’. As outlined by Brown *et al.* (2021) risk rating, likelihood and impact should be analysed individually to allow for a more nuanced understanding of the dimensions which are influenced by gender. In this study, we asked respondents to assess the likelihood of the risks affecting them or their home and, should an emergency be triggered, the level of impact they would experience. Likelihood was measured using a five-point scale with one for ‘extremely unlikely’ to five for ‘very likely’. Impact was also measured on a five-point scale with one representing ‘very low impact’ up to five for ‘very high impact’. To measure an individual’s overall risk rating for each of the 17 risks, we multiplied the likelihood and impact ratings together, in line with international practice. To control for priming effects and the possible impact of reduced cognitive effort, questions on likelihood and impact ratings were frontloaded and demographic data collected towards the end of the questionnaire. Each point on the Likert scale was assigned a descriptive label, and the endpoint labels did not contain absolute terms, such as “impossible”, which respondents may be less willing to choose.

The perceived likelihood, perceived impact, and the overall risk rating for each of the 17 risks were used as the dependent variables in the regression models. These risks were selected from three categories of the National Risk Assessment for Ireland: natural, technological and civil. The six natural risks considered were: Flooding, Drought, Snow, Storm, High Temperatures and Low Temperatures. The five technological risks were: Fire, Disruption to Energy Supply, Nuclear Incident Abroad, Radiation (Domestic) and Cyber Incident. The six civil risks were: Loss of Critical Infrastructure (e.g. Water), an Infectious

Disease Affecting Humans, an Infectious Disease Affecting Animals, Waterborne Disease Outbreak, Foodborne Disease Outbreak and Terrorism.

Since the dependent variables for likelihood and impact were ordered categorical variables, an ordered probit model was used for each. To interpret the estimated parameter coefficients of the ordered probit, the marginal probability effects were calculated and presented separately. The overall risk rating was treated as a continuous variable and analysed using a standard OLS regression model.

2.2.2 Variable Definitions - Independent Variables

The choice of independent variables was informed by protection motivation theory which shows experience and socioeconomic characteristics influence risk perception (Rogers, 1983; Rogers and Prentice-Dunn, 1997). Kellens *et al.* (2013, p.44) suggest the “most important characteristics seem to be age, gender, education, income, and home ownership”. Tobin and Montz (1997 cited in Lechowska, 2018) also suggest that the presence of a child in the household should be measured.

Gender was the key independent variable of interest in our study. It was coded as a dummy with ‘1’ assigned if the respondent declared as female and ‘0’ if they identified as male. The remainder of the socioeconomic factors were used as independent control variables and are listed in Table 2.1.

Respondents’ direct exposure to each of the 17 risks was measured using a self-reported check (dummy: yes/no measure) for each risk. These 17 dummy variables were summed to produce a construct: risk exposure, which measured the range of prior exposures to varying risks. This experience was not limited to their household setting to capture respondents with broader experience, such as those working in emergency response roles.

Lechowska's (2018) review of the risk perception literature on floods emphasised that while there remains an unclear relationship between risk perception and preparedness, it was likely a respondent could present with a lower risk perception score if they had already undertaken some preparedness activities. For this reason, our analysis also controlled for preparedness using two constructs: respondents' emergency preparedness based on a Household Preparedness Score and non-protective responses.

The first construct, Household Preparedness Score, drew from a list of 24 emergency items and actions which were used to measure household preparedness. In line with prior research, the list of items was split into three categories: evidence of planning; protective actions; and emergency resources (Brown *et al.* 2021). The scores for planning, action and resources were z-transformed separately, then summed and averaged to generate the Household Preparedness Score. This approach was followed to achieve equal weighting for each category within the construct. The Household Preparedness Score was checked for reliability using Cronbach's alpha, which was calculated using the three scores from the individual preparedness categories (Cronbach's $\alpha=.70$).

The second preparedness construct, non-protective responses, controls for denial, wishful thinking or fatalism among respondents (Grothmann and Reusswig, 2006). This construct was drawn from two lines of questioning:

- (1) Respondents who said they did not want to think about preparedness, or respondents who said they would not prepare because the 'emergency services will help me' were coded as a dummy with '1' applied, '0' otherwise.

For each of the 17 risks, respondents were asked if there was anything they could do to prepare. These responses were also coded as dummy measures, where '1' applied if the respondent said 'no'.

These responses were subsequently summed to form the ‘non-protective response’ scale ranging from 0 to 19 (19 indicating a high level of non-protective responses). Non-protective responses had a Cronbach’s $\alpha=.89$.

Table 2.1 Independent Control Variables Used in Regressions and Marginal Effect Calculations

Characteristic	Value	Description
Household (1977n)		
Child in the home	44.4% (872n)	1 for child in the home, 0 otherwise
Owns the home	77.8% (1536n)	1 for homeownership, 0 otherwise
Age (1977n)		
34 or under	38.4% (760n)	1 if aged 34 or under, 0 otherwise
35-54	49.3% (975n)	1 if aged 35-44, 0 otherwise
55 or older	12.2% (242n)	1 if aged 45 or older, 0 otherwise
Lives in (1977n)		
A city	17.3% (342n)	1 for city, 0 otherwise
The suburbs or outskirts of a city	10.1% (199n)	1 for Suburbs, 0 otherwise
A town	19.7% (389n)	1 for town, 0 otherwise
A village	26% (515n)	1 for village, 0 otherwise
A rural area	26.9% (532n)	1 for rural area, 0 otherwise
Years living at current address (1970n)		
Mean (SD)	12.56 (10.45)	
Mode	10	
Median (min, max)	10 (<1, 100)	
Household Income (1603n)		
Below 30,000	19.5% (321n)	1 for income below 30,000, 0 otherwise
30,000-70,000	47.3% (759n)	1 for income 30,000-70,000, 0 otherwise
Over 70,000	33.2% (532n)	1 for income over 70,000, 0 otherwise
Higher Education (1968n)		
Has a Degree or above	71.8% (1413n)	1 for degree or above, 0 otherwise
Household Preparedness Score (Z-Score) (1935n)		
Mode	1.031	
Median (min, max)	0.043 (-2.256, 1.841)	
Non-protective responses (1850n)		
Mean (SD)	3.35 (3.55)	
Mode	0	
Median (min, max)	2 (0, 19)	
Risk Exposure (1974n)		
Mean (SD)	5.20 (2.99)	
Mode	4	
Median (min, max)	5 (0, 17)	

2.3 Results

The 17 modal scores by gender were plotted on a radar chart together with the outputs from the NRA (2017), see Figure 2.1. The figure showed the modal score for 10 of the 17 risks were the same for both male and female respondents. For these, a comparison with the NRA (2017) data revealed there was agreement between males, females and the NRA for only two risks, Nuclear and High Temperatures. Food Borne Disease and Infectious Disease (Human) received a higher rating in the NRA, while Storm, Low Temperatures, Fire, Loss of Critical Infrastructure, Infectious Disease (Livestock), Water Borne Disease were rated as posing a lower level of risk.

For the seven risks where there was a difference between the females and males scores, the risks were judged higher in all but one case by females. Drought was the only risk which was rated higher by males (a modal score of 3 for males and 2 for females). The most substantial gender difference in risk rating was for Radiation (domestic), which had a modal score of 4 for males and 15 for females. For this set of risks, the NRA scores were closer to those of females for Flooding, Disruption to Energy Supply and Cyber Incident and closer to those of males for Drought, Snow, Radiation (Domestic) and Terrorism.

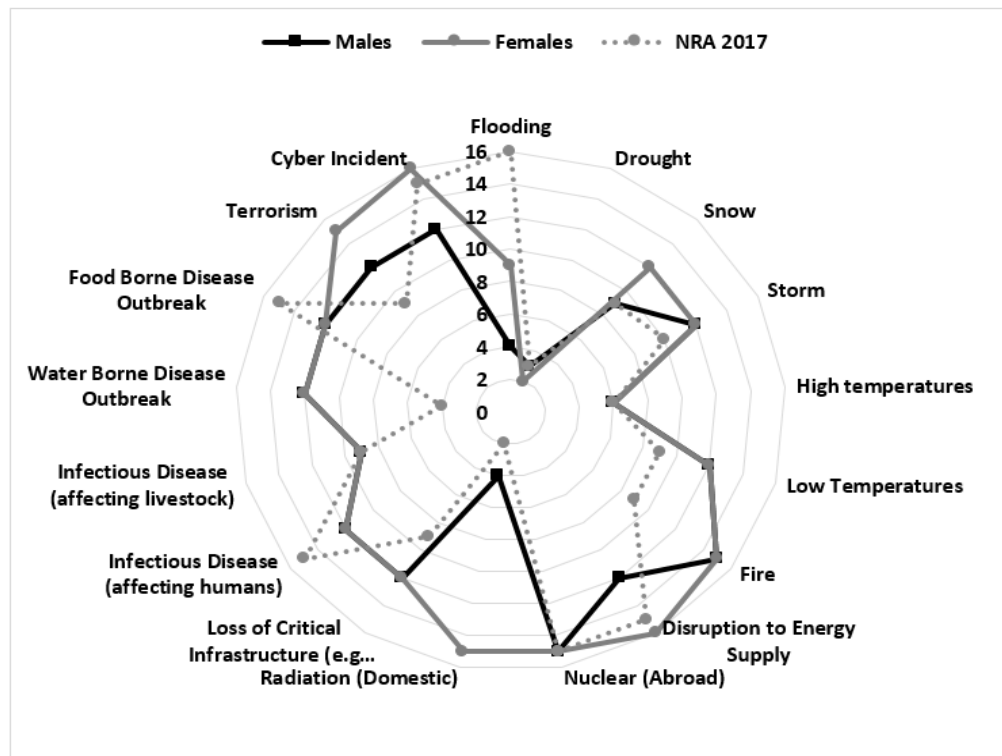


Figure 2.1 Overall Risk Rating (Modal) for Females, Males, and the NRA (2017)

The descriptive analyses presented in Figure 2.1 helped to visualise the differences in the impact of gender on each of the 17 risks in Ireland, and though the findings suggested seven risk ratings might be influenced by gender, a more comprehensive analysis was required. To investigate further the relationship between gender and risk, when controlling for risk exposure, non-protective responses, preparedness and socioeconomic factors (see Table 2.1), regression analytical tests were required. Figure 2.2 visualises the results of these regressions and are representations of the data provided in Supplementary Table 6 in the Appendix.

Figure 2.2 was used to illustrate the influence of gender on the assessment of overall risk, likelihood and impact ratings. The results for each risk were plotted in ranked order on a candlestick stock chart with gender coefficients as the centre point and the low and high shadow lines representing the upper and lower 95% confidence interval limits. Figure 2.2

provides a helpful illustration of the extent to which the impact of gender varied by risk when controlling for the factors listed in Table 2.1.

The likelihood and impact coefficients for gender were calculated using an ordered probit model. Figure 2.2 showed the gender coefficients from the ordered probit models of risk likelihood and risk impact rating results (by order of magnitude). For risk likelihood, chi-squared values and log likelihoods ranged between $\chi^2(16) = 54.12$, $p < 0.001$ (Fire, Log-Likelihood = -1753.07) and $\chi^2(16) = 169.84$, $p < 0.001$ (Terrorism, Log-Likelihood = -2032.69). Gender (females) was shown to be significant and positive in 15 of 17 likelihood regressions. This suggested that when we controlled for the other factors (Table 2.1), females consistently judged the likelihood of these risks triggering an emergency as higher than males. The risk impact chi-squared values and log likelihoods ranged between $\chi^2(16) = 36.21$, $p = 0.003$ (Fire, Log-Likelihood = -1672.34) and $\chi^2(16) = 112.18$, $p < 0.001$ (Low Temperatures, Log-Likelihood = -1896.49).

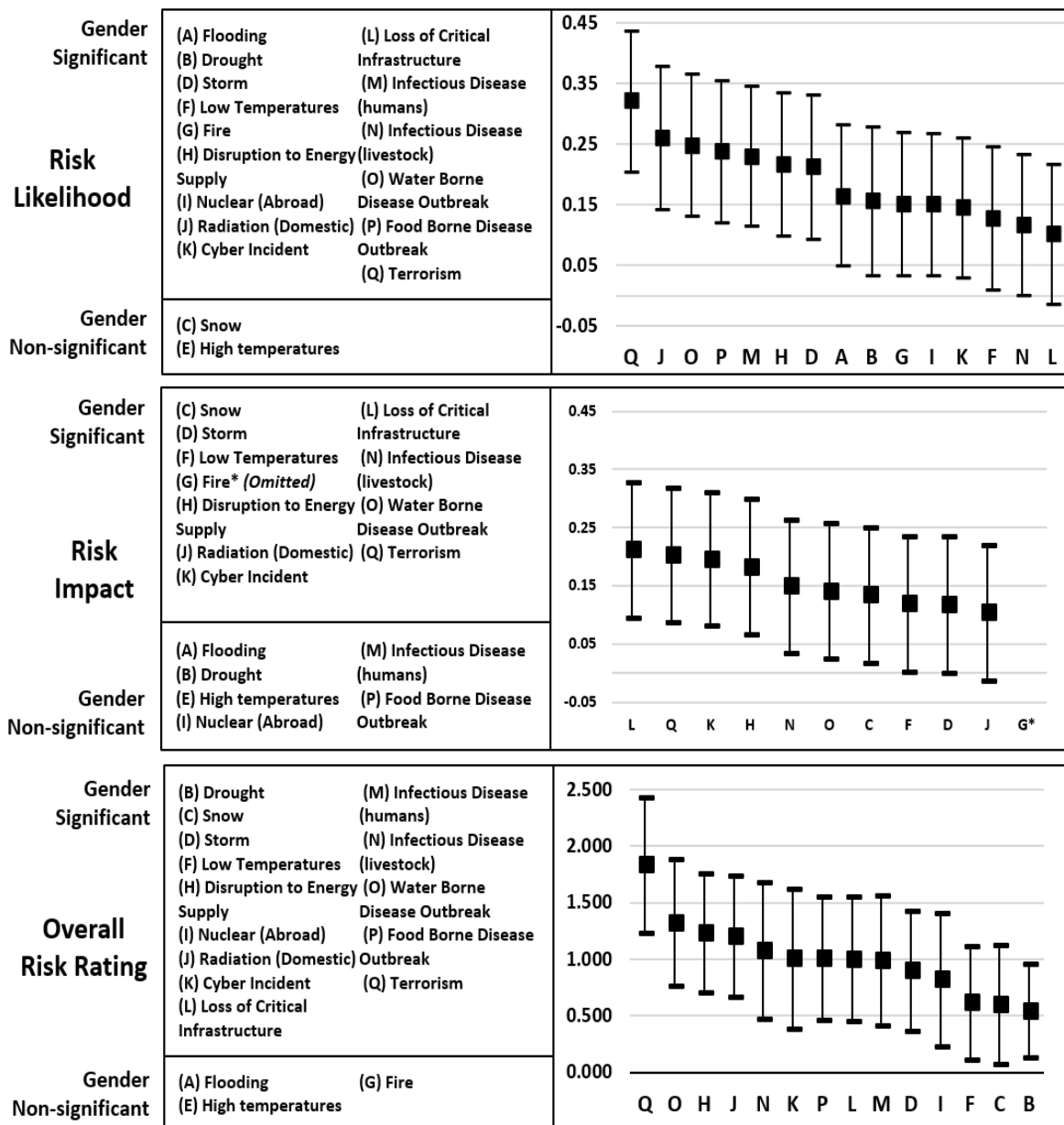


Figure 2.2 Coefficients on Gender (Female) from Ordered Probit Analysis

Note: Gender coefficients values are provided on the vertical axis; coefficient significance is reported in Supplementary Table 6 and ranges between $p < 0.1$ & $p < 0.01$. “Fire G*” is omitted from “Risk Impact” due to the negative coefficient ($\beta = -0.115$).

Figure 2.2 coefficients on gender (female) from ordered probit analysis of risk impact ratings showed the relationship between females and the risk likelihood rating was positive and significant for 15 of the 17 risks. Only the likelihood ratings for snow and high temperatures presented as having a non-significant effect with gender. The gender

coefficient was significant in fewer of the risk impact ratings, although significant differences remained for 11 of the 17 risks. In 10 of the 11 risks (excluding Fire – risk impact rating), the results showed the relationship between being female and assessment of risk impact was positive and significant. From these results, the conclusion can be drawn that gender has a significant effect on likelihood and impact ratings in Ireland and that the strength of the association varied by risk component.

An OLS regression was run for each of the 17 risks to examine the effect of gender on overall risk rating (i.e. likelihood multiplied by impact), and the results are also reported in Figure 2.2 (overall risk rating). The gender (female) coefficient was positive and significant in 14 OLS regressions, showing that, when controlling for risk exposure, non-protective responses, household preparedness and sociodemographic factors (see Table 2.1) being female had a significantly positive influence on the respondents' overall risk ratings. The OLS gender (female) coefficients ranged between $\beta=0.563$ (Drought) and $\beta=1.856$ (Terrorism), with the largest gender differences observed for Terrorism, Disruption to Energy Supply, Waterborne Disease Outbreak, and Radiation (Domestic). The lowest significant gender differences were evident for Drought, Snow, and Low Temperatures with values of $\beta=0.563$, $\beta=0.618$, and $\beta=0.636$, respectively. Furthermore, for this Irish sample, the Risk Ratings for Flooding, High Temperatures and Fire were found not to be significantly impacted by gender. The conclusion drawn from these results suggested the impact of gender on overall risk ratings fluctuates by risk highlighting the gender impact was not consistent when Table 2.1 factors are controlled.

Having established a variation in the impact of gender on risk ratings (overall risk, likelihood and impact), the subsequent analyses explored more deeply the components of

risk: likelihood and impact ratings, using the marginal effect calculated from the ordered probit analysis in Supplementary Table 6 in the Appendix and Figure 2.2.

Tables 2.2 and 2.3 set out the marginal effects of gender on perceived likelihood and impact of a risk, based on the ordered probit analysis. These tables report the difference in the probability of a female as opposed to a male stating each response (on the risk likelihood or impact scale), having controlled for all other explanatory variables (Table 2.1) and evaluated at the mean values of these explanatory variables. The marginal effect calculations helped to quantify the gender differences in likelihood and impact assessments for each risk. In addition, the point estimates of the marginal effects showed, for each risk component, how the impact of gender varied by risk rating.

In line with the positive coefficient on ‘female’ reported in the ordered probit regressions, the associated marginal effects reflect a redistribution of probabilities away from stating lower levels of likelihood towards higher categories. Overall, the marginal effects in Table 2.2 (part A) show that for the statistically significant risks being female decreases the probability that the individual will state the risk likelihood rating is ‘Extremely Unlikely’. For example, females were 10 percentage points less likely than males to say Terrorism was ‘Extremely Unlikely’; 8.4 percentage points less likely to say Radiation (Domestic) was ‘Extremely Unlikely’; and 5.6 percentage points less likely to say Flooding was ‘Extremely Unlikely’. Overall, Snow and High Temperature both resulted in non-significant estimates, suggesting no impact from gender when all other explanatory variables equal their mean score in the model. Of the statistically significant estimates, the risk likelihood rating for Loss of Critical Infrastructure was least affected by gender, with Terrorism presenting as being one of the risks most affected by gender.

Table 2.2 Ordered Probit Analysis: Marginal Effect of Gender on Likelihood (part A) and Impact (part B)

		Gender: Likelihood (Part A)				
		Extremely Unlikely	Very Unlikely	Unlikely	Likely	Very Likely
Natural Risks	Flooding	-5.6%***	-1%***	2.8%***	2.8%***	1%***
	Drought	-6.2%**	0.7%**	3.5%**	1.4%**	0.5%**
	Storm	-1.6%***	-2.3%***	-4.1%***	3.7%***	4.3%***
	Low Temperatures	-1.2%**	-1.7%**	-2.2%**	3.2%**	1.9%**
	Fire	-1.3%**	-2.3%**	-1.8%**	4%**	1.4%**
Technological Risks	Disruption to Energy Supply	-1.1%***	-2.6%***	-4.9%***	4.6%***	4%***
	Nuclear (Abroad)	-4.8%**	-1.3%***	2.5%**	2.8%***	0.8%**
	Radiation (Domestic)	-8.4%***	-2.0%***	6.0%***	3.5%***	0.9%***
	Cyber Incident	-2.6%**	-2.1%**	-1%**	3.6%**	2.1%**
	Loss of Critical Infrastructure	-1%*	-2%*	-0.7%*	2.7%*	1%*
Civil Risks	Infectious Disease (humans)	-4%***	-3.8%***	-0.3%	6%***	2.1%***
	Infectious Disease (livestock)	-3.1%**	-1.4%**	0.3%	3.1%**	0.9%**
	Water Borne Disease Outbreak	-4.7%***	-4.3%***	1.7%***	5.7%***	1.6%***
	Food Borne Disease Outbreak	-3.8%***	-4.5%***	1.1%***	6%***	1.2%***
	Terrorism	-10.0%***	-2.7%***	4.6%***	6.2%***	2.0%***
		Gender: Impact (Part B)				
		Very low Impact	Low Impact	Moderate Impact	High Impact	Very high Impact
Natural Risks	Snow	-1.3%**	-2.9%**	-0.8%**	3.4%**	1.6%**
	Storm	-0.6%*	-2.4%**	-1.7%**	3.1%**	1.6%**
	Low Temperatures	-1.5%**	-3.1%**	1%*	2.9%**	0.7%**
	Fire	0.4*	0.9*	1.5*	1.8*	-4.6*
Technological Risks	Disruption to Energy Supply	-1.1%***	-3.4%***	-3%***	3.5%***	4%***
	Radiation (Domestic)	-1.6%*	-1.7%*	-0.9%*	0.7%*	3.6%*
	Cyber Incident	-2.9%***	-3.6%***	-1.3%***	3.5%***	4.3%***
	Loss of Critical Infrastructure	-1.5%***	-2.5%***	-3.8%***	0.8%**	7%***
Civil Risks	Infectious Disease (livestock)	-3.4%***	-2.3%***	-0.1%	2.5%***	3.3%***
	Water Borne Disease Outbreak	-1.5%**	-2%**	-2%**	1.1%**	4.5%**
	Terrorism	-3.7%***	-2.9%***	-1.6%***	1.7***	6.5%***

Note: *p<0.1, **p<0.05, ***p<0.01. Non-significant variables removed.

Table 2.2 (part B) reported the difference in the predicted probability of each response for a female compared to a male, controlling for all other explanatory variables. In line with the results on ‘female’ reported in the ordered probit regressions, the results in Table 2.2

(part B) show considerable variation for the significance of gender on each of the 17 risk impact ratings. A total of six risk impact ratings were found not to be significantly affected by gender, which was the largest grouping of non-significant gender results in any of our analysis. This suggested the effect of gender on risk not only varied by risk, but also for each risk, there was a different effect on likelihood and impact ratings.

Overall, Table 2.2 (part B) showed that for all significant risks but one (Fire), the predicted probability of a female classifying the impact of a risk as ‘High’ and ‘Very High’ was larger than for a male respondent. In Table 2.2 (part B), the greatest gender differences were evident for Loss of Critical Infrastructure and Terrorism, where the probability of females perceiving these two risks as ‘Very high’ was 7 and 6.5 percentage points more than for males. But, in the case of the risk impact rating for Fire, the pattern changed. For Fire, the marginal effect of being female was negative for ‘Very high Impact’ as opposed to positive. This was the only risk where this significant gender shift occurred and is in line with the significant negative coefficient on ‘female’ reported in the ordered probit regression for the impact rating of Fire. This suggested that males had a higher probability of rating the impact of Fire higher than females.

2.4 Discussion & Conclusion

Against the backdrop of Article 6 of the European Union Civil Protection Mechanism (Council Decision 1313/2013/EU), NRA guidelines provided vital direction on the risk assessment process for the Member States (Commission Staff Working Paper, 2010; 2017; Poljanšek *et al.*, 2019). There was no reference, however, to ensuring gender representation within the NRA. The significance of this omission was difficult to determine at the outset of this study as less was known about how the impact of gender varied by risk within one country and, most specifically, regarding involuntary risks drawn from an NRA. Therefore,

using 17 involuntary risks taken from the Irish NRA, this study tested the influence of gender on likelihood, impact and overall risk rating using a sample of 1977 respondents. Appropriate risk selection was vital to achieving our goal, especially as some previous studies had combined risk constructs, e.g. Flynn *et al.* (1994) joined storms and floods. This methodology allowed us to reveal that gender had a broad and varied influence on risk rating and that the risk components, likelihood and impact, were affected differently across a variety of involuntary risks.

The first stage of the analysis compared the modal risk ratings for both genders with the 17 risks reported in the NRA (2017). Knuth *et al.* (2015) examined the alignment of perceived risk (likelihood) and objective risk (likelihood) for five involuntary risks (terrorism, traffic accidents, flood, domestic fire, public fire) among members of the general population, some of whom had experiences of an emergency. The results of their study indicated “an impact of gender as well as emergency experience on the accuracy of risk perception” (Knuth *et al.*, 2015, p.592). They found that “although men and women with no emergency experiences underestimated their specific objective risks for fire and traffic accidents, women were much closer to their objective risks than were men. This trend was also found in the general-s [group of general survivors] sample. Men underestimated both risks whereas women estimated both risks correctly.” (Knuth *et al.*, 2015, p.592). Although the methodologies between the two studies are not directly comparable, the NRA outputs can be viewed as an expert opinion against which the risk ratings by females and males can be compared. The results in Figure 2.3 confirm the Knuth *et al.* (2017, p.596) finding that “it should not be assumed that men and women will always perceive their risk differently to either objective estimations of the risk or to each other”.

For clarity, the regression results from stage two of the analysis are summarised in a Venn diagram (Figure 2.3) showing the significance of gender on likelihood, impact and overall risk rating.

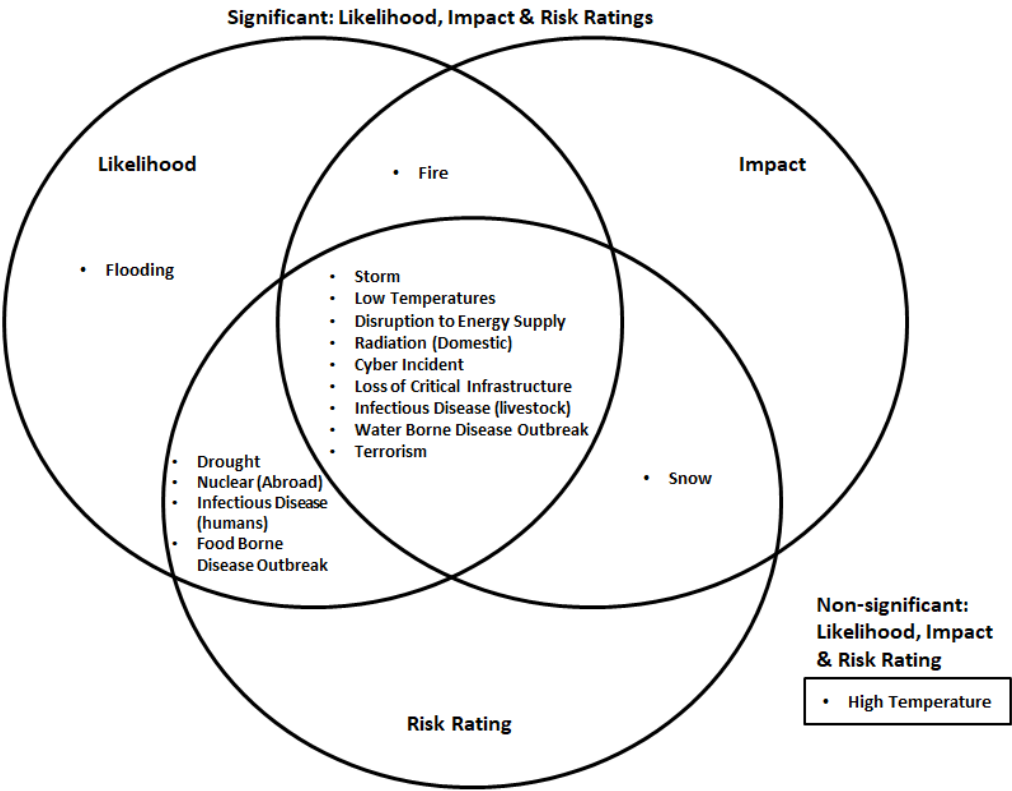


Figure 2.3 Venn diagram outlining the significance of gender on each component of risk

In summary, the results of the regressions indicated that gender was significant across many of the 17 involuntary risks, with the coefficient on gender significant in a total of 40 of the 51 regressions (which controlled for the other factors in Table 2.1). More specifically, the analysis showed that gender was significant for 15 likelihood risk ratings; 10 impact risk ratings; and 14 overall risk ratings. These results indicated higher risk ratings for females rather than males. All other results were insignificant apart from the fire impact rating, which males rated higher than females. Generally, these results supported previous studies that had included involuntary risks within the analysis (see Brody, 1984; Flynn *et al.*, 1994; Finucane *et al.*, 2000; Peacock *et al.*, 2005; Armaş, 2006; Lindell and Hwang, 2008; Kellens *et al.*, 2011; Lujala *et al.*, 2015). These results also contradicted studies that had

shown no significant relationship between gender and risk rating (see Siegrist and Gutscher, 2006; Plapp and Werner, 2006; Whitfield *et al.*, 2009; Akompab *et al.*, 2013). Most importantly, as previously discussed, these prior studies were typically unsuitable for comparison due to small differences in research design, variations in control variables included, and the coding of some involuntary risks (e.g. combining involuntary risks into one construct, such as ‘natural disasters’). Hence, selecting natural, technological and civil risks from the Irish NRA allowed us to explore subtle differences in the risk ratings across the Irish sample.

These findings supported the earlier premise that gender had a varying influence on likelihood and impact ratings for the set of involuntary risks. For example, the results showed the likelihood rating for Infectious Disease (affecting humans) was impacted by gender; yet the impact rating was not. Where significant differences were found, the predicted probabilities of a female, compared to a male, classifying the risk likelihood as ‘Likely’ and ‘Very Likely’ ranged from 1.9 percentage points higher for Drought to 8.2 percentage points higher for Terrorism. Similarly, the probabilities that females would rank risks as having ‘High Impact’ and ‘Very High Impact’ ranged from 3.6 percentage points higher for Low Temperatures, to 8.2 percentage points higher for Terrorism, compared to males.

In Ireland, participants of the focus groups first assessed likelihood and then impact for each risk. By examining the marginal effects for both the likelihood and the impact ratings, this study showed that Terrorism, Cyber Incident, Water Borne Disease Outbreak, Storm, Disruption to Energy Supply, and Loss of Critical Infrastructure had the greatest potential exposure to different outputs in the absence of gender representation. These empirical findings suggested that a failure to ensure gender representation within the NRA focus

groups has the potential to impact the assessment of certain risks more negatively than others.

Emergencies have also been shown to affect females and males differently (Neumayer and Plümper, 2007), and this difference could affect risk rating; further justification for gender representation within the NRA focus groups. Focus groups collect rich data from participants' discussions and interactions (Morgan, 1988; Morgan, 2012). In a risk assessment context, diversity, including gender representation, should help ensure a platform where different viewpoints on risk can be discussed. Gender diversity should lessen the chances of under or overestimation of risk. We recommend countries use diverse multi-stakeholder focus groups. To ensure gender representation, stakeholders should be encouraged to send both male and female experts, and data on the composition of the focus groups should be reported within the NRA documents. In line with the EU Joint Research Centre recommendation (Poljanšek *et al.*, 2019), an input from the general public is also proposed as it presents an opportunity to include a more diverse range of opinions within the NRA. This recommendation has been adopted by the Irish Government, and public risk assessments form part of the NRA (2020) methodology.

Future research could test the impact of diverse focus groups on the output from NRAs. Due to pan-national variance, this study cannot be used to identify the risks impacted by gender outside of Ireland (see Boholm, 1998; Olofsson and Rashid, 2011). The methods of this study are, however, repeatable, and it would be instructive to replicate the study in other countries to build a complete picture across member states and to inform EU guidance on the completion of NRAs.

This study extends previous NRA studies by examining the impact of gender on the rating of involuntary risks, as well as the fluctuation of this impact across risks. The findings

demonstrate that while the general idea that risk is judged as higher by women than by men is sound, there is variation within these 17 involuntary risks. The findings underline the importance of gaining a more nuanced view of the impact of gender on risk rating at a national level and the need to consider how gender-biased multi-stakeholder focus groups could impact the reliability of NRA outputs.

3. Chapter Three – Paper 2

The influence of expertise on perceived and actual household disaster preparedness

Brown, G.D., Largey, A. and McMullan, C., 2021. The influence of expertise on perceived and actual household disaster preparedness. *Progress in Disaster Science*, 9, p.100150. <https://doi.org/10.1016/j.pdisas.2021.100150>

3.0 Abstract

The impact of disasters triggered by natural, technological and civil hazards may be mitigated by effective household preparedness. For those working in front line emergency and health services, household preparedness is critical as these individuals need to leave their homes and families to perform disaster-related duties. However, should front line staff feel concern for the safety of their home and family, they may face role conflict and ultimately be less likely to report for duty during a disaster.

Although differences between expert and non-expert risk assessment is well documented, the extent to which expertise impacts on household preparedness is less studied. Similarly, while a gap between perceived and actual preparedness has been identified in the population as a whole, the extent to which this applies to experts remains unclear. To address these shortfalls in the literature, 2087 Irish households, 678 of which are the homes of experts, are surveyed to ascertain their level of disaster preparedness. The data is analyzed using Spearman's correlation; Ordinary Least Squares regressions; and ordered probit models with marginal effects. The findings show that expertise has a positive and significant effect on both perceived and actual household preparedness. However, perceived and actual disaster preparedness align similarly for both groups - experts are no

more accurate in judging the level of actual preparedness in their homes. From a practical perspective, the findings of our study could inform the design and delivery of more effective disaster preparedness campaigns within disaster response organizations and at a national level.

3.1 Introduction

In early 2018 Ireland experienced an atypical period of severe weather which resulted in widespread snow and ice impacting the entire country. This severe weather came about because of two weather events, Storm Emma and the so-called “Beast from the East”, a mass of cold polar continental air which had become established over Ireland. The National Emergency Coordination Group (NECG) noted that not since 1982 had a weather event of this severity been experienced (NECG, 2018b). As the weather incident approached, most households purchased a significant volume of supplies. This surge in buying, and the inability of supply chains to match demand, led to newspaper headlines such as “Shoppers clear supermarket shelves ahead of Storm Emma” (Irish Times, 2018) and “Empty shelves point to [the] fragility in our food supply” (Independent, 2018b). To prepare for the impending snowstorm, a countrywide “Status Red” severe weather warning was issued by Met Éireann, the national weather service (Met Éireann, 2019). The NECG issued a statement: “for reasons of public safety, the National Emergency Coordination Group is advising that people should not be out of doors from 4 pm today [1st of March 2018]. Please use the hours between now and then to make sure you and yours are indoors by the time” (NECG, 2018a). The Taoiseach Leo Varadkar (Prime Minister of Ireland) further emphasized this advice when he warned, “everyone should be at home after 4 pm, nobody should be on the roads after that” (Independent, 2018a). Research presented at the “Major Emergency Management National Conference” suggests that there was a high level of

adherence to the NECG lockdown request (Whelan, 2018). While this extraordinary measure was in place, the Irish Defence Forces, the emergency services, and front-line health professionals were expected to continue to work.

National resilience relies on frontline response services (e.g. Fire, Police and Ambulance/Health) remaining operational during a disaster. A report by U.S. Federal Emergency Management Agency (FEMA) (FEMA, 2017) stresses that unless the homes of disaster response personnel are resilient and prepared for emergencies, “responders will be hindered in their ability to perform their jobs when a disaster strikes, and will instead be focused on personal and family safety” (p.1). There is some expectation that members of the frontline services are more prepared than non-experts, and therefore ready to leave their families during national disasters (Landahl and Cox, 2009). However, Landahl and Cox (2009), in a study investigating the role of emergency-related public agencies’ in building employees’ disaster preparedness, find that only 29.1% of organizations from the homeland security community had delivered training and education designed to help build employee and family preparedness. More than 70% of the relevant organizations did not appear to be cognizant of the role they could play in ensuring maximum attendance for duty during a disaster.

This tension between professional and personal responsibility also emerges in the literature. Where frontline staff feel concern for the safety of their home and family during a disaster, they may face role conflict and ultimately be less likely to report for duty (Qureshi *et al.*, 2005; Quarantelli, 2008; Carameli, 2010; Arbon *et al.*, 2013; Melnikov, Itzhaki and Kagan, 2014; Shapira *et al.*, 2016). Quarantelli (2008) states that during a disaster, emergency service personnel “consciously feel concern about ensuring the safety of their family and significant others, and yet also feel they have professional responsibilities to carry out their

work” (p.890). From a disaster management perspective, it is critical that those working in front line services not only have prepared households but that they also can evaluate their preparedness accurately – i.e. that perceived and actual preparedness is high and aligned. Being prepared and feeling prepared should reduce concern for family and in turn, increase willingness to work during a disaster (Qureshi *et al.*, 2005).

Among the public, strong alignment between perceived and actual household disaster preparedness is not evident in practice (Basolo *et al.*, 2009). Research focused on individuals’ ability to judge levels of household preparedness find that while 61% of respondents felt “adequately prepared for a disaster” only 8% have a disaster supply kit with three days of food, water and medications (p.531) (Kapucu, 2008). This indicates that people’s perception of their preparedness may not align with their actual or checklist preparedness and that preparedness may mean different things to different people. To date, research shows only a weak correlation between perceived and actual preparedness among the public (Basolo *et al.*, 2009; Kirschenbaum, Rapaport and Canetti, 2017). Basolo *et al.* (2009) highlight the divergence between perceived and actual preparedness as an “area for future research” (p.358).

Little is known about experts’ household disaster preparedness. Therefore, to add to the body of knowledge on household disaster preparedness, this study will address the following research questions:

1. Are experts’ homes more prepared than those of non-experts (where experts are defined as disaster management personnel or members of frontline services)?
2. Is there a greater alignment between perceived and actual preparedness among experts than non-experts?
3. Controlling for other relevant factors identified through a review of the literature, such as risk rating, prior exposure to disasters and socio-demographics, does expertise influence actual and perceived preparedness?

3.2 Systematic Literature Review

The first step towards answering the research questions set out above involves the completion of a Systematic Literature Review (SLR).

3.2.1 SLR Methodology

To facilitate a transparent and replicable process, the SLR follows the PRISMA methodology (Moher *et al.*, 2009). The SLR was conducted between November 2019 and January 2020 and identifies all relevant studies from ten databases: Academic Search Complete/Business Source Complete, Google Scholar, Emerald Management Xtra, SAGE journals online, ScienceDirect, Scopus, SpringerLink, Taylor & Francis Online, Web of Science and Wiley Online Library.

A structured stepwise search using four rounds of keywords is applied - see Table A1 (Appendix) for an overview and breakdown of the search outputs. This ultimately gives the following string: (“disaster preparedness” OR “emergency preparedness” OR “crisis preparedness”) AND (“perceived preparedness” OR “actual preparedness” OR “checklist preparedness”) AND (“household preparedness” OR “individual preparedness”) AND (“regression”). These keywords are applied to “all text” to search the title, keywords, abstract, and full paper fields. No date range limit was applied.

An overview of the search process is included in Figure 3.1. To ensure an accurate, replicable process the following exclusion and inclusion criteria are applied:

1. Document Limitation: Only articles published in peer-reviewed journals are included. Hence, reports, conference abstracts, theses, and other grey material are excluded.

2. English and Access check: only articles available in English, and with full-text availability are selected for inclusion.
3. Eligibility check: articles are excluded if they did not examine the factors that predicted preparedness or differences between perceived and actual preparedness.

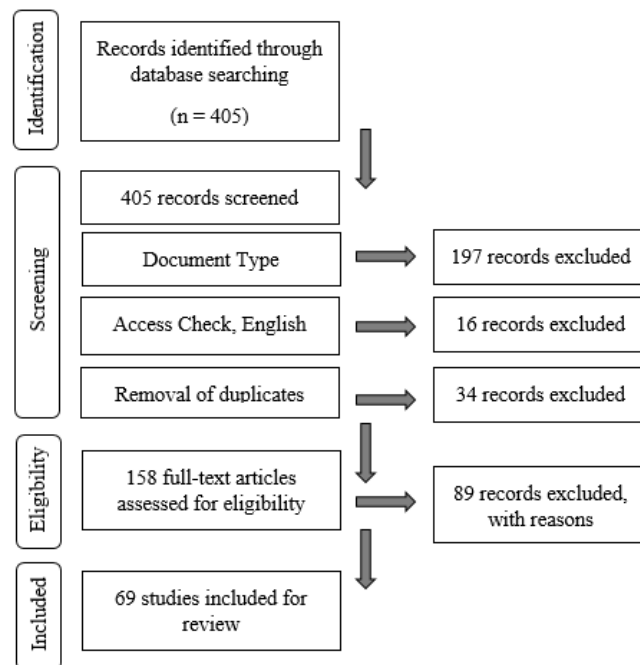


Figure 3.1 SLR flow diagram adapted from PRISMA (Moher *et al.*, 2009; PRISMA, 2015)

Following steps 1 and 2 of the screening process, the remaining 192 papers are retrieved from the online databases and duplicates removed, leaving 158 papers. The full-texts are reviewed for eligibility, and given a relevance rating from one, for poor relevance, up to three for highly relevant: examining both perceived and actual preparedness. A rating of two denotes a somewhat relevant paper which examines either perceived or actual preparedness. A total of 69 papers were rated two or three, and are included within the SLR and listed in the Table A2 - Appendix 2.

3.2.2 SLR Overview: Geographical & Hazard Context

The 69 peer-reviewed papers include four relevant literature reviews (Kohn *et al.*, 2012; Levac, Toal-Sullivan and O’Sullivan, 2012; Bourque, 2013; Wachinger *et al.*, 2013) and

their findings are also referenced in this review. All 69 papers are published between 2004-2020 (Figure 3.2). Of the 65 papers which include data analysis, three studies use qualitative methods to examine the preparedness variable(s) (Becker *et al.*, 2012, 2013, 2017), while the remainder (n=62) utilize quantitative methods.

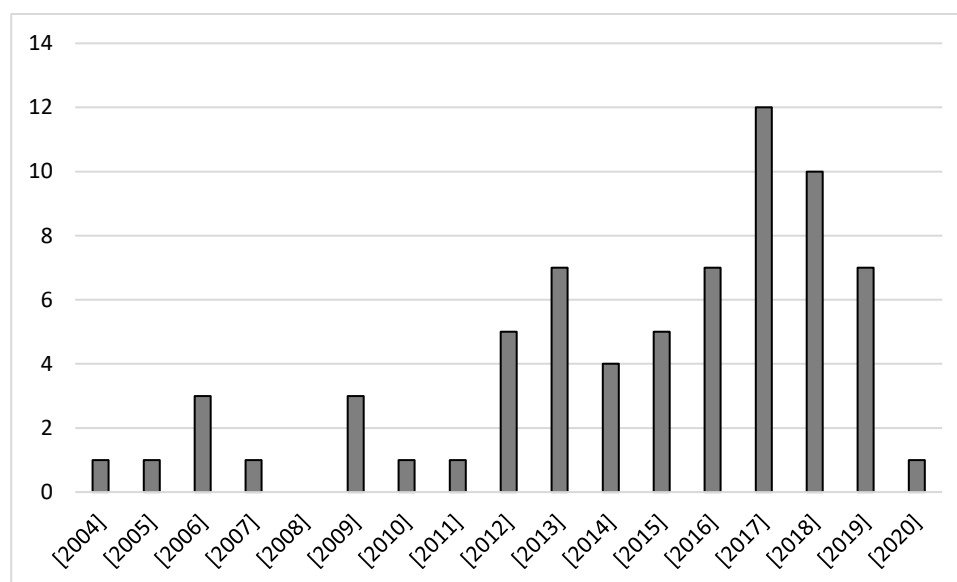


Figure 3.2 Distributions of the papers by year

A growing body of work focusing on household preparedness (Figure.3.2) concerning a wide range of hazards has been completed across many nations. The 65 studies are catalogued by country as geographic and cultural variables may help explain perceived and actual household disaster preparedness. The majority (n=58) use a sample drawn from one country, with seven studies drawing a sample from two or more countries. The most studied countries are the USA (n=25) followed by Israel (n=6), New Zealand (n=5), China (=3) and Germany (n=3). Two studies are completed in Ethiopia, Iran, Italy, Japan, Philippines, Taiwan, Thailand, Turkey and one study is conducted in Belgium, Canada, Finland, Ireland, Malta, Lebanon, Namibia, Netherlands, Republic of Ghana, Scotland, Slovak Republic, Uganda, and Zambia.

More than half of the 65 studies examine one hazard (n=35): 12 studies examine Earthquakes (Nguyen *et al.*, 2006; Paton *et al.*, 2010; Becker *et al.*, 2012, 2013, 2017; Oral

et al., 2015; Baytiyeh and Naja, 2016; Jang *et al.*, 2016; Wu *et al.*, 2017; Han *et al.*, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Ranjbar *et al.*, 2018) and eight study flooding (Bradford *et al.*, 2012; Espina and Teng-calleja, 2015; Adame and Miller, 2016; Ejeta *et al.*, 2016, 2018; Kerstholt, Duijnhoven and Paton, 2017; Abunyewah, Gajendran and Maund, 2018; Mabuku *et al.*, 2018), Terrorism is studied in three papers (Wood *et al.*, 2012; Bourque *et al.*, 2013; Wirtz, Rohrbeck and Burns, 2019), as is Hurricanes (Basolo, Steinberg and Gant, 2017; Hung, 2019; Kyne *et al.*, 2020). Three hazards are studied twice: War (Bodas *et al.*, 2015, 2018), Volcanic hazards (Corwin *et al.*, 2017; Wei and Lindell, 2017) and Pandemic / Public Health Emergencies (Prati, Pietrantoni and Zani, 2011; DeBastiani *et al.*, 2015). Finally, there is one study focusing on Wildfires (McNeill *et al.*, 2013), one examined Residential Fires (Stumpf *et al.*, 2017), and another landslides (Xu *et al.*, 2018).

Our review also highlights the practice of grouping several hazards into one group, for example, disasters, or the now discredited term, natural disasters. 20 studies opt to examine preparedness for multiple hazards in one location. These papers examined how factors such as disaster experience, prior exposure to disasters, or the likelihood of being impacted by a “natural disaster” influenced household preparedness (see, (Kirschenbaum, 2004, 2006; Ablah, Konda and Kelley, 2009; Landahl and Cox, 2009; Jasempour *et al.*, 2014; Tej *et al.*, 2014; Tomio *et al.*, 2014; Donahue, Eckel and Wilson, 2014; Henly-Shepard *et al.*, 2015; Annis, Jacoby and De Mers, 2016; DeYoung and Peters, 2016; Hoffmann and Muttarak, 2017; Kelly and Ronan, 2018; Kruger *et al.*, 2018; Appleby-Arnold *et al.*, 2018; Cope *et al.*, 2018; Donner and Lavariega-Montforti, 2018; Yong and Lemyre, 2019; Chen *et al.*, 2019; DeYoung *et al.*, 2019)).

Five studies examine two hazards within one study: Typhoons and Earthquakes (Wei, Sim and Han, 2019), Earthquakes and Tsunami (Muttarak and Pothisiri, 2013), Earthquakes and Household Fires (Joffe *et al.*, 2016), Fires and Medical Emergencies (Knuth *et al.*, 2017), and Hurricanes and Earthquakes (Basolo *et al.*, 2009). These studies provide an opportunity to consider how preparedness for different types of disasters may change depending on the hazard (Basolo *et al.*, 2009; Rebmann *et al.*, 2013; Knuth *et al.*, 2017) or its risk rating (Muttarak and Pothisiri, 2013; Rebmann *et al.*, 2013; Joffe *et al.*, 2016; Wei, Sim and Han, 2019). For example, Wei *et al.* (2019) rather than opting for one measure of disaster experience, select three: the experience of typhoons only; of earthquakes only; and of both emergencies. They find that only experience of a Typhoon is significant in predicting preparedness.

Only two papers study three or more individual hazards or groups of hazards. Paton (2007) used several factors (critical awareness, trust, action coping, outcome expectancy) to predict the preparedness intentions of respondents for three hazards, Bushfires, Volcanoes, and Earthquakes. Kirschenbaum (2005) regresses actual preparedness on risk perception for six hazard groups: Natural (Earthquakes), Accident (Road and Work), Industry (Industrial Accidents), Technology (Power Outage), National (Future War and Nonconventional), Self-Family (Chemical and Biological Weapons, and Conventional Weapons). In one model, Kirschenbaum (2005) shows that perceived risk of future and non-conventional war positively and significantly influences preparedness (supplies). However, for road and work accidents, the opposite is evident - as perceived risk increases, preparedness (supplies) decreases. In another model which regresses preparedness planning, Kirschenbaum (2005) finds all categories are non-significant. This research appears to suggest that multiple hazards (or multiple hazards by category) will have different and varying effects on preparedness.

In relation to hazard type, the evidence drawn from the SLR suggests that where hazard-specific preparedness is compared, the factors which predict the level of preparedness are not constant across the models (Paton, 2007; Basolo *et al.*, 2009; Rebmann *et al.*, 2013; Knuth *et al.*, 2017). Multi-hazard studies provide an important insight that suggests people are motivated to take different levels of preparedness action depending on the hazard type. It is therefore important that we focus not only on hazard-specific preparedness but also examine how overall risk perception in relation to a range of hazards impacts overall household preparedness (e.g. (Kirschenbaum, 2005)). The evidence from the SLR suggests the latter is under-examined.

3.2.3 SLR Findings: Perceived & Actual Preparedness, & Intention to Prepare

Measurement of household preparedness should include more than simply storing supplies. It should encompass the possession of disaster skills, household emergency plans, and other physical/structural protection measures (Kirschenbaum, 2005). The reviews by Kohn *et al.* (2012), Levac *et al.* (2012), and Wachinger *et al.* (2013) underscore this by highlighting a wide-ranging set of constructs used to measure disaster preparedness. Levac *et al.* (2012) and Kohn *et al.* (2012) suggest disaster household planning and stockpiling are vital components of an accurate preparedness measure. Kohn *et al.* (2012) draw attention to the critical differences between the measures for perceived and actual preparedness. Reporting that only some measures of actual preparedness (e.g. planning) seem to align with perceived preparedness (Basolo *et al.*, 2009). A sentiment reinforced by Kyne *et al.* (2020) who note “When evaluating disaster preparedness, difference between subjective preparedness and objective preparedness must be taken into consideration” (p.2). Wachinger *et al.* (2013) in their literature review, introduce a third dimension - willingness or intention to prepare. They suggest that in some studies the intention to prepare is taken, perhaps erroneously, as an indicator of perceived or actual preparedness. As outlined in Table 3.1, five papers

examine only the intention to prepare and do not proceed to identify levels of perceived or actual preparedness.

This section includes an examination of the 62 papers which analyzed measures of preparedness as dependent variables. As a first step, the preparedness measures are categorized as perceived preparedness, actual preparedness, or intention to prepare (or evacuate). Perceived preparedness is defined as a subjective self-assessment of the level of household preparedness (Kyne *et al.*, 2020). For example, Bradford *et al.* (2012) ask respondents how prepared they feel on a 5-item scale from not at all prepared to very well prepared. Conversely, actual preparedness usually involves objective reporting as to whether respondents have disaster preparedness items or have completed specific preparedness actions. It is most commonly measured using a checklist (e.g. (Bodas *et al.*, 2015; Oral *et al.*, 2015)) which can be divided into sub-categories such as provisions/supplies, skills, planning, and protection measures (e.g. (Kirschenbaum, 2004, 2005, 2006)). In summary, actual preparedness can be viewed as an objective measure of preparation for a disaster (Kyne *et al.*, 2020). As stated above, some studies include a measure of intention to prepare. This measure is distinctly different from perceived and actual preparedness as it examines people's declared future plans rather than current preparedness. While some studies only examine intentions to prepare (e.g. (Jang *et al.*, 2016)) others include it alongside a checklist. For example, Kerstholt *et al.* (2017) use a 15-item preparedness checklist which allows respondents to indicate whether they have or intend to complete each action.

Of the 62 studies, actual preparedness is the most common with 54.8% (n=34) of studies measuring only actual preparedness. An additional 24.2% (n=15) of studies include a

measure of actual preparedness and at least one other preparedness measure. The number of studies with each potential combination is presented in Table 3.1.

Table 3.1 Coding preparedness

Preparedness Measures Included	n
Actual measure only	34
Intention measure only	5
Perceived measure only	8
Actual and Intention measures	6
Actual and Perceived measures	7
Perceived and Intention measures	0
All three measures	2
Total	62

Of greatest significance to this paper is the cluster of studies which include measures for perceived and actual preparedness and capture the differences between perceived and actual preparedness within one data sample. Of the nine studies that included at least one measure for both perceived and actual preparedness, two studies included perceived preparedness as an explanatory variable for predicting actual preparedness (Nguyen *et al.*, 2006; Rebmann *et al.*, 2013). One study investigated actual (objective) and perceived (subjective) preparedness by examining the four possible combinations a person might exhibit (thinking they are prepared, but not prepared; thinking they are prepared and being prepared; thinking they are not prepared, and not being prepared, thinking they are not prepared but being prepared) (Kyne *et al.*, 2020). The remaining six studies include an examination of the differences between the factors that predict perceived and actual preparedness (Basolo *et al.*, 2009; DeBastiani *et al.*, 2015; Henly-Shepard *et al.*, 2015; Basolo, Steinberg and Gant, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Ranjbar *et al.*, 2018).

In terms of the association between perceived and actual preparedness, tests indicate small, positive, significant correlations (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017;

Kirschenbaum, Rapaport and Canetti, 2017). There are inconsistencies between studies in relation to the determinants of perceived and actual preparedness, though it is impossible to draw definitive conclusions, as studies differ in terms of the specific measure of preparedness analysed and the sets of predictors included in the models. Even for commonly included factors such as experience, risk perception, gender, having a child, age, education, and owning a home, results of the SLR suggest their signs are consistent but the level of significance varies across the six studies. Table 3.2, an extract from Appendix A2, highlights these differences by showing the relevant studies and findings. For example, Basolo *et al.* (2009) and Ranjbar *et al.* (2018) find that experience does not influence perceived and actual preparedness, while Basolo *et al.* (2017) and Henly-Shepard *et al.* (2015) report that experience predicted one of their two measures of actual preparedness, but was not significant for other or for perceived preparedness. Kirschenbaum *et al.* (2017) similarly demonstrate that experience influenced actual preparedness but not perceived preparedness.

The SLR reveals inconsistency in terms of how risk perception is measured. The 2009 study by Basolo *et al.* (2009) uses dread, the likelihood of occurrence in the next decade, and the likelihood of fatalities as measures of risk perception (Basolo, Steinberg and Gant, 2017). They found that these factors were non-significant in all actual preparedness models (hurricanes and earthquakes) and one perceived preparedness (earthquakes) model. For perceived preparedness (hurricanes) the likelihood of fatalities had a significant negative effect. A later study by Basolo *et al.* (2017) combine the measures for dread and likelihood of fatalities to create one measure, perceived risk (hurricanes), and found that it positively influenced perceived preparedness, but was non-significant for predicting actual preparedness. Considering this evidence, it would seem that variables associated with risk

perception may influence perceived preparedness, but, at the same time, will not impact actual preparedness. However, further testing is required.

Table 3.2 SLR Extract - predictors of perceived and actual preparedness

Reference	Hazard Context	Preparedness Variable	Constructs & Variables - Predicting Preparedness	
			<u>Key:</u> NS = Non-Significant variable SIG = Significant variable +ev = Significant positive variable	-ev = Significant negative variable N/A = Variable not in a model A, B, C, D , denote results from multiple models
Basolo et al.	Hurricane / Earthquakes	Perceived & Actual	<i>DV = Perceived Level of Preparedness for Earthquakes (=A), for Hurricanes (=B)</i> Confidence in government, +ev (A & B) Information sources, +ev (A & B) Fatal, -ev (B) Non-significant: Experience, Dread, Happen, Gender, Marital status, Annual household income, Age, Race, Child, Education, Tenure.	
			<i>Preparedness Actions for Earthquakes</i> <i>DV = Family Plan</i> - Information sources +ev , remainder NS <i>DV = Supplies</i> - All NS <i>DV = Mitigation</i> - All NS <i>DV = Shut off Utilities</i> - Information sources & Tenure +ev , remainder NS <i>Preparedness Actions for Hurricanes</i> <i>DV = Family Plan</i> - Confidence in government & Dread & Marital status +ev , remainder NS <i>DV = Supplies</i> - Child & Tenure +ev , remainder NS <i>DV = Shut off Utilities</i> - Gender & Age, remainder NS	
Basolo et al.	Hurricane	Intention / Perceived & Actual	<i>Model C, DV's= Level of perceived preparedness (A), household preparedness (family plan) (B), household preparedness (all recommended items on hand) (C)</i> White, NS (All) Gender, NS (All) Marital status, NS (A & B), +ev (C) Child, NS (All) Age, +ev (A), NS (B & C) Immigrant, -ev (A), NS (B & C)	Education, NS (All) Annual HH income, NS (All) Tenure, +ev (A & C), NS (B) Information (some), NS (All) Information (a lot), NS (A & C), +ev (B) Hurricane experience, NS (A & C), +ev (B) Perceived readiness of local government, +ev (A & B), NS (C) Perceived risk, +ev (A), NS (B & C)
			<i>(Number of Preparedness Items)</i> Sex, SIG Race, SIG Age, SIG Education, SIG	<i>(Perceived Preparedness)</i> Sex, SIG Race, SIG Age, SIG Education, SIG
DeBastiani et al.	Health Emergency	Perceived & Actual	Sex, SIG Race, SIG Age, SIG Education, SIG	

Henly-Shepard <i>et al.</i>	Natural Hazard	Perceived & Actual	"The majority of explanatory variables regressed against all three outcomes, self-reported preparedness, coping and adaptive capacity indices, were not found to be statistically significant. The findings from each regression specification are listed in Appendix 5 in ESM." Non-significant results are not reported. <i>Summary for perceived preparedness, multiple model specifications</i> 5-10 years residence, -ev Know of safe places to evacuate to, +ev Have experienced or heard stories of disasters, +ev	<i>Summary for Household Coping Capacity, multiple model specifications</i> Feel the community is prepared, +ev 1-5 years residence, -ev Participation in a Community Group, +ev <i>Summary for Household Adaptive Capacity</i> Female, -ev I can and will support myself/my family, +ev I can and will support myself/my family and anyone in need of assistance, +ev I can and will support myself/my family and community at large, +ev 1-5 years residence, +ev Participation in a Community Group, +ev
Kirschenbaum <i>et al.</i>	Earthquake	Perceived & Actual	<i>Hierarchical linear regression (Model 3 with Moderators) predicting actual preparedness (A) and perceived preparedness (B)</i> Age, NS (A), -ev (B) Gender, NS (A), +ev (B) Education, +ev (A & B)	Living in risk zone, NS (A), +ev(B) Religion, -ev (A), NS (B) Past experience, +ev (A), NS (B) Trust in information source, NS (A & B) Past experience*trust, NS (A & B)
Ranjbar <i>et al.</i>	Earthquake	Intention / Perceived & Actual	<i>DV: Actual preparedness behavior (A), Intention to prepare (B), Perceived preparedness (C)</i> Trust, +ev (All) Past experience NS (A & C), N/A (B) Gender, +ev (A), N/A (B & C) Ownership, NS (A), N/A (B & C)	Job situation, N/A (A & B), NS (C) Family members, +ev (A), N/A (B), -ev (C) Age, NS (A), +ev B, N/A (C) Residence region N/A (A & C), +ev (B) Monthly income, +ev (A), N/A (B & C)

3.2.4 SLR Findings: Factors Used to Predict Preparedness

This section of the SLR provides an overview of the most prevalent factors that are used to examine household preparedness. These factors are categorized into three groups: risk rating; coping factors; and individual and contextual factors.

3.2.4.1 Risk Rating

The literature review of Bourque (2013) notes that “although risk perception may be a necessary predictor of preparedness, it is not a sufficient predictor and is, in fact, largely mediated or moderated by other factors” (p.363). The SLR suggests there are two common approaches to analyzing risk and that the results across these studies are divided. Firstly, some studies use a combined construct (e.g. risk rating or risk perception) to predict preparedness: some report it as non-significant (Bourque *et al.*, 2013; Knuth *et al.*, 2017;

Wei and Lindell, 2017; Mabuku *et al.*, 2018; Hung, 2019) while other studies report significant findings (Espina and Teng-calleja, 2015; DeYoung and Peters, 2016; DeYoung *et al.*, 2019). In other cases, risk ratings (likelihood and impact) or risk perception (likelihood, impact and fear) are analyzed as multiple separate constructs; for example, Ejeta *et al.* (2018) report on three dimensions: likelihood, consequence and anxiety. Results are again divided, probability/likelihood and consequence/impact are sometimes both reported as significant factors in predicting actual preparedness (Kerstholt, Duijnhoven and Paton, 2017; Wei, Sim and Han, 2019), and perceived preparedness (Han *et al.*, 2017). While others find only some of the risk dimensions significant for predicting preparedness: for example, severity (McNeill *et al.*, 2013), vulnerability (Wirtz, Rohrbeck and Burns, 2019), perceived threat (Ejeta *et al.*, 2016; Xu *et al.*, 2018), and certainty and immediacy (Adame and Miller, 2016). Yet in the same studies other dimensions are non-significant: for example, likelihood (McNeill *et al.*, 2013), severity (Ejeta *et al.*, 2016; Wirtz, Rohrbeck and Burns, 2019), worry (Xu *et al.*, 2018), and susceptibility (Adame and Miller, 2016). Given the lack of consistency in findings, a wide range of risk perception indicators should be considered for inclusion in any household preparedness model.

3.2.4.2 Coping Appraisal

Coping appraisal relates to individuals' subjective perception of their ability to cope and the efficacy of their preparedness actions. Most of the studies in the SLR contain at least one coping appraisal, and these are usually significant in predicting preparedness. Examples include: outcome expectancy (Paton *et al.*, 2006; Paton, 2007; Mabuku *et al.*, 2018), self-efficacy (Adame and Miller, 2016; DeYoung and Peters, 2016; Joffe *et al.*, 2016; Mabuku *et al.*, 2018; Wirtz, Rohrbeck and Burns, 2019), Response-efficacy (Bourque *et al.*, 2013; Adame and Miller, 2016; Mabuku *et al.*, 2018), and self-reliance (Donahue, Eckel and Wilson, 2014; Chen *et al.*, 2019). There are, however, some instances

when coping factors such as collective efficacy and self-efficacy are not significant (Jasempour *et al.*, 2014; Ejeta *et al.*, 2016; Stumpf *et al.*, 2017; Kelly and Ronan, 2018).

Overall, the SLR indicates that an individual's perceived ability to cope with a disaster will generally have a positive, significant, effect on their household preparedness levels. However, these findings are not consistent across all preparedness studies. There is conflicting evidence as to whether the impact of coping factors on preparedness is positive or negative (i.e. the signs of coefficients on some factors are not consistent over all studies), see Appendix A2 for the detailed set of findings on these factors. For example, Joffe *et al.* (2016) and Mabuku *et al.* (2018) find self-efficacy has a negative significant relationship with preparedness. While others show self-efficacy has a positive significant association (Adame and Miller, 2016; DeYoung and Peters, 2016; Joffe *et al.*, 2016; Wirtz, Rohrbeck and Burns, 2019). Further research is needed to investigate the relationship. Alternative model specifications could test for possible interaction effects that may impact preparedness e.g. expertise (knowledge and training) with self-efficacy (confidence and ability).

3.2.4.3 Individual & Contextual Factors

Individual and contextual factors are regularly included within preparedness models. Variables such as age, gender, education, disaster experience, income, homeownership, and having children are most often studied. However, the significance of the relationship between these factors and preparedness can vary greatly (see Appendix A2). Other than demographics, homeownership and disaster experience are frequently found to be significant. For example, several studies report disaster experience as a significant factor in promoting preparedness (Bradford *et al.*, 2012; Donahue, Eckel and Wilson, 2014; Espina and Teng-calleja, 2015; Henly-Shepard *et al.*, 2015; Oral *et al.*, 2015; Hoffmann and

Muttarak, 2017; Donner and Lavariega-Montforti, 2018; Ejeta *et al.*, 2018), but some report no significant influence (Basolo *et al.*, 2009; Kruger *et al.*, 2018; Ranjbar *et al.*, 2018; Xu *et al.*, 2018; Hung, 2019).

The SLR found that expertise was one of the lesser-studied factors in relation to perceived and actual preparedness. In total, six papers studied the effects of expertise (or specialist disaster-related training) on household preparedness. In a study examining perceived preparedness for coastal environmental threats, Cope *et al.* (2018) note that working in the oil industry has a significant negative effect on preparedness while working in the fishing industry is not a significant predictor. Chan *et al.* (2019) and Rebmann *et al.* (2013) find that having participated in recent disaster training (1-2 years) significantly increases actual household preparedness. Rebmann *et al.* (2013) report that where employers encourage staff to undertake household preparedness actions (e.g. establish a household disaster plan), this has a positive and significant effect on general disaster preparedness but not pandemic preparedness. Landahl and Cox (2009), in a study of emergency-related personnel, find that 65.9% of Homeland Security organizations provide some general disaster preparedness training to staff but only 29.1% had plans in place to promote family disaster preparedness to staff. Furthermore, Landahl and Cox (2009) did not study the effects of expertise (or disaster training) on household preparedness. Tej *et al.* (2014) compared staff of municipal administration offices against the public (residents) and find some significant differences for factors such as following evacuation rules. They conclude that there is an “awareness gap between public administration employees and respondents who are not public administration employees (residents)” (p.8) (Tej *et al.*, 2014).

Not all studies suggest expertise has a significant effect. Knuth *et al.* (2017) study the influence of multiple factors, including being from the Civil Defence/Medical Sector, on

having or intending to purchase preparedness measures: fire extinguishers, fire blankets, smoke detectors, and first aid kits. Out of the seven tests they perform, being a member of the Civil Defence/Medical Sector only has a positive significant effect on respondents' intention to acquire a fire blanket. Corwin *et al.* (2017) compare response professionals and laypeople's actual preparedness levels and find significant differences between groups for only five out of 20 actual preparedness measures. Response professionals are more likely to have an emergency contact person outside the area, own a smoke detector, seek information on local volcanic hazards, have a trained first-aider in the family, and know who are the vulnerable people in their neighborhood or community. They also find that "Significantly more response professionals agree with each self-efficacy statement than do laypeople" (p.9), but laypeople and response professionals were similar with regards to their views on who is responsible for their safety and provision of emergency supplies (Corwin *et al.*, 2017).

3.2.5 SLR Summary

The findings of the SLR indicate that while there is an extensive body of research related to household preparedness, very few studies examine both the influence of risk rating and exposure to disasters across a range of hazards. Our study will close this gap by examining the influence of risk rating and of prior exposure to three groups of hazards: natural (drought, flooding, high temperatures, low temperatures, snow, and storms); technological (cyber incidents, disruption to energy supply, fire, nuclear incident abroad, and radiation (domestic)); and civil: (foodborne disease, infectious disease (affecting humans), infectious disease affecting livestock, loss of critical infrastructure, terrorism, and waterborne disease).

With regards to expertise, Landahl and Cox (2009) stress “The assumption that first responders will report is the foundation of the ability of organizations to maintain continuity and provide essential services to citizens affected by disaster” (p.1) and Corwin *et al.* (2017) emphasize “the need for more detailed studies of hazard knowledge, risk perception, and preparedness among the response professional community” (p.16). However, the SLR found that only a small number of studies examine the effect expertise has on preparedness, and none examined differences in its effect on perceived and actual preparedness. The SLR results also highlight that there is insufficient data available to establish definitively the relationship between perceived and actual preparedness; a conclusion in line with Basolo *et al.* (2017) and Kirschenbaum *et al.* (2017).

3.3 Methods

This study uses a cross-sectional design with households as the unit of analysis. The focus of the research is to examine the alignment between perceived and actual preparedness, as well as the relationship between these factors and expertise, as outlined in the three research questions. To meet the research objectives and capture data from a relatively large sample of Irish respondents in a narrow time frame, data is collected using a survey methodology outlined by McLennan *et al.* (2015). The questionnaire was administered in mid-2016, made available in both online and paper format, and collected responses from 2087 households across Ireland. Participants could voluntarily opt-in once they had read the plain language statement explaining the research and guaranteeing participants anonymity.

The online data collection software Qualtrics is used to gather the majority of data. Twitter and Facebook were used to promote the questionnaire, with a combination of paid ads and participants being encouraged to re-share the link. The questionnaire was also promoted on social media by government and public agencies, such as the Office of Emergency

Planning, Met Éireann (the national meteorological service), County Councils, and Dublin Fire Brigade. Each questionnaire took approximately 20 minutes to complete. To access more specialist communities, the questionnaire was also sent via email to members of the emergency services and via online forums to reach State Registered Nurses and Midwives. Paper copies were also distributed to community and health facilities across Ireland, to encourage responses from less computer literate citizens. Completed survey data was input to Qualtrics.

Regarding the socio-demographic distribution of the non-expert data collected (see Table 3.3); the gender balance within the sample (52.8% female respondents) is close to that reported by the Central Statistics Office (CSO) Ireland (CSO, 2016a), for the nation (51.1% female). Home ownership, (75% for non-experts) and household income (65.7% earn less than €70,000) are also reasonably well aligned with the national data (67.6% home ownership; income: 62.6% had a gross income of less than €60,000) (CSO, 2016c, 2016b). However, there is over-representation of respondents from the 18 to 34 year age range when compared to the national figure (29.5%, (CSO, 2016a)). Regarding the expert group, socio-demographic data is not available, but the gender profile and education range were skewed in comparison with our non-expert data. The skew in education may be explained by the fact that most frontline emergency services personnel hold a university qualification. As for the gender skew towards females, this may be explained by a large percentage of respondents from the health sector which is predominantly female (McMullan, Brown and O'Sullivan, 2016).

The analysis is conducted using the statistical software package STATA (StataCorp: Release 14.2/SE). The objectives of the analysis are to (1) examine the differences between expert and non-expert preparedness; (2) inspect the alignment between perceived and actual

preparedness among experts and non-experts; (3) explore the effect expertise has on influencing both perceived and actual preparedness while controlling for other relevant factors.

3.3.1 Analysis

In line with the research objectives, the analysis is divided into three stages. First, we use descriptive statistics to describe the preparedness levels of experts and non-experts within our study. Using Z-tests for the difference in proportions, we explore the difference in individual checklist item preparedness between experts and non-experts. To conclude this first stage of analysis, we use a Mann-Whitney U test to examine whether a statistical difference exists between experts and non-experts perceived and actual preparedness. This nonparametric test is considered most appropriate for our data as it allows us to compare experts' and non-experts' perceived preparedness (a three-point scale) and, separately, actual preparedness (which is treated as a continuous scale, 0-24 items).

Second, we examine how the measures for perceived and actual disaster preparedness compare by using correlation and ordered probit analysis with marginal effect calculations. The analysis is undertaken separately for experts and non-experts. Our focus is on testing if a positive association exists between perceived and actual preparedness, not to identify the direction of causality.

For the final stage of the analysis, where our aim is essentially to identify and compare the impact of expertise on each of perceived and actual preparedness, we estimate multivariate regression models for each, including the same set of measured predictor variables. Drawing from the SLR, several factors likely to influence household preparedness are identified and included as control variables. This results in the following general form for each of the preparedness variables:

Preparedness =
f[socio-demographics, risk ratings, risk exposures, self-efficacy, expertise]

Different types of regression are employed to predict actual and perceived preparedness, with the choice determined by how the dependent variable is measured. We use an Ordinary Least Squares (OLS) regression to predict actual preparedness and an ordered probit analysis with marginal effect calculations to examine the ordinal variable, perceived preparedness. Liddell and Kruschke (2018) point out that “analyzing ordinal data as if they were metric can systematically lead to errors” (p.328) and emphasize the need to use an ordered regression model such as ordered probit in cases like ours where the dependent variable is measured on a Likert scale.

To perform the necessary model diagnostic checks, we used the variance inflation factor (VIF) value to check for multicollinearity and White’s test for heteroskedasticity. A VIF score of five or over indicates multicollinearity. Our results show VIF scores within acceptable limits (O’Brien, 2007) having a maximum VIF of 2.21 and a mean VIF of 1.46. The results of White’s test suggest no problem of heteroskedasticity ($p=0.919$).

3.3.2 Variable Definitions

3.3.2.1 Perceived & Actual Disaster Preparedness

The practice of measuring actual preparedness against a checklist of items designed to identify the level of disaster preparedness within households is well established in disaster research (Kirschenbaum, 2002; Spittal *et al.*, 2006; Levac, Toal-Sullivan and O’Sullivan, 2012). However, as well as checking supplies, deliberate actions, such as having a plan, or taking out insurance protection should also be captured. Levac *et al.* (2012) and Paek *et al.* (2010) highlight that a respondent having supplies may not show intentional preparedness. For this study, it is the level of preparedness within the home which we are seeking to establish, however, within the questionnaire we also ask respondents to declare if they have

taken action to protect themselves or their home in case of an emergency. This captures deliberate preparedness and controls for additional measures not specified.

Our study uses a checklist of 24 disaster preparedness items and actions which act as broad indicators of household preparedness. These are selected from established preparedness guidelines prepared by FEMA, the American Red Cross and the Irish Office of Emergency Planning (see Table 3.4, (American Red Cross, 2016a; FEMA, 2016; Office of Emergency Planning, 2016)). The 24 items are split into three categories: Planning, Action, and Resources, which was comparable with the American Red Cross preparedness campaign “Get a Kit; Make a Plan; Be Informed” (American Red Cross, 2016b) and the work of Corwin *et al.* (2017). To achieve equal weighting, the scores for resources, planning and action are z-transformed separately. These standardized z-scores are then averaged to give the Household Preparedness Score. Further, to check the reliability and validity of these four preparedness indicators, we use both Cronbach’s alpha and Spearman correlation coefficients.

Cronbach's alpha is considered critical “in the evaluation of assessments and questionnaires” (p.54) (Tavakol and Dennick, 2011). But, Kohn *et al.* (2012) report that only 40% of studies about disaster preparedness provide Cronbach’s α as a construct reliability metric. Of these, Kohn *et al.* (2012) report a variance between $\alpha=.42$ and $\alpha=.99$ depending on the items selected. One reason for the lack of reported Cronbach’s α could be that studies using a checklist method may obtain low scores. However, a checklist preparedness construct with low internal consistency (i.e. a low Cronbach's alpha score) does not necessarily indicate an untrustworthy scale. For example, a higher error variance with a checklist scale only means a respondent with a certain number of items may score the same as a respondent with a different set of items. This will only have a serious impact

if certain preparedness items are weighted differently. That said, we report Cronbach's α to allow for comparison with other studies. Also, to support the reliability testing of our preparedness measures, we use Pearson's correlations. The results of these two tests are: Preparedness Planning (a 5-item construct) $\alpha=.47$; Preparedness Action (a 3-item construct) $\alpha=.51$; Preparedness Resources (a 16-item construct) $\alpha=.74$; Household Preparedness Score (the combined 24-item construct) $\alpha=.81$. Pearson's correlations show that all four preparedness indicators are significantly ($p<.01$) and positively correlated with one another. Individual correlations range from weak for "action – planning" ($r=.355$, $p<.01$), too strong for "Household Preparedness Score – resources" ($r=.829$, $p<.01$). Overall, these results are acceptable.

Perceived preparedness, i.e. a self-reported assessment of preparedness, is measured early within the questionnaire (before we show respondents the list of preparedness items) and asks if respondents consider themselves prepared for a disaster (ordered scale: no, somewhat, yes). A fourth option (unsure) was present within the questionnaire; however, to facilitate ordering of responses, the category and associated responses are removed. Similarly, Basolo *et al.* (2009) measure perceived preparedness on a binary scale (yes/no), while Kirschenbaum *et al.* (2017) use a 3-point scale from not prepared at all up to fully prepared.

3.3.3.2 Expertise

We measure expertise as a dummy variable (1 if the respondent is an expert and 0 otherwise). Experts are individuals who self-identified as a member of the emergency services (voluntary or paid), a member of the defence forces (voluntary or paid), a disaster/crisis/business continuity professional, and/or a member of the health services (a nurse or doctor). We label these respondents as experts because they have professional

subject-matter expertise relevant to our study. Their disaster training, education and experience, combined with a deeper understanding of disasters and risk, and greater knowledge of the Irish disaster management system should, in theory, result in differences between experts and non-experts. By definition, experts should be better informed about what preparedness actions are necessary and, therefore, maybe in a better position to judge their household preparedness. For our analysis, a total of 678 respondents (32.5%) are coded as an expert; which leaves 1409 respondents as non-experts.

3.3.3.3 Risk ratings, Exposure, Self-efficacy, & Socio-demographics

Besides the variables described above, perceived and actual disaster preparedness, and expertise, the final stage of analysis includes the additional variables: risk ratings, prior exposure to disasters, self-efficacy, and socio-demographics.

The questionnaire includes 17 household-related risks drawn from the 26 risks listed on the 2012 Irish National Risk Assessment (McMullan *et al.*, 2018). These are grouped into three categories:

- natural hazards: drought, flooding, high temperatures, low temperatures, snow, and storms;
- technological hazards: cyber incidents, disruption to energy supply, fire, nuclear incident abroad, and radiation (domestic);
- civil hazards: a foodborne disease outbreak, infectious disease (affecting humans), infectious disease (affecting livestock), loss of critical infrastructure (e.g. water), terrorism, and waterborne disease outbreak.

There are two standard methods for assessing risk: unknown/fear (Slovic, Fischhoff and Lichtenstein, 1980) and/or likelihood and impact ratings (Lindell, M, 1994; Lindell and Whitney, 2000). For this study, we use the latter (likelihood and impact ratings). For consistency, we use the five-point Likert scales drawn from the Irish National Risk

Assessment (McMullan *et al.*, 2018). Likelihood ranges from extremely unlikely (1) to very likely (5), and impact categories range from very low (1) to very high (5). These scales are then multiplied to create a risk rating measure for each (with a value between 1 and 25) and are then averaged for each classification. Natural hazards have a mean value of 8.713 (standard deviation of 3.252), Technological hazards have a mean value of 10.918 (standard deviation of 3.841), and Civil hazards have a mean value of 10.552 (standard deviation of 4.389). The three risk ratings are checked for reliability using Cronbach's α , and all are within acceptable limits (risk ratings to Natural Hazards $\alpha=.79$; risk ratings to technological hazards $\alpha=.77$; and risk ratings to civil hazards $\alpha=.89$).

Respondents' direct exposure to disasters is measured by asking respondents to indicate those, from the list of 17, they have experienced. Responses are summed by classification and averaged. Exposure to natural hazards has a mean of 0.449 (standard deviation of 0.266); exposure to technological hazards has a mean of 0.228 (standard deviation of 0.164), and exposure to civil hazards has a mean of 0.224 (0.222 standard deviations).

Self-efficacy measures respondents' perceived ability to deal with a threat (Kievik and Gutteling, 2011). Self-efficacy is measured by asking if respondents believed they needed assistance from their neighbors, non-profit organizations, emergency services, local government, and/or national government in the event of a disaster. Each of the six sources of assistance was rated from no assistance required (6) to substantial assistance required (1). Categories are summed and averaged to produce a measure of self-efficacy – with 1 representing the lowest self-efficacy score and 6 the highest. Self-efficacy has a mean score of 3.53 (standard deviation of 1.23) with a Cronbach's $\alpha=.87$.

Finally, Table 3.3 presents the summary characteristics listing the socio-demographic variables of the respondents.

Table 3.3 Respondents' socio-demographic frequencies

Characteristic	Experts	Non-experts	Description
Gender (551 experts, 1408 non-experts)			
Female	75.3% (415n)	52.8% (744)	1 if female, 0 otherwise
Age (551 experts, 1409 non-experts)			
18-34	30.3% (167n)	41.6% (586n)	1 if aged 18-34, 0 otherwise
35-54	60.8% (335n)	44.9% (633n)	1 if aged 35-44, 0 otherwise
55 or older	8.9% (49n)	13.5% (190n)	1 if aged 45 or older, 0 otherwise
Lives in (551 experts, 1409 non-experts)			
A city	15.4% (85n)	18% (254n)	1 for city, 0 otherwise
The suburbs or outskirts of a city	15.2% (84n)	8.1% (114n)	1 for Suburbs, 0 otherwise
A town	27% (149n)	16.7% (235n)	1 for town, 0 otherwise
A village	16.2% (89n)	29.9% (421n)	1 for village, 0 otherwise
A rural area	26.1% (144n)	27.3% (385n)	1 for rural area, 0 otherwise
Own vs Rent Home (551 experts, 1406 non-experts)			
Own Home	75% (413n)	79.2% (1113n)	1 for homeownership, 0 otherwise
Years living at current address (551 experts, 1406 non-experts)			
Mean (SD)	10.69 (9.14 SD)	13.29 (10.80 SD)	Range <1-100
Adults (age>18) living at the address (549 experts, 1406 non-experts)			
Mode	2	2	Range 1-7
Children (age<18) living at the address (540 experts, 1406 non-experts)			
Mode	0	0	Range 0-7
Household Income (466 experts, 1125 non-experts)			
Below 30,000	9% (42n)	23.7% (267n)	1 for income below 30,000, 0 otherwise
30,000-70,000	60.1% (280n)	42% (472n)	1 for income 30,000-70,000, 0 otherwise
Over 70,000	30.9% (144n)	34.3% (386n)	1 for income over 70,000, 0 otherwise
Education (543 experts, 1408 non-experts)			
Higher Educated	89.1% (484n)	65.4% (921n)	1 if higher educated, 0 otherwise

3.4 Results & Discussion

In this section, and consistent with our objectives, we present and discuss our research findings across the three stages of analysis. Firstly, we provide an overview of preparedness using summary statistics as well as tests for statistically significant differences between experts and non-experts. Secondly, we examine the measures of perceived and actual preparedness to estimate the extent to which these measures are aligned. Finally, we continue our examination of the impact of expertise, risk ratings and prior disaster exposure on the dependent variables: perceived and actual preparedness.

3.4.1 Expert & Non-expert Preparedness

Summary statistics for actual checklist preparedness are presented in Table 3.4 and separated into experts and non-experts. For 19 of the 24 items, a higher percentage of experts have the preparedness item than non-experts. These differences range from 0.5% to 11.8%, with some of the largest differences presented below.

- 11.8% more experts have a carbon monoxide detector than non-experts;
- 11.4% more experts store enough water for 3+ days than non-experts;
- 9.3% more experts have a fire blanket than non-experts;
- 9.1% more experts knew if they had household insurance for flooding than non-experts;
- 8.5% more experts have acted to protect self or home in case of a disaster than non-experts;
- 8% more experts have a household disaster plan for a specific situation than non-experts.

For each item, a Z-test, for the difference in proportion between expert and non-expert, is conducted and the results are reported in Table 3.4. A statistically significant difference is most evident concerning the more specialist checklist items. Experts appear to have a greater appreciation of the need for mitigation and planning (pre-disaster plans, carbon monoxide detection, smoke detectors); items needed during a disaster (water, fire blankets, battery torch, contact numbers, fire extinguishers, first aid kits); and during recovery (flood insurance). For more general items such as food, fuel, medicine, household insurance, tool kits, generators, documents and barbecues, there was no significant difference between experts and non-experts. Finally, cash and battery-powered radios were more often found in the homes of non-experts.

For perceived preparedness: 59% of experts consider themselves to be somewhat prepared, 19.1% feel they are prepared, and 14.2% report not being prepared. As for the non-experts, similarly, the majority rate themselves as somewhat prepared (57.7%), but a smaller percentage (12.5%) report being prepared. Perhaps as expected, a higher percentage of non-

experts (20%) specified they were not prepared. Overall, these results do not show any vast difference between experts and non-experts.

Table 3.4 Household preparedness indicators

	Expert % (n)	Non-expert % (n)	Z-test
Planning			
Disaster plan - all situations	12.6% (74)	6.2% (87)	4.796**
Disaster plan - specific situations	58.1% (342)	50.1% (706)	3.248**
List of emergency contact numbers	49.4% (291)	44% (620)	2.211*
Important documents kept in the home	86.1% (507)	84.6% (1192)	0.845
Cash kept in the home	41.8% (246)	47.8% (673)	-2.453**
Action			
Acted to protect self or home in case of a disaster	62% (412)	53.5% (753)	3.669**
Household insurance	84.3% (488)	83.4% (1174)	0.462
Household insurance for flooding	52.6% (301)	43.5% (613)	3.689**
Resources			
Smoke detector	99.2% (584)	96.5% (1360)	3.304**
Fire extinguisher	63.2% (372)	57.9% (819)	2.177*
Fire blanket	58.1% (342)	48.8% (688)	3.766**
Carbon monoxide detector	57.4% (338)	45.6% (642)	4.819**
Generator	8% (47)	9.4% (133)	-1.039
Gas Grill (with spare gas)	33.6% (198)	34.1% (480)	-0.194
Tank of fuel (small can, etc.)	31.9% (188)	28.1% (396)	1.709
Tool set	82.5% (486)	83.3% (1173)	-0.401
Axe/Chainsaw	55% (324)	52.7% (742)	0.959
First aid kit	90.8% (535)	84.3% (1188)	3.855**
Batteries	82.9% (488)	78.3% (1103)	2.312*
Torch	90.7% (534)	87.2% (1228)	2.215*
Battery powered radio	30.4% (179)	35.3% (497)	-2.103*
Enough water for 3+ days	40.5% (238)	29.1% (407)	4.983**
Enough food for 3+ days	86.6% (509)	84.1% (1179)	1.401
Enough meds for 8+ days	46% (269)	44.1% (612)	0.785

Notes: Expert (n) = 572-664; Non-expert (n) = 1389-1409; Items coded as 0,1 (No, Yes); *p<0.05, **p<0.01

A Mann-Whitney U test is conducted to examine if a significant statistical difference exists between the experts and non-experts for both preparedness variables. The results show a significant difference in preparedness ratings between experts and non-experts. For actual preparedness, based on the Household Preparedness Score, experts (mean rank = 1048.18) and non-experts (mean rank = 938.50) are shown to be significantly different (U= 432,807.0, z=3.920, p<0.001). Similarly, for perceived preparedness experts (mean rank = 1013.99) and non-experts (mean rank = 908.02) scores indicate a significant difference at U= 433,387.0, z=4.649, p<0.001. These results show that expertise does affect both perceived and actual preparedness.

Within the risk literature, similar results have been attributed to prior exposure, social status (Slovic, 1999) and familiarity (Siegrist *et al.*, 2007). Therefore, to examine further the effect expertise has on perceived and actual preparedness, the regression analysis in Section 3.3 includes these, and other, factors as control variables.

Focusing on the respondents who did not take action to protect themselves or their home in case of a disaster; Table 3.5 reports the percentages of experts and non-experts who identify reasons for not taking action to prepare and the results of a chi-square test of association between expertise and reason for no action. Where a statistically significant association existed, having no time to prepare was the only response where a higher percent of experts indicated it was their reason not to prepare.

Table 3.5 Reasons for no action taken to prepare

Reason for no action	Experts	Non-experts	Chi-square
Not knowing what to do	22.6% (57n)	39.6% (260n)	$\chi^2(1) = 23.053, p < 0.001$
Having no time to prepare	21.8% (55n)	16.6% (109n)	$\chi^2(1) = 7.115, p = 0.008$
Not wanting to think about it	9.1% (23n)	16% (105n)	$\chi^2(1) = 3.339, p = 0.068$
Expense	16.3% (41n)	21.6% (142n)	$\chi^2(1) = 3.270, p = 0.071$
Suggesting the emergency services would assist them	15.1% (38n)	20.7% (136n)	$\chi^2(1) = 3.755, p = 0.053$
Believing it would not make a difference	18.7% (47n)	18.4% (121n)	$\chi^2(1) = 0.005, p = 0.943$

3.4.2 Perceived & Actual Preparedness for Experts & Non-experts

To explore the extent to which the measures of perceived and actual preparedness are aligned, we perform two tests. Firstly, correlation analysis is used to examine the four constructs of perceived and actual preparedness. Secondly, we undertake four ordered probit regressions with marginal effect calculations. By including ordered probit analysis this study extends the methodology of Basolo *et al.* (2009) and Kirschenbaum *et al.* (2017), to include an estimated probability change in perceived preparedness following a one standard deviation change in actual preparedness. For the analysis in Section 4.2, experts and non-experts are analyzed separately.

Both sets of correlation tests show similar results suggesting actual preparedness was significant, though weakly, positively correlated with perceived preparedness. For experts, the correlations with perceived preparedness are planning: $r=.355$ $p<.01$, action: $r=.289$ $p<.01$, resources: $r=.331$ $p<.01$, and the Household Preparedness Score: $r=.416$ $p<.01$. For the non-experts, the correlations for perceived preparedness are planning: $r=.338$ $p<.01$, action: $r=.346$ $p<.01$, resources: $r=.357$ $p<.01$, and the Household Preparedness Score: $r=.436$ $p<.01$. These results suggest only slight differences exist between how accurately experts and non-experts judge their perceived preparedness.

Four ordered probit regression models are estimated to expand our understanding of the relationship between perceived and actual preparedness. These regressions measure the relationship between the respondents' perceived preparedness (as a dependent variable) and actual preparedness (as the independent variable). In the case of models 2a and 2b, the marginal effect estimates are completed with all other explanatory variables set at their mean values. The subsequent results are displayed in Table 3.6.

Table 3.6 Ordered probit analysis with marginal effects

Independent Variables	Dependent Variable: Perceived Preparedness				
	Ordered probit Coef.	Std. Err.	Marginal effects (dy/dx)		
			No	Somewhat	Yes
Regression 1a: Non-expert Only					
Household Preparedness Score (Z-Score)	0.724***	0.047	-0.197***	0.067***	0.130***
Chi-squared (df =1)	$\chi^2=261$ ***				
N	1240				
Regression 1b: Expert Only					
Household Preparedness Score (Z-Score)	0.693***	0.072	-0.143***	-0.043*	0.186***
Chi-squared (df =1)	$\chi^2=99.10$ ***				
N	524				
Regression 2a: Non-expert Only					
Planning Preparedness Scale (Z-Score)	0.255***	0.042	-0.069***	0.024***	0.046***
Action Preparedness Scale (Z-Score)	0.256***	0.039	-0.070***	0.024***	0.046***
Resources Preparedness Scale (Z-Score)	0.216***	0.043	-0.059***	0.020***	0.039***
Chi-squared (df =3)	$\chi^2=261.42$ ***				
N	1240				
Regression 2b: Expert Only					
Planning Preparedness Scale (Z-Score)	0.276***	0.060	-0.057***	-0.017*	0.074***
Action Preparedness Scale (Z-Score)	0.201***	0.060	-0.041***	-0.012*	0.054***
Resources Preparedness Scale (Z-Score)	0.208**	0.067	-0.043**	-0.013 [‡]	0.056**
Chi-squared (df =3)	$\chi^2=99.85$ ***				
N	524				

Note: *p<0.05, **p<0.01, ***p<0.001. Coefficient marked ‡ is significant at p=.052. Planning, Action, and Resources were z-transformed for this analysis.

The results in Table 3.6 show a significant positive relationship between actual preparedness and perceived preparedness. For example, Regression 1a predicts a one standard deviation increase in the Household Preparedness Score increases the probability that a non-expert states they are prepared for a disaster by 0.130 (13 percentage points). For experts, the equivalent figure from Regression 1b is 0.186 (18.6 percentage points). However, the regression coefficients in 1a and 1b are not statistically different (p=0.663), suggesting perceived and actual preparedness align in the same way for both experts and non-experts. This matches the conclusion drawn based on the correlation tests. The estimated ordered probit coefficients suggest no statistically significant difference in the

alignment of perceived and actual preparedness for experts versus non-experts. This would indicate that experts appear no more accurate at predicting their preparedness, or lack thereof, than non-experts.

The results in this section contribute to the existing theory by first replicating prior findings which show a relatively weak relationship between perceived and actual preparedness (Basolo *et al.*, 2009; Henly-Shepard *et al.*, 2015; Kirschenbaum, Rapaport and Canetti, 2017). Our correlation tests are in line with the results of Basolo *et al.* (2009) who found the correlations for perceived and actual preparedness range between $r=.18$ to $r=.33$ ($p=.05$) depending on the measure for actual preparedness. Kirschenbaum *et al.* (2017) similarly found a slightly stronger significant correlation of $r=.401$ ($p<.01$) between perceived and actual preparedness. Secondly, by estimating the ordered probit models and computing the marginal effects, we explore more fully this significant relationship. We show that the respondents are making some connection between both preparedness constructs as an increase in actual preparedness corresponds with a percentage point increase in the probability a respondent will perceive they are prepared. Further, our study reveals that this marginal impact is relatively large.

3.4.3 Significance of Expertise in Influencing Preparedness

In the previous sections, we show a statistical difference between the level of preparedness of experts and non-experts, with experts having higher mean rankings for preparedness (Section 4.1). Further, we establish perceived, and actual preparedness are not independent of one another for experts or non-experts (Section 4.2). As outlined earlier, the literature points to the possibility that prior exposure to disasters, risk ratings, and other social factors can influence preparedness. In this section, we address our third research objective by exploring the effect expertise has on perceived and actual preparedness, while controlling

for risk rating and prior disaster exposure. Additionally, we control for gender, age, home ownership, rural/urban setting, family size, education, income, and self-efficacy.

The results for the OLS, with Household Preparedness Score as the dependent variable, and the Ordered Probit regression, with perceived preparedness as the dependent variable, are presented in Table 3.7. In both regressions' expertise is significant ($p < 0.001$) and positive. This supports the findings in Section 4.1 confirming the positive effect expertise has on actual and perceived preparedness. Furthermore, prior studies about household disaster preparedness (see, (Grothmann and Reusswig, 2006; Siegrist and Gutscher, 2008; Paton *et al.*, 2010; Poussin, Botzen and Aerts, 2014)) highlight the significance of factors including prior exposure to specific disasters, self-efficacy, and socio-demographics, and having controlled for these factors the impact of expertise remains significant. A check for interaction effects between expertise and factors such as prior exposure or self-efficacy revealed the coefficients on interaction variables to be individually and jointly insignificant.

In addition to highlighting the significance of the relationship between expertise and preparedness, our results identify other factors that influence perceived and actual preparedness. Alongside expertise, the variables self-efficacy, exposure to natural hazard-related disasters, and having an income of €30,000 or above, are significant and positive in both the perceived and actual preparedness regressions. Being female has a strongly significant negative relationship with perceived preparedness, but only a weakly significant and negative relationship with actual preparedness.

Like Kirschenbaum, *et al.* (2017) our results also show that some variables influence perceived or actual preparedness, not both. Having a higher risk rating towards natural hazard-related disasters, and having a higher number of children in the household, both negatively impact perceived preparedness but are not significant for actual preparedness.

Conversely, home ownership increased years of residency in the home, and exposure to technical disasters, have a significant positive impact on actual preparedness but not on perceived preparedness.

Table 3.7 Influencing perceived and actual preparedness

Independent Variables	<i>OLS Regression</i>			<i>Ordered Probit Regression</i>		
	Dependent Preparedness Score (Z-Score)	Variable: Coef.	Household P	Dependent Preparedness	Variable: Std. Err.	Perceived P
Female	-0.069 [†]	0.040	0.082	-0.379***	0.068	<0.001
Age 35-54	0.026	0.045	0.558	0.103	0.077	0.182
Age 55 & Over	0.076	0.070	0.276	-0.020	0.119	0.869
Lives in a village	0.037	0.051	0.475	-0.057	0.088	0.518
Lives in a town	0.121*	0.054	0.026	0.104	0.092	0.258
Lives in a suburb/outskirts of a city	0.080	0.069	0.244	0.118	0.118	0.319
Lives in a city	0.127*	0.057	0.028	0.097	0.098	0.319
Owns home	0.498***	0.050	<0.001	0.035	0.086	0.69
Years at address	0.007***	0.002	0.001	0.004	0.004	0.257
Number of children (at household)	-0.006	0.017	0.745	-0.051 [†]	0.030	0.086
Higher Educated	-0.033	0.045	0.457	-0.001	0.077	0.986
Income 30,000-70,000	0.231***	0.052	<0.001	0.182*	0.090	0.044
Income Over 70,000	0.382***	0.058	<0.001	0.219*	0.099	0.027
Risk Rating of Natural Hazards	-0.001	0.007	0.893	-0.026*	0.012	0.036
Risk Rating of Technological Hazards	-0.006	0.008	0.446	-0.001	0.014	0.958
Risk Rating of Civil Hazards	0.005	0.007	0.508	-0.017	0.012	0.165
Exposure to Natural Hazards	0.310***	0.083	<0.001	0.452***	0.142	0.001
Exposure to Tech. Hazards	0.332*	0.133	0.013	0.290	0.228	0.203
Exposure to Civil Hazards	0.098	0.101	0.333	0.119	0.170	0.486
Self-Efficacy	0.052***	0.016	0.001	0.105***	0.027	<0.001
Expert	0.209***	0.045	<0.001	0.383***	0.076	<0.001
Constant	-1.170	0.113	<0.001			
Cut 1 Constant				-0.459	0.197	
Cut 2 Constant				1.504	0.200	
R ²	0.225					
F	20.45***					
χ ² (Chi-squared) (df = 21)				159.76***		
N	1,503			1,397		

Note: *p<0.05, **p<0.01, ***p<0.001. Coefficients marked † are significant at p<0.1

Table 3.8 reports the marginal effects of the probit model for perceived preparedness. The marginal effect values reveal that the probability that a respondent state they are prepared for an emergency is 9.5 percentage points higher if they are an expert, controlling for all other variables at their mean values.

Table 3.8 Marginal effects for perceived preparedness

Independent Variables	Marginal effects (dy/dx)		
	No	Somewhat	Yes
Female	0.098***	-0.008	-0.089***
Age 35-54	-0.027	0.004	0.024
Age 55 & Over	0.005 [‡]	-0.001	-0.004
Lives in a village	0.015	-0.002	-0.013
Lives in a town	-0.027	0.002	0.024
Lives in a suburb/outskirt of a city	-0.030	0.002	0.028
Lives in a city	-0.025	0.002	0.023
Owns home	-0.009	0.001	0.008
Years at address	-0.001	0.000	0.001
Number of children (at household)	0.014 [‡]	-0.002	-0.012 [‡]
Higher Educated	0.000	0.000	0.000
Income 30,000-70,000	-0.048*	0.006	0.042*
Income Over 70,000	-0.056*	0.004	0.052*
Risk Rating of Natural Hazards	0.007*	-0.001	-0.006*
Risk Rating of Technological Hazards	0.000	0.000	0.000
Risk Rating of Civil Hazards	0.005	-0.001	-0.004
Exposure to Natural Hazards	-0.120***	0.016 [‡]	0.103**
Exposure to Tech. Hazards	-0.077	0.011	0.066
Exposure to Civil Hazards	-0.031	0.004	0.027
Self-Efficacy	-0.028***	0.004*	0.024***
Expert	-0.094***	0.000	0.095***

Note: *p<0.05, **p<0.01, ***p<0.001. Coefficients marked ‡ are significant at p<0.1

3.5 Conclusions & Implications

In this paper, we first examine whether experts' homes are more prepared than those of non-experts'. Secondly, we test for greater alignment between perceived and actual preparedness among experts than non-experts. Finally, we explore whether expertise influences actual and perceived preparedness while controlling for relevant factors drawn from the SLR, and examine if there are differences in the factors that affect perceived and actual preparedness.

One of the most significant findings to emerge from our study is that expertise has a positive, significant effect on both perceived and actual preparedness. Experts' households are better prepared for a disaster than those of non-experts. Having controlled for a wide range of variables (as outlined in Table 3.7), this research points to a direct relationship between expertise and both perceived and actual preparedness. The SLR illustrates that prior research on this topic has shown mixed results. Our finding, to a degree, contradicts

the prior research by Corwin *et al.* (2017) and Knuth *et al.* (2017) who find expertise does not have a consistent significant impact on respondents' preparedness levels. Corwin *et al.* (2017), conclude that "response professionals [experts] largely mirror laypeople in terms of their household preparedness levels" (p.13). In other research, Cope *et al.* (2018), studying coastal environmental hazards, observe that working in the oil industry had a negative and significant effect on household preparedness.

Landahl and Cox (2009) and FEMA (FEMA, 2017) emphasize the importance of disaster management personnel and members of frontline services being prepared at home. Our findings are that experts are better prepared than non-experts. However, we also find that experts are no more accurate in judging the level of actual preparedness within their households, which, as outlined by Quarantelli (2008), could allow role conflict to emerge among some experts. That is, an expert who feels their household is not prepared (i.e. low perceived preparedness and low or high actual preparedness) for a disaster may be conflicted between fulfilling their personal and professional responsibilities. Hence, an objective for disaster response and management organizations should be to help ensure perceived and actual preparedness is high and aligned among staff.

A key finding from our research is that there is a positive relationship between experts' and non-experts' perceived and actual preparedness. As a person's actual preparedness increases, so does their perceived preparedness. Studies by Basolo *et al.* (2009) and Kirschenbaum, *et al.* (2017) report significant correlations that range from $r=.18$ to $r=.40$. Our reported correlations support these findings. We obtain significant positive correlations ranging between $r=.289$ and $r=.436$. To expand on these correlations, we undertook ordered probit analyses with marginal effects. The results confirm the significant positive relationship between actual and perceived preparedness (see Table 3.6). However, we find

that the level of alignment for perceived and actual preparedness is similar for both experts and non-experts. It might be expected that an experts' perceived and actual preparedness would align more strongly and that their assessment of preparedness would be more objective than subjective given their training and experience. This is not supported by our findings.

Evidence suggests that workplace preparedness can influence household preparedness (Rebmann *et al.*, 2013). A program of training designed to firstly strengthen household preparedness and then align perceived preparedness, perhaps using a checklist approach, could be rolled out in frontline disaster response organizations. However, Landahl and Cox (2009) report such training is not readily available even in the Homeland Security organizations they surveyed in the USA. We suggest this is an area which should be built into new recruit training across all response organizations and could be built into national preparedness campaigns. Further research is required to examine the best approach to such training, and the impact of training and preparedness campaigns on actual preparedness and perceived preparedness.

From a methodological perspective, future research could adjust how perceived preparedness is measured. Our study, like those conducted by Basolo *et al.* (2009); Henly-Shepard *et al.* (2015); Kirschenbaum, *et al.* (2017), uses a standard categorical measure to gauge perceived preparedness. To facilitate more precise analysis, there is value in using a more nuanced scale, such as the use of a continuous scale, to measure perceived preparedness.

Our paper sheds some light on the factors, other than expertise, which influence perceived and actual preparedness. Firstly, as noted within the SLR, consistent patterns have not been found with regard to which variables influence perceived preparedness, and which actual

preparedness. Secondly, the papers reviewed point to different variables predicting perceived and actual preparedness. Our findings contribute additional evidence on the different predictors of perceived and actual preparedness. For example, our results show that living in a town or city, and owning your own home both have a significant and positive relationship with actual preparedness, but the same factors are non-significant in the perceived preparedness model. Similarly, as the number of children in a household increases, the level of perceived preparedness decreases, but the level of actual preparedness is not impacted.

The SLR highlighted that coping factors such as self-efficacy, confidence in one's ability to take preparedness actions, were not consistent in their effects on preparedness. We considered it likely that expertise (knowledge and training) may have had a statistically significant interaction effect with self-efficacy. However, we find these interactions were non-significant.

The results from our data and the SLR also emphasize the importance of using risk rating for, and exposure to, a wide range of disaster types to predict perceived and actual preparedness. Previous work by Kirschenbaum (2005) shows that individuals' rating of different hazards can have varying effects on household preparedness. That is, within the same model, some risk ratings are positively related to preparedness, while others are non-significant, or have a negative effect. Similarly, we find that exposure to disasters triggered by natural hazards significantly increases both perceived and actual preparedness, while a higher risk rating for natural hazards negatively impacts on perceived but not actual preparedness. We also show that for technological hazards and civil hazards, both risk rating and prior exposure are non-significant in influencing perceived or actual preparedness.

From a policy perspective and given the national reliance on frontline response organizations, the results of this research can help policy-makers gain a greater understanding of the measures needed to build household and national preparedness. These findings could be used to inform the design and delivery of more effective disaster preparedness education campaigns and training within response organizations. For example, to minimize role conflict among disaster response personnel and members of frontline services, a preparedness campaign offering guidance and support to females and households with children, two socio-demographics found to have a negative, significant effect on perceived preparedness, could be designed. A suite of targeted education campaigns, alongside specialist training initiatives, should promote household preparedness among experts and help ensure perceived and actual preparedness are high and aligned.

From a risk communication perspective, both experts and non-experts should be targeted by preparedness campaigns in light of the considerable proportion who had taken no action to prepare (38% and 46.5%, respectively). These campaigns should be focused on knowledge – how to prepare, given that 22.6% of experts and 39.6% of non-experts who did not take action indicated they did not know what to do.

Notwithstanding the issues that exist among those who had taken no action, experts have higher levels of actual preparedness than non-experts, see Table 3.7. It would be instructive in future research to explore why this may be the case and tailor messaging to remove the preparedness barriers for non-experts, thus bridging the preparedness gap. A further dimension could be to explore the path from risk communication to preparedness actions for experts and non-experts.

Over a fifth of experts who did not take action to prepare stated they had no time to do so. Therefore, in terms of risk communication, a campaign aimed at encouraging those working in frontline response organizations to make the time to prepare their homes could help to remove barriers to response during a disaster.

In times of a national emergency, such as occurred in Ireland during Storm Emma, risk and preparedness messages tailored to frontline response services must be issued separately to those for the general public. Clearly, the instruction that “everyone should be at home after 4 pm, nobody should be on the roads after that” [6] cannot apply to frontline response services (experts) who will be required to leave their homes and work during an emergency. This will only be successful if their households and families are prepared, and they have confidence in the preparedness actions taken, that is, their perceived and actual preparedness are high and aligned.

4. Chapter Four – Paper 3

Voices from the frontline: a review of EMS first responders' experience of COVID-19 in Ireland

Brown, G.D., Largey, A., McMullan, C., O'Shea, G. and Reilly, N., 2022. Voices from the frontline: a review of EMS first responders' experience of COVID-19 in Ireland. *International Journal of Emergency Services*, 12(1), pp.103-118.

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4.0 Abstract

Purpose: This study explored the experiences of Irish emergency medical services (EMS) first responders during the first nationwide restrictions to curb the spread of COVID-19.

Design/methodology/approach: A systematic literature review (SLR) of research into healthcare workers' and first responders' experiences during the COVID-19 and 2003 SARS pandemics was performed. The SLR informed the content of an online questionnaire distributed via the Irish Pre-Hospital Emergency Care Council to 2,092 first responders on its live register. Data analysis used both descriptive and content analysis.

Findings: EMS first responders faced many challenges including PPE quality, training on its use, issues with decontamination facilities, and organisational effectiveness. Emotional challenges included the anxiety experienced, the impact on families, and ethical dilemmas confronted related to patient care. Positive findings also emerged, such as first responders' dedication to working through the pandemic, collegiality, and the community goodwill displayed.

Originality/value: While investigations of the impact of the COVID-19 pandemic on healthcare workers have been undertaken globally, studies focusing exclusively on the experiences of EMS first responders have been rare. This study addressed this knowledge gap, providing an insight into the challenges and successes experienced by first responders and identifying opportunities for learning that can be applied to future public health emergencies.

4.1 Introduction

On 30th January 2020, the World Health Organisation (WHO) declared the COVID-19 pandemic a Public Health Emergency of International Concern (WHO, 2020). During public health emergencies, professional and volunteer medical first responders are responsible for the preliminary treatment of suspected cases.

Infectious disease emergencies “will always create challenges for a health service, both in terms of the scale of added clinical activity and increased demands on the workforce and available resources” (McMullan *et al.*, 2016, p.6). In 2017, prior to the current COVID-19 pandemic, infectious disease was one of the highest rated risks on the National Risk Assessment for Ireland (NRA) (McMullan *et al.*, 2018). Within three years this risk was realised and plans activated to deliver a national level response. This study focuses on the experiences of Irish emergency medical services (EMS) first responders during the first period of COVID-19 restrictions in Ireland. These restrictions were commonly referred to as a lockdown and ran from midnight, 27th March 2020, until midnight, 17th May 2020. They included a national stay-at-home order (except for those working in essential services), the closure of non-essential shops, community centres, and a ban on all gatherings (Citizens Information, 2020).

A Systematic Literature Review (SLR) covering EMS first responders' experiences during the COVID-19 pandemic and the previous 2003-2004 SARS pandemic, both respiratory pathogens from the coronavirus family, was undertaken. Primary data was collected using an online survey distributed to 2,092 EMS first responders. For this study, the term EMS first responder includes advanced paramedics, paramedics, emergency medical technicians (EMT), and specialist, cardiac, and first aid responders who were recognised by the Irish Pre-Hospital Emergency Care Council (PHECC). The SLR informed the survey and provided essential background knowledge against which to contextualise the study findings.

4.2 Systematic Literature Review

The SLR was undertaken using, Academic Search Complete, Emerald Management Xtra, Google Scholar, SAGE journals, Web of Science, and the Wiley search databases, in compliance with the PRISMA methodology (Moher *et al.*, 2009). Papers were selected based on the keyword string:

allintitle: ("SARS" OR "COVID-19" OR "Coronavirus" OR "Corona virus") AND ("frontline" OR "First responders" OR "healthcare workers" OR "lessons learned").

Given that the COVID-19 pandemic was in its infancy at the time this study began in April 2020, with only a small number of papers covering COVID-19 published, the term SARS was included to capture any findings that could inform the design of this study. Other keyword combinations were also considered during the planning phase of the SLR. The terms paramedic, EMS and EMT were included but these produced no additional relevant results. The SLR was subsequently expanded to include the term healthcare workers as related findings were considered most applicable to informing the study design. The SLR

keyword string identified an initial 135 articles published between 2003 and May 2020. An alert query remained in place for four weeks until mid-June to capture additional relevant papers due to the fluid nature of the pandemic. This resulted in the inclusion of three further papers. These 138 papers were reviewed according to the criteria illustrated in Figure 4.1, producing a final set of 37 articles. Papers were excluded if their results, on closer inspection, had no bearing on the current study: e.g., sometimes the findings related to anaesthesiology or human rights.

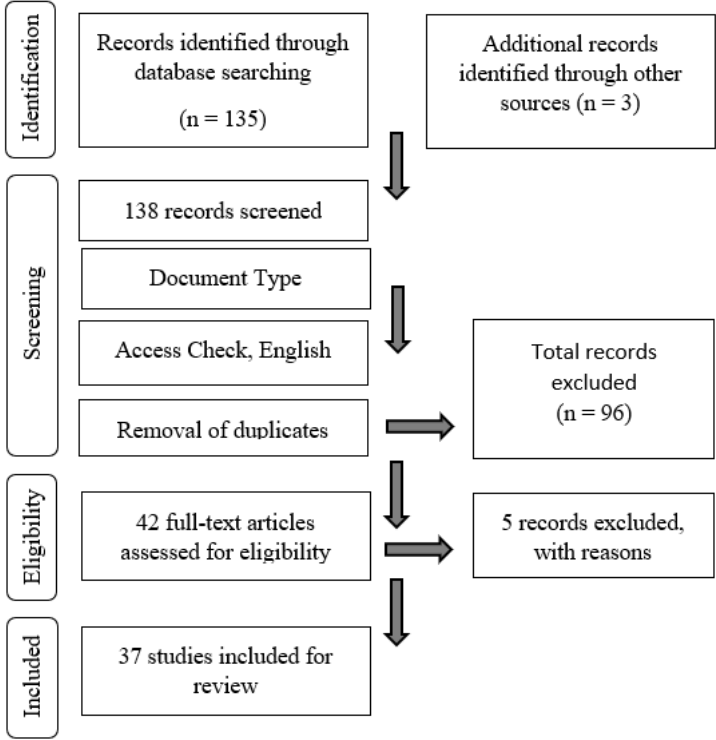


Figure 4.1 SLR Flow Diagram. Adapted from PRISMA (Moher *et al.*, 2009).

Most COVID-19 papers included primary research completed in China, the USA or the UK. None utilised Irish datasets. The remaining eight were review articles focused on SARS. The 37 articles primarily concerned healthcare workers (HCWs) such as doctors and nurses in clinical settings. While the findings were not directly applicable to EMS first responders, the papers were used to inform the design and analysis of the study. The impact of COVID-19 on the broader group of emergency services personnel, such as police, was

acknowledged in editorials and commentaries (Lusher *et al.*, 2020; Sim, 2020). This paper addresses an identified gap in the literature by soliciting the opinions of EMS first responders. The SLR is categorised thematically, and the outputs presented in sections 2.1 to 2.3.

4.2.1 Need for Information

The need for HCWs to have access to relevant, reliable information to perform their duties without compromising their own safety was highlighted by several authors (Delgado *et al.*, 2020; Key *et al.*, 2020; Sim 2020; Bhagavathula *et al.* 2020; Hasnain 2020). In an online survey of 936 physicians, nurses and allied health professionals, Delgado *et al.* (2020) reported that 24.5% lacked access to workplace safety policies/procedures while 38.9% lacked access to telemedicine resources. However, in a similar online questionnaire of doctors, nurses and other healthcare professionals, over 80% showed high awareness of government and health PPE guidelines relevant to their clinical area (Key *et al.*, 2020). Hasnain *et al.* (2020) recommended harnessing digital technology to constantly update HCWs on evolving standards of practice through big data and machine learning, concurrent with dialogue between policymakers, HCWs and medical researchers. Changes must be communicated in a manner which can be clearly understood (Walton *et al.* 2020; Semaan *et al.* 2020).

4.2.2 Mental Health

Mental health was a prevalent theme throughout the SLR. Lai *et al.*'s (2020) investigation of the mental health of Chinese HCWs in February 2020 found that out of 1,257 physicians, nurses and other healthcare professionals, 71.5% reported symptoms of distress, 50.4% described depressive symptoms, 34.0% suffered insomnia and 44.6% experienced anxiety. While factors such as marital status and parental status did not have a statistically

significant relationship with HCWs' risk perception (Koh *et al.* 2005), Souadka *et al.* (2020) described how additional childcare responsibilities due to crèche and school closures contributed to HCWs' stress. Colleagues' perception of those with families as more likely to carry COVID-19 also increased stress levels (Souadka *et al.*, 2020), while HCWs performed a delicate balancing act between attending to patients at work and caring responsibilities in the home (Aghili and Arbabi, 2020).

The overarching fear among HCWs was of becoming infected or infecting relatives and friends (Aghili and Arbabi 2020; Angelos, 2020; Cai *et al.*, 2020; Collado-Boira *et al.* 2020; Huynh *et al.* 2020; Misra *et al.* 2020; Semaan *et al.* 2020). Collado-Boira *et al.*'s (2020) thematic analysis of 62 interviews with final-year Spanish nursing and medical students revealed over 45% feared becoming a source of contagion. There were instances of HCWs abandoning their hospital duties to "isolate and quarantine themselves alleviating their worries despite their social responsibility and altruism as a member of the medical society" (Aghili and Arbabi, 2020, p. 2).

Contagion fears were often aggravated by a lack of PPE or guidance on its use (Chan-Yeung 2004; Collado-Boira *et al.* 2020; Santarone *et al.* 2020; Aghili and Arbabi 2020; Jin *et al.* 2020; Walton *et al.* 2020). Even when supply and instruction on use was not an issue, many HCWs were unprepared for the physical exertion of the persistent donning and doffing of PPE (Gan *et al.*, 2020).

Many studies emphasized the need to manage HCW's stress, anxiety and fear levels (Tam *et al.* 2004; Maunder 2004; Alsahafi and Cheng 2016; Aghili and Arbabi 2020; Cai *et al.* 2020; Angelos 2020; Sasangohar *et al.* 2020; Pappa *et al.* 2020; Santarone *et al.* 2020; Hu *et al.* 2020; Chersich *et al.* 2020; Hasnain 2020; Zhu *et al.* 2020; Jin *et al.* 2020; Pothiwala 2020; Chung *et al.* 2020; Aksoy and Kocak 2020). Safeguarding HCWs' mental wellbeing

had both a practical and ethical dimension: Key *et al.* (2020) noted that high anxiety levels could lead to increased absenteeism through sick leave, jeopardising duty of care to patients, while Santarone *et al.* (2020, p.1531) observed that aiding the mental health and resilience of HCWs was “imperative to ensure global recovery from the COVID-19 pandemic”. Proposals to support the mental health of HCWs included providing informal workplace counselling sessions for staff (Key *et al.*, 2020; Walton *et al.*, 2020) and promoting mental health education to enable HCWs to seek psychological help without stigma (Santarone *et al.*, 2020; Walton *et al.*, 2020).

4.2.3 PPE & Infection Control

Gan *et al.* (2020) highlighted the example of Singapore which, following SARS, founded the National Centre for Infectious Diseases to stockpile PPE in anticipation of future outbreaks. However, issues with PPE extended beyond adequate supply: with infection control measures such as handwashing and coughing/sneezing etiquette (Gudi and Tiwari, 2020), appropriate training in the donning and doffing of PPE was identified as crucial. In a cross-sectional survey of over 2,000 nurses based in hospitals in Wuhan, China, almost all (94.8%) reported the development of PPE-induced skin lesions, with 15.7% of these nurses stating they did not know how to manage these conditions (Hu *et al.*, 2020). This could have consequences for infection control as Yassi *et al.* (2005) found HCWs were less likely to wear poorly designed PPE that caused them discomfort. Sasangohar *et al.* (2020) related how training videos on donning and doffing used by a Texan hospital were not updated to reflect the specific PPE used at the onset of COVID-19, nor were the instructions provided intuitive for less experienced personnel. They called for the provision of structured training on large-scale disaster management and response. Following SARS, Suwantararat and Apisarnthanarak (2015) advocated for a designated staff member to supervise HCWs in the proper donning and doffing of PPE. Empowering individual HCWs

to monitor infection control in their department (Chersich *et al.*, 2020) or nominating “PPE champions” as points of contact for colleagues offering advice and reassurance on PPE (Key *et al.*, 2020) were proposed strategies to achieve compliance with PPE good practice standards.

In a survey of 58 Nepalese HCWs, 81% favoured splitting the emergency department into COVID and non-COVID emergencies to reduce the risk of becoming infected (Acharya *et al.*, 2020a). They also highlighted that fear of infection was leading to overuse and wastage of PPE: “Health care workers working in non-COVID emergencies felt that providing full PPE would increase their level of safety. However, we need to use PPE rationally, as per uninterrupted supply... At this point all patients with respiratory problems should be considered as COVID-19. However, making this decision before time will consume resources unnecessarily” (Acharya *et al.*, 2020a, p. 45). Faster assessment to distinguish COVID and non-COVID cases was also endorsed by Cheng *et al.* (2013, p. 415), who called for “provision of personal protective equipment and [early] isolation of patients”. The challenge, however, is that these infection control measures require budgetary investment along with dedicated resources (Cooper *et al.* 2020).

4.3. Methodology

4.3.1 Research Design

The data focuses on the early response to COVID-19 and was collected during the Irish “lockdown” between 30th of April and the 17th of May 2020. Closing the questionnaire before May 18th was critical as on this date the Irish Government eased COVID-19 restrictions. To survey the EMS first responders within this narrow timeframe, an online questionnaire was deemed the most appropriate method to collect quantitative and qualitative data.

This quantitative and qualitative data were collected and analysed concurrently, and a comprehensive understanding of participant experiences was possible due to the extensive comments provided by participants (Creswell *et al.*, 2011). Nonetheless, a limitation of this method, compared to interviews or focus groups, is that it was not possible to follow up with the participants and probe more deeply into their responses.

Participants provided quantitative responses via a combination of Likert scales, sliders, multiple-choice and binary yes/no answers, including “How did your level of worry change during the response to COVID-19 in Ireland? (Increased, Decreased or Stayed the Same)”, “My organisation has provided me with adequate Personal Protective Equipment” (1= Strongly Disagree up to 7 = Strongly Agree) and “On reflection, do you feel you were professionally prepared for COVID-19?”. Participants also completed 15 open-ended questions explaining their responses. A selection of question types from the online questionnaire is included in Figure 4.2. The study was undertaken in line with the University research ethics policy and was approved by the Research Ethics Committee.

Please indicate your level of satisfaction with respect to your organisations provision of:

	Extremely displeased	Moderately displeased	Slightly displeased	Neither pleased nor displeased	Slightly pleased	Moderately pleased	Extremely pleased	N/A
PPE	☐	☐	☐	☐	☐	☐	☐	☐
Handwashing facilities	☐	☐	☐	☐	☐	☐	☐	☐
Uniform washing facilities	☐	☐	☐	☐	☐	☐	☐	☐
Social distancing measures	☐	☐	☐	☐	☐	☐	☐	☐
Staff hygiene facilities	☐	☐	☐	☐	☐	☐	☐	☐
Clinical guidelines	☐	☐	☐	☐	☐	☐	☐	☐
Clinical directives	☐	☐	☐	☐	☐	☐	☐	☐
Cleaning guidance for Ambulances/Vehicles	☐	☐	☐	☐	☐	☐	☐	☐
Health & Well-being Advice	☐	☐	☐	☐	☐	☐	☐	☐

When was the last time you received training in the techniques for Donning & Doffing of Personal Protective Equipment (PPE).

During the COVID-19 response

within the past 6 months

within the past year

between 2 to 5 years ago

6 years ago or greater

What do you see as a particular issue(s) of concern during this pandemic response?

Has a friend/family member (who does not live in your home) contracted COVID-19?

Yes

No

Figure 4.2 A selection of question types taken from the online questionnaire.

4.3.2 Data Collection

The questionnaire was pilot tested with EMS first responders and emergency management researchers, and subsequently amended to ensure questions were correctly understood (face validity) and that questions addressing different concepts were indeed distinct from each other (content validity) (Taherdoost, 2016). PHECC distributed the survey to all members (2,092 of the 5,398 EMS first responders) who indicated, under GDPR protocols, a willingness to participate in research projects.

The 58-question questionnaire was hosted on Qualtrics. The SLR informed the questions, which elicited respondent experiences by recording socio-demographic data; participants' perceived and actual levels of risk, impact and worry; perceived preparedness; and experiences regarding staff safety, health and wellbeing both in relation to COVID-19 and more generally.

4.3.3 Data Analysis

Descriptive analysis was accomplished using the STATA software package (StataCorp; Release 14.1/SE) to provide an overview of the quantitative data. This was accompanied by content analysis of qualitative responses as detailed by Krippendorff (2018). The eight-phase analytical process is summarised below:

- **Phase 1:** Qualitative submissions and associated socio-demographic information were organised into a single table for import into NVivo R1.
- **Phase 2:** An initial set of codes were formed through “open coding”. These were labelled according to themes identified by participants themselves to “conceptualise their own experiences and world view” (Lincoln and Guba, 1985, p.334).
- **Phase 3:** The initial codes generated in Phase 2 were allocated to different categories, enabling further data analysis. Categories were revised via distilling, re-labelling, and merging to ensure their labels accurately reflected coded content.
- **Phase 4:** The newly-restructured categories were divided into sub-categories, facilitating more in-depth understanding of the data.
- **Phase 5:** Data reduction involved consolidating and refining codes into a final framework of codes.

- **Phase 6:** Analytical memos were created synopsising each categories' content.
- **Phase 7:** Analytical memos were validated by substantiating findings through evaluation of the relationships across and between categories and the effect of participant demographics on these, supported by textual quotes within the data.
- **Phase 8:** Analytical memos were combined and refined into clear findings.

4.4 Results and Discussion

815 questionnaire responses were received (response rate = 39%). The key organisations represented were the ambulance services (65.7%), fire service (17.83%) and civil defence (9.79%). The primary roles undertaken by the EMS first responders were advanced paramedics (22.2%), paramedics (40.21%), EMTs (23.95%), specialist first responders (6.47%) including mountain rescue and civil defence, and others (7.17%) which included cardiac first responders, first aid responders and a small number of doctors and nurses. It should be noted that each cohort's exposure to COVID-19 and caseloads would have varied. For example, those in specialist first responder roles were more likely to be involved in intermediate care and staffing COVID-19 testing centres while paramedics responded to 112/999 emergency dispatches. Respondents' professional experience ranged from less than one to 44 years, with a median of 10 years. All nine healthcare regions were represented. 78% of survey respondents were male, and 54% had at least one child. The experiences, challenges, and perspectives of these EMS first responders' are presented in the subsequent sections.

4.4.1 Organisational Effectiveness

47.51% of respondents agreed or strongly agreed that they felt adequately trained by their organisation to respond to the pandemic, extending to 72.40% when those who somewhat agreed were included. However, tensions were evident, with 19.06% disagreeing or strongly disagreeing that their organisation looked after their basic needs. This figure rose to 27.71% when those who somewhat disagreed were included. Some expressed frustration

with the lack of standardisation of safety procedures and inadequate communication contributed to this problem:

At a later stage, guidelines for PPE and cleaning were changed regularly (e.g. at one point there was a poster in the ambulance stating that even with a confirmed case no goggles were required unless aerosol generating procedures were part of care, this was changed 3 weeks later to a case-to-case base). (R329)

Getting emails sent to a [work] email address which I cannot access from home and may not be able to access prior to being sent off to an emergency is not good enough. Especially not when information and policies change frequently. (R329)

Such coordination issues support Hasnain *et al.*'s (2020) identification of the need for efficient ICT-based knowledge dissemination to keep pace with changing developments.

Asked if their organisation had provided adequate PPE, 56.59% agreed or strongly agreed, rising to 74.36% when those somewhat agreeing were included, while 46.24% agreed or strongly agreed that their organisation had provided appropriate PPE to enable them to do their work safely (extending to 68.95% when those who somewhat agreed were included). However, PPE remained a concern raised by over 1 in 4 responders, especially its quality and suitability:

PPE particularly the goggles fogging up is causing a lot of safety issues when dealing with the busier calls. People cannot clearly see what they are doing. (R109)

PPE equipment, why do we think droplets from sneezing and coughing won't land on our hair and shoes?? (R254)

For other respondents it was not simply about the provision of appropriate high-quality PPE, but its use among health professionals that caused concern:

Hospital staff making fun of you for being properly suited up in PPE. It really bugs me that does. (R29)

Initially, I suppose, PPE, the supply of it.....now from HCW perspective I hope that we don't become complacent with PPE (R15)

As found in the SLR, it was not only the effectiveness of PPE but its comfort and usability that influenced HCWs' adherence to wearing it (Yassi *et al.*, 2005).

450 participants responded to the open question: "If you could change one thing about the pandemic response, what would it be, and why?". The three most-common themes were: 1) the need for an earlier, speedier "lockdown", mentioned in 122 comments; 2) earlier education, training and communication (69 comments); 3) the need to maintain a stockpile of PPE (59 comments). In addition to these common themes, the word "earlier" emerged in almost 50% of responses. Similarly, though used less often, the words "sooner", "quicker", and "faster" were included when discussing PPE. The frequency and use of such words suggest pace of implementation is a key consideration for future pandemic responses. It is worth noting that overall, it seemed respondents were not critical of the actions taken, but of the time which elapsed before these actions were embedded in policy, communicated, and implemented.

Satisfaction with the quality of organisational facilities varied considerably (Figure 4.3). Satisfaction was highest for PPE, with 55.32% of respondents rating it moderately or extremely good, rising to 68.34% when those rating it slightly good were included. Uniforms and uniform storage facilities were highly criticised, with only 42.09% and 42.17% respectively rating these items as at least good. Elaborating on the reasons for their ratings, most described poor workplace facilities as a longstanding problem:

My ambulance station has 1 shower for 8 coming on duty/going off duty staff, no relief staff lockers, no sluice, no wash bay, no station cleaner, no sight of any of this changing in the foreseeable future even with current pandemic. (R415)

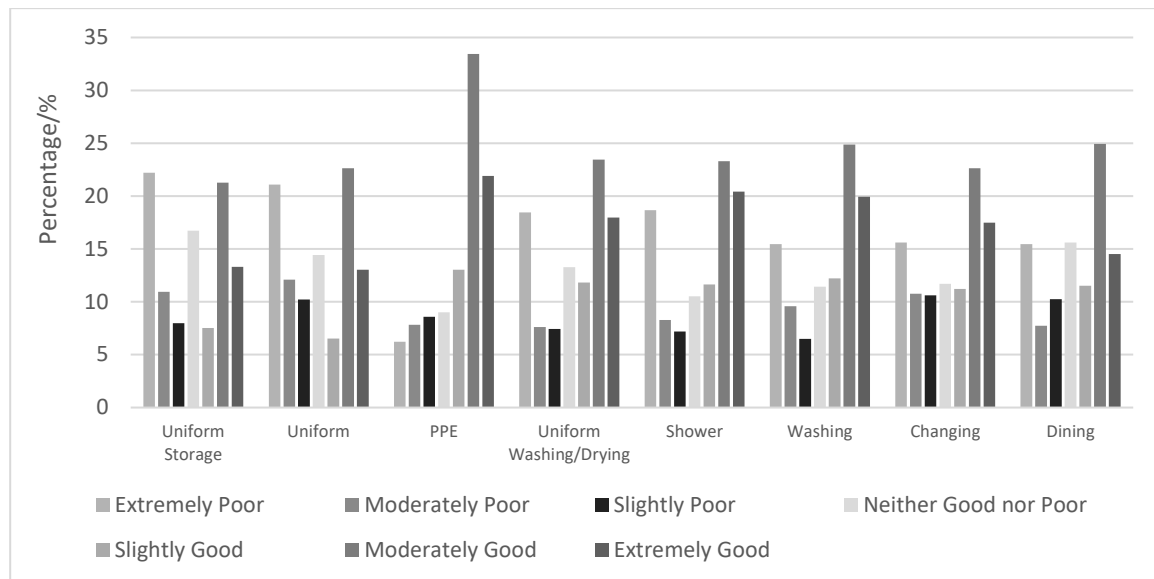


Figure 4.3 Satisfaction with facilities

4.4.2 Worry & Familial Impact

91.5% of respondents believed their occupation placed them at higher risk of contracting COVID-19, mainly due to regular contact with infected or asymptomatic patients. Participants recorded their level of worry as the virus spread from China to Italy to Ireland, on a five-point scale from “not at all” to “a great deal” (Figure 4.4). When cases were first reported in China, 38.64% were moderately or more than moderately worried, with 21.15% not at all worried. Reported levels of worry increased further when cases were reported in Italy, with 78.07% moderately worried or higher. When cases were reported in Ireland 94.09% were at least moderately worried with 33.96% reporting they worried 'a great deal'. Respondents were also asked how their level of worry changed during the response to COVID-19 in Ireland, most (42.35%) stated that their worry levels were unchanged while 17.68% reported decreased worry and 39.97% recorded increased worry.

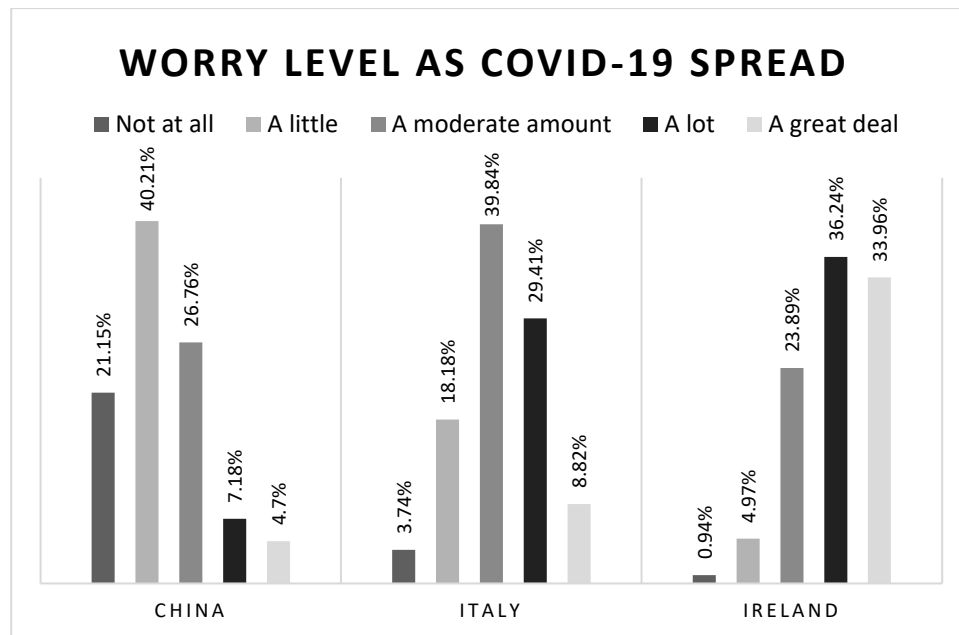


Figure 4.4 Level of Worry as COVID-19 Spread.

As identified in the literature, the chief cause of increasing worry was the fear of contracting and spreading COVID-19 (Aghili and Arbabi 2020; Angelos, 2020; Cai *et al.* 2020; Collado-Boira *et al.* 2020; Huynh *et al.* 2020; Misra *et al.* 2020; Semaan *et al.* 2020). Awareness of high transmission rates, concerns for family members with underlying conditions/vulnerabilities, and lack of public adherence to safety regulations contributed to these fears.

Concerns about family safety resulted in 82.64% of respondents reporting that COVID-19 had altered their family interactions. 387 participants related how COVID-19 impacted on their family life, with the five most-common themes being: Practice Social Distancing in the Home (coded 158 times); Social Isolation from Extended Family (coded 83 times); Sanitising Before and After Contact (coded 79 times); Social Isolation from Immediate Family (coded 74 times); Decontaminate Clothes (coded 62 times). The burden this placed on responders was exemplified by responses such as:

I work in a hospital but had to move out of my family home because I was working in the hospital and am at risk to giving it to my family. (R99)

Having to keep a distance, not able to fully relax at home, worry about infecting family, they worry about me at work. Mealtimes are affected as we now eat apart. (R109)

I minimise my time spent in their company. All my clothing is washed separately. All my ware (as in cups, cutlery, plates, and bowls) are washed and stored separately. The main bathroom has now become my bathroom only due to work for showering. (R189)

I no longer hug my family when I get home. (R198)

Sent my two sons to stay somewhere else, one of them is a severe asthmatic and I would not take the chance of me bringing the virus home to him. BREAKING MY HEART! (R534)

Sleeping alone in spare room... keeping away from vulnerable family members. Total social distancing and more awareness of hand hygiene and general disinfection use at home. (R607)

Despite these barriers to responding, the large majority desired to continue working during the COVID-19 response, with 83.48% either disagreeing or disagreeing strongly with the statement "I am not willing to work on the COVID-19 response". 72.44% reported agreement or strong agreement to being prepared to work extended hours/days as required, with the figure rising to 84.27% when those who agree somewhat were included.

Caring and childcare responsibilities were the most cited reasons affecting willingness to work on the COVID-19 response, in line with Aghili and Arbabi's (2020) observation that HCWs were shouldering the burden of caring for COVID-19 patients at work then returning to look after their family at home:

I have 5 kids at home, plus a mum who relies on me to do her weekly shopping and take care of her wounds, so I would not be available as much as I would like. (R78)

Nonetheless, on a five-point scale from very low to very high impact, more respondents perceived COVID-19 as having a high or very high impact on the nation (86.81%) than on individual households (41.69%).

Respondents were asked to reflect on how prepared they felt for the COVID-19 pandemic across three categories: professionally, domestically, and nationally. Respondents rated their level of preparedness on a scale from 0% (not at all prepared) to 100% (fully prepared), with intervals of 10%. Respondents reported a higher level of professional preparedness (mean of 52.02%) than in their household (mean of 49.82%) or nationally (mean of 40.38%). Table 4.1 presents a further breakdown of mean preparedness by role. It highlights a marked difference between paramedics and EMTs, with EMTs reporting higher levels of perceived preparedness across all three measures.

Table 4.1 Mean Preparedness by Role

Role	Professional Preparedness	Household Preparedness	National Preparedness
Advanced paramedics	49.87%	48.30%	39.03%
Paramedics	49.71%	47.69%	36.69%
EMTs	56.68%	52.81%	46.73%
Specialist first responders	53.72%	52%	38.04%

4.4.3 Ethical Dilemmas

29.2% of respondents encountered ethical dilemmas, mainly in deciding whether to advise a patient to attend hospital where there was an increased risk of contracting COVID-19. Some were quite affected by the scenes they witnessed, describing feeling conflicted about their role and being unprepared to have to make such ethical decisions in the changed circumstances of the pandemic:

Nursing home patient's family waiting outside at the ambulance to say goodbye for last time knowing their parents will die, I know they'll die,

why am I transporting someone to an ED to die. Patient died 4 hours later in a busy resus room. (R412)

Overall, 86.42% reported “Yes” that they were providing appropriate care to patients.

Those who did not often felt that PPE limited their ability to convey emotion to reassure patients, and slowed response times through cumbersome donning and doffing:

The PPE means we cannot provide that smile that makes the patient feel better, even for a second! The PPE makes everything more difficult and sweaty. (R147)

Cardiac arrests - we cannot use normal gold standard techniques and we are unable to respond immediately due to having to put on PPE, both of these are difficult for us as it gives our patients a lesser chance of survival (R211)

Those who responded to 112/999 emergency calls during COVID-19 were more likely to report experiencing ethical dilemmas during the pandemic:

Table 4.2 Experienced Ethical Dilemmas by Role

Role	Experienced Ethical Dilemmas
Advanced paramedics	38%
Paramedics	35%
EMTs	18%
Specialist first responders	15%

4.4.4 Collegial & Community Support

Respondents were aware of their vital role in the COVID-19 response. When asked if they had considered leaving their profession during the response phase of the pandemic, 80.7% answered “No”. Describing their desire to remain, 77.5% of comments were coded as the participant describing themselves as a “Fully Committed Professional” or underlining their “Desire to Play my Part”. The most recurring words in the text assigned to the “Fully Committed Professional” code were “love” and “job”. “Job” occurred in 110 of the 125

comments coded, and in conjunction with the word “love” in 50 of these comments. The word cluster in Figure 4.5 encapsulates this relationship:

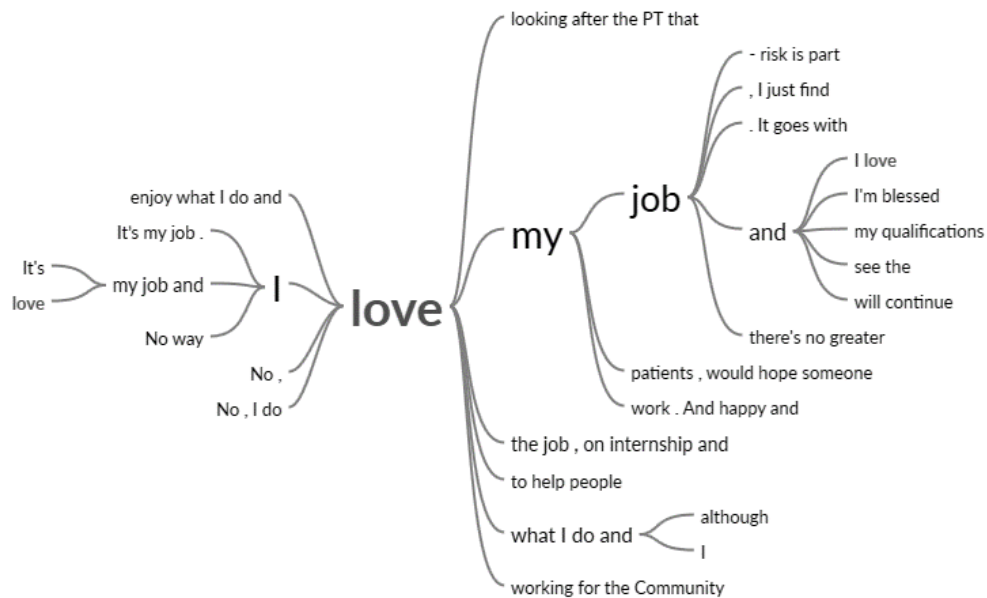


Figure 4.5 Relationship between love and job in participants’ responses

Respondents felt obliged not to abandon their co-workers, with 86.23% reporting a sense of duty to their colleagues and organisation to make themselves available to work during the response. Respondents’ loyalty to their workmates was evident, as the camaraderie of being “all in it together” emerged as the dominant theme in the reasons given for their sense of duty to co-workers:

We are all in this together. They are my second family. (R240)

When retired friends are returning to work, I am not going to turn my back on the situation. We are all needed to play our part. (R245)

Their dedication was recognised by a public outpouring of support, and respondents identified this gratitude and community spirit as the two major sources of strength spurring them on. 73.86% stated they had experienced acts of kindness during the COVID-19 response, ranging from general moral support and community goodwill to boost their

spirits, to donations of food and drink, to more personalised gestures such as childminding and collecting and delivering shopping or medication:

Clapping, candles being lit, flags hanging out. (R166)

Lots of community support. Was delivering PPE in a marked vehicle and a person came up to us and gave us lotto tickets and thanked us. (R131)

Words of thanks, allowed to skip queues in uniform, [grocery store] healthcare worker shopping (very thankful), free coffee at [service station] makes a huge difference, [fast food restaurant] feeding us, etc. It was an outpour of support. (R359)

4.5 Conclusion

The findings revealed Irish EMS first responders faced many challenges while operating during the strict COVID-19 restrictions. The ever-present risk their work brought in terms of the contraction and passing of COVID-19 to loved ones and colleagues emerged as a fundamental concern. A lack of facilities and the equipment needed for protection and sanitisation also caused distress. Participants felt a compelling duty of care to their patients, the public, colleagues and their employers. Duty of care created tensions with care for their families – especially around the increased risk of contracting COVID-19. They faced a range of ethical dilemmas including advising people to remain at home when they would typically have advised they attend hospital and bringing patients to hospital knowing this increased their risk of infection. Balancing the wearing of PPE for protection with the desire to deliver personal reassurance and care was a source of professional unease for respondents.

However, positive aspects during the response were also identified. Balancing their dedication to working during the pandemic with their personal commitments and fears of infecting loved ones revealed a fundamental humanitarianism among EMS first responders.

Likewise, the community goodwill shown to them acted as a motivator in unprecedented circumstances.

This study is not without its limitations, and further research is recommended. Firstly, EMS first responders' perceptions and experiences may have evolved over the past two years. A follow up study is advised. Secondly, the learning and challenges experienced by other emergency services, such as police, should also be captured to inform emergency management. Thirdly, this paper does not cover similarities and differences between those in different regions, ranks, roles, and organisations, thus providing further opportunities for further analysis.

Concerning pandemic planning, this study highlights where action is needed to ameliorate EMS first responders' worry and demotivation. Furthermore, it confirms a need for enhanced planning in areas such as communication, psychological support, PPE/uniforms, uniform storage, and decontamination and changing facilities. There is also a need for greater training and support in managing ethical dilemmas and the challenge of balancing professional and home life.

5. Chapter Five – Paper 4

Fire safety protection motivation and preparedness in Irish apartments:

A Post-Grenfell analysis.

Brown, G.D., Largey, A., McMullan, C. and Daffy, P., 2022. Fire safety protection motivation and preparedness in Irish apartments: a post-Grenfell analysis. *Safety Science*, 148, p.105630. <https://doi.org/10.1016/j.ssci.2021.105630>

5.0 Abstract

This study used an extended version of Protection Motivation Theory (PMT) to identify the variables that influence fire safety preparedness in apartment buildings. PMT was extended to include an individual's perceived responsibility for fire safety within their building.

A survey of 455 respondents living in apartments in Dublin, Ireland, was undertaken to ascertain the level of fire safety awareness and preparedness among residents. Data analysis included correlations, ordinary least squares regressions and probit analysis.

The findings reveal a worrying lack of preparedness and that fire safety preparedness motivation is complex, sometimes producing counterintuitive results. For example, a high level of worry about a fire increased the probability that a respondent tested their smoke detector(s) by 27.4 pp, yet was associated with a 33.3 pp reduction in the probability that a respondent acted in line with the building evacuation policy. The factors which influenced preparedness motivation also varied depending on the specific safety measure. For instance, assuming a personal responsibility for fire safety in the building was positively associated with perceived preparedness and having an extinguisher or fire blanket. Conversely, no relationship was observed between personal responsibility for fire safety and the presence

of household fire plans, appropriate fire alarm response behaviour, or smoke detector testing.

The critical contribution of this study is the identification of factors that act as barriers to, or facilitators of, fire safety in residential apartments. Understanding what drives fire safety can be used to enhance the effectiveness of preparedness messaging to inform public fire safety campaigns.

5.1. Introduction

5.1.1. Background & Context

The risks associated with fires in residential accommodation are complex due to factors such as occupancy density, building type, the behaviour of residents, the level of fire risk awareness and preparedness, and the influence of a wide range of socio-demographic characteristics (Canter, 1990; Kobes *et al.*, 2010; Glauberman and Qureshi, 2018). These risks are heightened in high-rise, multi-unit apartments, making the need for fire safety and risk mitigation measures within these buildings even more critical. In their review of human behaviour in fires, Thompson *et al.* (2018) made the distinction between residential and PCI (public, commercial and industrial) fires and, within residential fires, distinguished between those in single occupancy homes and high-rise multi-occupancy buildings. They suggested high-rise dwellings incorporated features of both PCI and single occupancy homes, i.e., they have both communal areas and private spaces and, while less formal than in PCIs, apartment buildings also tend to have some form of building management, all of which influence fire safety management.

The Grenfell Tower fire in London, June 2017, brought the risk of fire within residential apartments to the forefront of government and public attention. In the aftermath of this

tragedy and out of concern for the safety of residents living in similar circumstances, the Irish Government instigated a national review of fire safety, including an audit of multi-storey, multi-unit apartment buildings (Murphy, 2017). Completed in May 2018, the review called for further research to determine “the extent to which fire safety measures are in place in peoples’ homes and the public’s understanding of risk in the domestic setting with a view to informing further fire safety campaigns” (NDFEM, 2018, p.24). In response to the call, this study explored the factors influencing fire safety preparedness within Irish residential apartments in order to provide critical insight into fire safety preparedness and make a theoretical and practical contribution to fire safety research.

Previous research has shown that fire preparedness actions taken by residents were influenced by knowledge and experience, perceived responsibility, and risk awareness (Kobes *et al.*, 2010; McLennan *et al.*, 2013). However, risk awareness alone has been shown to have only a weak correlation with positive fire safety behaviour (McCaffrey, 2008). While fire safety campaigns are used to promote good practice in the home, influence attitudes, and raise public awareness of the preparedness measures that should be implemented (Department of Housing, Planning and Local Government, 2019), risk communication and fire safety campaigns must be built upon sound research and a greater understanding of the specific factors which promote good fire safety behaviour if they are to influence protection motivation.

5.2. Research Objectives

The objectives of this study were twofold: firstly, to examine the level of fire safety awareness and preparedness within residential apartments, and secondly to determine the factors that motivate or deter apartment residents from adopting fire safety measures in

their homes by applying an extended Protection Motivation Theory (PMT) model (see Section 2.1 for an overview of PMT).

A range of models have been developed to explain and predict behaviour intentions and actual behaviours (Jansen and van Schaik, 2017) when faced with perceived risks or hazardous situations. The most prominent of these models include PMT (Rogers 1975; Maddux and Rogers, 1983), the Protective Action Decision Model (Lindell and Perry, 2000), the Health Belief Model (Rosenstock *et al.*, 1988) and the Reasoned Action Approach (Fishbein and Ajzen, 2010). The key strengths of PMT, as outlined by Jansen and van Schaik (2017, p.167), include its applicability to a range of scenarios, the fact it has “evolved over time towards a powerful explanatory theory for precautionary behaviour”, and unlike some adoption theories, PMT includes the concept of risk. PMT focuses on the “cognitive processes that individuals apply in order to evaluate threats and coping measures” (Jansen and van Schaik, 2017, p.167), where theories such as the Health Belief Model consist of a set of variables that have an effect on behaviour. Finally, a key strength of PMT is its value as a framework on which interventions and communication campaigns may be developed and evaluated (Norman *et al.*, 2005).

While PMT has been used to examine emergency preparedness behaviours in several risk contexts: earthquakes (Mulilis and Lippa, 1990), flooding (Grothmann and Reusswig, 2006; Poussin *et al.*, 2014; Bubeck *et al.*, 2018), and wildfires (Martin *et al.*, 2007; Westcott *et al.*, 2017) it has not been applied to apartment fires. Given the limited research focused on apartment fires (Glaubergerman and Qureshi, 2018), it is unknown whether the same factors that influence protection motivation apply. For example, individuals may feel a greater sense of control over residential fires than over risks such as floods, hurricanes, and earthquakes (Stumpf *et al.*, 2017).

5.2.1. Protection Motivation Theory

Rogers first proposed PMT as a model which described a person's motivation to protect themselves within the context of health-related risks (Rogers, 1975; Maddux and Rogers, 1983). At the centre of PMT are two key determinants of preparedness behaviours. The first is threat appraisal which is described as the process used to evaluate risk (Rogers and Prentice-Dunn, 1997). Sometimes likened to risk perception (Grothmann and Reusswig, 2006), it is the "subjective judgment[s] that people make about the characteristics and severity of a risk" (Darker, 2013, p.110), threat appraisal can be described as an individual's assessment of their vulnerability (perceived likelihood of a risk occurring) and the risk severity (perceived impact should a risk occur) (Rogers and Prentice-Dunn, 1997). Connected with threat appraisal are factors such as fear and worry (Babicky and Seebauer, 2019; Rogers, 1975), which play a secondary role in the threat appraisal process (Rogers and Prentice-Dunn, 1997). Fear and worry influence how an individual assesses risk and their decision to take protective action (Miceli *et al.*, 2008; Reynaud *et al.*, 2013).

According to PMT, the second key determinant of preparedness behaviour is coping appraisal, an individual's assessment of their perceived ability to cope and mitigate risk (Rogers and Prentice-Dunn, 1997). Three variables inform the coping appraisals (Rogers and Prentice-Dunn, 1997; Grothmann and Reusswig, 2006): 1) response efficacy: the perceived effectiveness of the protective action; 2) self-efficacy: an individual's perceived capability to carry out the protective action; 3) cost-efficacy: the perceived costs (time and financial costs) associated with adopting the protective action. PMT suggests a person will be motivated to take preparedness action if they think that the risk posed is high (a high threat appraisal), and if they perceive that the protective action(s) available are effective, feasible to implement, and not too costly (a high coping appraisal) (Rogers and Prentice-Dunn, 1997; Grothmann and Reusswig, 2006; Poussin *et al.*, 2014). Furthermore, the

intention to prepare for an emergency may also be influenced by several other variables (Grothmann and Reusswig, 2006; Martin *et al.*, 2007; Poussin *et al.*, 2014), including:

- Prior exposure to an emergency;
- Fatalism, denial, and wishful thinking – commonly described as non-protective responses;
- Socio-economic variables such as age, gender and homeownership.

This study extends PMT by including a measure for personal responsibility (Mulilis and Duval, 1997; Mulilis *et al.*, 2001). It was necessary to consider personal responsibility for fire safety as research showed a significant relationship between this and the taking of protective actions (Beringer, 2000; Martin *et al.*, 2007; McCaffrey *et al.*, 2011; McNeill *et al.*, 2013).

5.3 Methods

5.3.1 Research Design

This study used a cross-sectional design with a sample of 455 respondents drawn from residents of apartments in Dublin. Data collection employed a survey methodology, using a questionnaire designed on the Qualtrics platform. Academic and government questionnaires informed the questionnaire design (FEMA, 2015; Grothmann and Reusswig, 2006; Martin *et al.*, 2007; Terpstra and Lindell, 2013; Poussin *et al.*, 2014). To help ensure accuracy and validity, the questionnaire was pilot-tested with specialists in emergency management and members of the public to refine the questions based on their feedback before its distribution.

The extended version of PMT measured the key determinants of preparedness behaviours, namely: threat appraisal in the form of respondent's risk ratings (likelihood*impact ratings), the influencing factors concern and worry, and coping appraisal through response-

efficacy, self-efficacy, and cost-efficacy. Other PMT-related variables recognised in the literature as affecting preparedness were: fatalism (associated with non-protective responses) and direct and indirect exposure to fire. Additionally, several measures related to fire safety and preparedness (e.g., declaring the smoke detector(s) were tested and evidence of fire evacuation plans) were included. Each variable is defined in Section 3.3.

5.3.2 Data Collection Procedure

This research complies with the University's research ethics policy. The study, classified as a low-risk social research project, was approved by the Business School Research Ethics Sub-Committee. In line with this policy, participation was voluntary, responses were anonymous, participants received a plain language statement before completing the questionnaire, and respondents provided informed consent before proceeding.

A sample of seven high-rise apartment complexes from a diverse range of locations in Dublin city were randomly selected from the Dublin Fire Brigade database. An overview of the research and its objectives were outlined in a leaflet format and 1500 of these flyers were printed and then distributed at the seven apartment complexes between April 26th and May 27th, 2018.

Similar to McLennan *et al.* (2015, p.41), it was not “practical (in light of budget and time constraints) to conduct a mail survey of residents, nor to conduct interviews with selected individual householders”. Instead, an occupant from each apartment was asked to participate by completing the online questionnaire (linked via URL and QR code). Once the participant opened the online link, they received the plain language statement explaining the purpose of the study and were then directed to the questionnaire. Apartment occupants also shared the questionnaire online, thus participants extended beyond the seven sites originally identified.

5.3.3 Measures

5.3.3.1 Dependent Variables

General household preparedness tends to be measured using indicators such as the quantity of emergency-related items/resources within the home, existence of an emergency plan, physical protection measures, and preparedness actions (Kirschenbaum, 2002; Levac *et al.*, 2012). Following this approach, a set of four actual fire safety preparedness measures were identified:

1. Having a fire blanket or fire extinguisher (NDFEM, 2013; Knuth *et al.*, 2017);
2. Smoke detector testing (at least yearly testing of the fire detection and alarm systems);
3. Acting in line with the fire evacuation policy for the building (Proulx, 1995; Proulx, 1999; NDFEM, 2018);
4. Having a household emergency plan (Department of Homeland Security, 2018; Red Cross, 2018; Paton *et al.*, 2005).

In addition to these four actual preparedness indicators, respondents were asked to rate their perceived level of preparedness for an apartment fire. Research into household preparedness suggests a weak relationship between perceived preparedness and actual preparedness (Kapucu, 2008; Basolo *et al.*, 2009; Kirschenbaum *et al.*, 2017; Brown *et al.*, 2021a,b). To minimise order effects bias, the effect of the sequencing of questions on the nature of a respondent's answer (Perreault, 1975), perceived preparedness was measured early within the questionnaire before respondents were shown any other fire preparedness-related questions. An 11-point scale measured perceived preparedness within the questionnaire, shown to respondents as a scale from 0% to 100%, at intervals of 10%.

Having a fire blanket or a fire extinguisher was coded as 1 if respondents reported having either resource within the apartment and 0 if they reported having neither.

Smoke detector testing measured the frequency with which the apartment's smoke detector(s) were tested. Responses were coded as 0 if respondents were not aware of the frequency of testing or if they did not test the smoke detector(s) at least once a year. The remainder of the sample, coded as 1, declared the detector(s) were tested between "more than once a month" to "once a year".

Research suggested that a variety of factors may influence occupants' behaviour upon hearing an evacuation alarm. For example, slower evacuations were more likely late in the evening or during the night when "occupants may be asleep, not dressed, etc. (i.e., they are not ready to evacuate)" (Ronchi and Nilsson, 2013, p.6). Others may be hesitant to evacuate, sometimes only leaving when directly instructed to do so. Finally, some choose to ignore the recommended evacuation route opting instead for their most familiar exit route (Proulx, 1995; Proulx, 1999). In the absence of direct observation, respondents were asked to confirm they would act in line with the building evacuation policy in response to a fire alarm, coded as 1, and coded as 0 for those declaring they would not follow the evacuation policy, e.g., investigate the fire alarm or ignore the fire alarm.

Having a household emergency plan was coded as 1 if respondents have an apartment fire or evacuation plan and 0 otherwise.

5.3.3.2 Explanatory Variables

Drawing from the literature and informed by an extended version of PMT (see Section 2.1), several explanatory variables likely to influence fire safety behaviours were selected.

Threat appraisal is indicated by three variables: risk rating, worry, and concern. According to PMT, a higher threat appraisal was expected to lead to a higher motivation to prepare and a greater likelihood of protective action (Rogers and Prentice-Dunn, 1997). However,

this relationship between perceived risk and taking protective action is not always evident empirically. For example, Kinateder *et al.* (2014; 2015) in a review examining the association between perceived risk and evacuation behaviour during the attacks on the World Trade Center on September 11th, 2001, found conflicting results between studies.

To be consistent with other PMT related studies, a risk rating was used (see, Grothmann and Reusswig, 2006; Martin *et al.*, 2007; Poussin *et al.*, 2014; Babcicky and Seebauer, 2019). Risk rating was measured as the likelihood of a fire occurring multiplied by the impact should it occur. Likelihood and impact were assessed on five-point Likert scales from the Irish National Risk Assessment process (McMullan *et al.*, 2018; Brown *et al.*, 2021a,b). Likelihood was scaled from extremely unlikely to very likely, and impact ranged from very low to very high.

Worry and concern regarding the risk of fire were measured using two independent scales. Worry about an apartment fire was measured using a four-point scale, from no worry up to a high level of worry. The probit models (see Section 3.3.3) included three dummy variables to capture worry levels, using “no worry” as the base category. The factor “concern (fire alarm)” measured how respondents reported feeling when a fire alarm was activated in their building using an 11-point scale and was shown to respondents as a percentage from 0% to 100%, with 10% intervals. 0% indicated staying calm or relaxed, and 100% indicated nervousness or fear.

PMT indicates that higher coping appraisal results in greater motivation to prepare and a higher likelihood of protective action (Rogers and Prentice-Dunn, 1997). Coping appraisal was captured using a dummy variable. This was coded 1 if respondents satisfied the requirements for a high coping appraisal, i.e., selected none of the statements below as applicable to them, and 0 otherwise.

- Related to response-efficacy: “Nothing I do to prepare will help should this emergency occur”; “I don’t think it will make a difference”.
- Related to self-efficacy: “I don’t know what to do”; “I will cope as I am”.
- Related to cost-efficacy: “I haven’t had time”; “It was too expensive”.

The questionnaire included six non-protective response options to account for respondents who adopt a more fatalistic perspective towards the risk of an apartment fire. These related to fatalism, denial, and wishful thinking: “I don’t want to think about it”; “I was okay during a previous fire; therefore, I will be okay in the future”; “The buildings fire suppression system will protect me”; “Others will help me, e.g. the emergency services, community members, etc.”; “I’m renting, it’s the landlord’s responsibility”; “I do not need to prepare for this emergency”. According to Grothmann and Reusswig (2006), non-protective responses should negatively affect respondents’ motivation to prepare and reduce the likelihood they will take protective action. Respondents who presented at least one fatalistic reason for not taking action (“non-protective response”) were coded as 1, 0 otherwise.

Stumpf *et al.* (2017, p.101) recommended that future studies on residential fires consider not just whether respondents had previous experience of such fires, but should differentiate based on the closeness of the experience, “fire at their own home, in someone else’s house, etc.”. The importance of indirect experience was also emphasised by Becker *et al.* (2013, p.1718), who found it “could prompt people to think about safety or undertake safe practices”. PMT-related research by Grothmann and Reusswig (2006) and Poussin *et al.* (2014) suggested that risk exposure can positively influence motivation to prepare, which can result in a higher likelihood of protective action. To measure prior exposure to a household fire, respondents were asked whether they had experienced a fire directly or indirectly (someone close to them has experienced a fire). Responses were recorded as two dummy variables.

Respondents were asked to identify with whom they felt responsibility for fire safety within the apartment building lay (termed perceived responsibility). Respondents could select multiple options: “The apartment management company”; “The residents”; “Landlords”; “The fire service”; and “Unsure”. In the regression, perceived responsibility for fire safety was coded as a dummy variable. Respondents who perceived the residents hold joint responsibility for fire safety within the apartment building were coded as 1. Those who did not indicate residents were responsible were coded as zero. Taking some responsibility for fire safety was expected to be positively related with protective actions (McCaffrey *et al.*, 2011; McNeill *et al.*, 2013).

Additional factors measured within the questionnaire included:

- Awareness of the presence of an evacuation plan (or set of evacuation instructions) located inside the apartment or within the building’s hallway. The purpose of an evacuation plan is to support residents in attaining situational awareness and inform decision making when evacuating a building (Craighead, 2009). It was hypothesised that a positive relationship would exist between an awareness of the displayed evacuation plan and three dependent variables: following the buildings evacuation policy, having a household fire/evacuation plan, and perceived preparedness.
- Whether they received fire safety training/evacuation instructions at their apartment complex or at work/school/college/university. Receiving such training should positively influence motivation to prepare and result in a higher likelihood of protective action.
- Respondents were also asked whether they would try to extinguish a fire or call for help if they discovered a small fire within their apartment. Willingness to fight a small fire was hypothesised to have a positive relationship with perceived preparedness, having a fire blanket or fire extinguisher, and having a household fire/evacuation plan.

Table 5.1 defines these variables and Table 5.2 describes the respondents' socio-demographic characteristics.

Table 5.1 Data description: dependent and explanatory variables.

Characteristic	Summary Statistics	Description
Perceived Preparedness	N=435	
Mean (Standard Deviation)	5.05 (2.45)	Range 0 (Not at all prepared) - 10 (Completely prepared)
Fire Blanket or Fire Extinguisher	N=347	
Has a fire blanket or fire extinguisher	68.6%	1 if yes, 0 otherwise
Household Emergency Plan	N=359	
Has a household emergency plan	60.7%	1 if yes, 0 otherwise
Building Evacuation Policy	N=355	
Follows the building evacuation policy	65.4%	1 if yes, 0 otherwise
Smoke Detector(s) Tested	N=337	
Aware of a test at least once a year	60.8%	1 if yes, 0 otherwise
Risk Rating	N=455	
Mean (Standard Deviation)	13.03 (5.65)	Range 1-25, Mode: 12
Worry	N=455	
No worry	19.1%	Reference category
Low level of worry	39.1%	1 for Worry: Low, 0 otherwise
Moderate level of worry	29.0%	1 for Worry: Moderate, 0 otherwise
High level of worry	12.7%	1 for Worry: High, 0 otherwise
Concern (Fire Alarm)	N=435	
Mean (Standard Deviation)	4.85 (2.5)	Range 0 (No concern) -10 (Very concerned)
Coping Appraisal	N=359	
High coping appraisal	69.6%	1 if high coping appraisal, 0 otherwise
Non-protective Responses	N=359	
Selected a fatalistic reason for not taking action	15.3%	1 if respondents presented at least one reason for not taking action, 0 otherwise
Prior Exposure to a Household Fire	N=416	
Directly experienced a fire	30.5%	1 if yes, 0 otherwise
Indirectly experienced a fire	16.1%	1 if yes, 0 otherwise
Responsibility for Fire Safety	N=337	
The residents	59.1%	1 if respondents perceived joint responsibility for fire safety, 0 otherwise
The apartment management company	65.3%	
Landlords	22.8%	
The fire service	12.5%	
Unsure	4.5%	
Received Safety Instruction	N=330	
Apartment	12.1%	1 if received safety instruction at apartment, 0 otherwise
Received Safety Instruction	N=333	
Workplace	90.4%	1 if received safety instruction at work/school/college/university, 0 otherwise
Willingness to Fight Fire	N=347	
Expect they would try to extinguish a fire	36.9%	1 for willingness to fight a fire, 0 otherwise
Displayed Evacuation Map (Aware)	N=357	
Awareness of the evacuation plan	43.4%	1 for awareness of evacuation map, 0 otherwise

Table 5.2 Socio-demographic characteristics.

Characteristic	Summary Statistics	Description
Gender	N=334	
Female	50%	1 if female, 0 otherwise
Age	N=334	
34 or under	24.6%	Reference category
35-54	63.5%	1 if aged 35-54, 0 otherwise
55 or older	12%	1 if aged 55 or older, 0 otherwise
Child/Children (age<18) in the Apartment	N=331	
At least one child present	23.3%	1 for child present, 0 otherwise
Education	N=334	
Higher Educated	71.9%	1 if higher educated, 0 otherwise
Household Income	N=326	
Below 30,000	12.3%	Reference category
30,000-70,000	61.7%	1 for income 30,000-70,000, 0 otherwise
Over 70,000	26.1%	1 for income over 70,000, 0 otherwise
Rents or Owns the Apartment	N=334	
Renting	42.2%	Excluded from the probit analysis
Household Insurance	N=333	
Insurance	58.3%	1 for home is insured, 0 otherwise
Ethnicity	N=332	
White	97.6%	Excluded from the probit analysis
Reported Physical Disability	N=429	
Physical Disability which impacts fire preparedness actions	0%	Excluded from the probit analysis
Floor Apartment is Situated on	N=455	
Ground or Basement	20.4%	Combined in reference category
1 st Floor	24.2%	Combined in reference category
2 nd Floor	22.2%	Combined in reference category
3 rd Floor	15.6%	Combined in reference category
4 th Floor	8.8%	Combined in reference category
5 th Floor or higher	8.8%	1 for 5th floor or higher, 0 otherwise
Number of Floors in the Apartment Block	N=445	
Two floors or less	11.5%	Combined in reference category
Three floors	28.5%	Combined in reference category
Four floors	22.2%	Combined in reference category
Five floors	19.6%	Combined in reference category
Six or more floors	18.2%	1 for six or more floors, 0 otherwise

5.3.3.3 Quantitative Data Analysis

Analysis was completed using the statistical software package STATA (StataCorp: Release 14.2/SE). Regression analysis was used to estimate the relationship between each of the five dependent variables discussed above and the same set of explanatory variables. For each dependent variable, Y^* , we have:

$Y^* = f$ [*threat appraisal (risk rating, concern, worry), coping appraisal, non-protective response, prior exposure to fire, perceived responsibility for fire safety, safety training, willingness to fight fire, insurance, evacuation awareness, socio-demographics*]

The functional form underlying each regression is: $Y_i^* = X_i\beta + \varepsilon_i, i = 1 \dots N$ (Equation 1), where Y_i^* is the value of the dependent variable for individual i , X_i is the $(1 \times k)$ vector of explanatory variable values for individual i , $\varepsilon_i \sim N(0, \sigma^2)$ is the random error term for individual i , β is the $(k \times 1)$ vector of coefficients to be estimated, and N is the total number of observations.

For the continuous dependent variable, perceived preparedness, Ordinary Least Squares (OLS) regression was used to estimate β . The OLS results are presented as Model 1 in Table 5.6. Included are partial eta-squared values (η_p^2) as measures of effect size. For each independent variable, η_p^2 measures the proportion of the variance in the dependent variable explained by that independent variable, having partialled out the contribution of all other independent variables. The benchmark values for small, medium and large effects are taken as 0.01, 0.09 and 0.25 respectively (Cohen 1988).

For each of the four binary variables (fire blanket or fire extinguisher, household fire/evacuation plan, follow the building evacuation policy, and smoke detector(s) tested at least once a year), coefficients were estimated using Probit analysis. It was assumed that for each binary dependent variable, there exists an unobservable continuous variable Y^* , with observations described by Equation 1. This latent variable can be thought of as a measure of the ‘tendency’ to take protective action. The observed variable, the binary counterpart, Y , is defined as $y_i = 1$ if $Y_i^* > 0$, and 0 otherwise. Under normally distributed error terms, the likelihood of a single observation (y_i, X_i) is given by $L(\beta, y_i, X_i) =$

$F(X_i\beta)^{y_i} (1 - F(X_i\beta))^{1-y_i}$, where $F(.)$ is the cumulative normal distribution. Given independently and identically distributed (IID) observations, the product $L(\beta, Y, X) = \prod_{i=1}^N F(X_i\beta)^{y_i} (1 - F(X_i\beta))^{1-y_i}$ is the likelihood of the entire sample. The coefficient vector was estimated as that which maximises the likelihood of the observed sample. That is, β was estimated by Maximum Likelihood Estimation.

Estimated coefficients for the binary dependent variable models are reported as Models 2 to 5 in Tables 5.6 and 5.7.

The magnitudes of the impact of explanatory variables on the binary dependent variables are identified more readily in the marginal effects presented in Table 5.8. These report the change in the predicted probability of observing a 1 on the dependent variable given a unit change in the independent variable. The marginal effect of each independent variable is computed assuming the values of all other explanatory variables at their means.

Where a socio-demographic factor was non-significant across all dependent variables, and where its exclusion improved the OLS-adjusted R^2 and the probit model fit statistic (the percentage of cases correctly classified), the factor was removed from the final model. This resulted in “Renting” being removed from the model. As none of the respondents declared a physical disability and only eight were non-white, these factors could not be tested.

For both the OLS regression and probit analyses, checks for multicollinearity were conducted. The Variance Inflation Factor (VIF) scores did not indicate a problem of multicollinearity, with the maximum VIF at 2.75 and a mean VIF score of 1.42. Thus, these were within acceptable limits as a VIF score of five or over indicates multicollinearity (O’Brien, 2007). In addition, the analysis used robust standard errors to address any concern of heteroscedasticity.

5.4 Results & Discussion

5.4.1 Fire Safety Behaviours: Awareness & Preparedness Levels

In Ireland, it is a legal requirement for apartment complexes to have smoke detectors fitted and that those in control of the apartment building “take all reasonable measures to guard against the outbreak of fire on such premises, and to ensure as far as is reasonably practicable the safety of persons on the premises in the event of an outbreak of fire” (Fire Services Act 1981, Section 18-2). Therefore, it was not surprising that the results show that 97.4% of respondents reported having a smoke detector within their apartment. In addition to having a smoke detector, the smoke detector must be tested regularly. Fire safety campaigns across Ireland are used to encourage weekly smoke detector testing, for example, the “Test-It-Tuesday” media campaign (NDFEM, 2018). However, the results showed that nearly 40% of respondents declared their smoke detector(s) were not tested at least once a year. Of the remaining 60.8% who did, only 6.8% (23n) declared that the smoke detector(s) were tested more than once a month, with 16.9% (57n) reporting smoke detector tests once a month, 24.9% (84n) once every six months and 12.2% (41n) once a year. This finding is in line with the results of McMullan *et al.* (2015) and confirms that the concerns of the NDFEM were justified: “it is not as clear that all are tested and are functioning at this high percentage” (NDFEM, 2018, p.22). The results suggest that although there has been an uptake in the installation of domestic smoke detectors, there remains a need for ongoing national smoke detector testing campaigns.

Overall, only 52.4% (175n) of respondents knew of a fire blanket within their apartment. Although legislation within Ireland stipulates that rental properties within multi-unit buildings must include smoke detector(s), an emergency evacuation plan, and a suitably located fire blanket (Housing (Standards for Rented Houses) Regulations, 2017), 43.3%

(61n) of renters were not aware of a fire blanket within their apartment. This compares with 50.8% (98n) of owners. A chi-square test of association was undertaken to test for a connection between ownership/rental status and awareness of an apartment fire blanket. The results revealed no significant association.

With regard to respondents' awareness of the presence of a fire evacuation plan, the findings revealed that only 43.4% (155n) of respondents reported they knew of a displayed fire evacuation plan. Further testing of ownership/rental status and awareness of a displayed fire evacuation plan, using a chi-square test of association, suggested no significant connection. Only 12.1% (40n) indicated they had received instruction or training in fire safety/evacuation at their apartment complex, although 90.4% (301n) had received similar training at work, school or college/university.

The findings concerning other safety-related emergency resources are shown in Table 5.3, with seven of the ten items being held by at least 50% of respondents. Table 5.3 shows that where a respondent does not have the resource, in most instances, there is an almost 50% split between them stating "No", they do not have the item, and "No, though I should get this". This suggests a further willingness by some respondents, if motivated, to take additional responsibility and enhance their fire safety preparedness.

Table 5.3 Safety-related emergency resources.

Resource	%(n)	Resource	%(n)
Smoke detector		Fire extinguisher	
No	2% (7n)	No	22.8% (79n)
No, though I should get this	0.6% (2n)	No, though I should get this	22.5% (78n)
Yes	97.4% (338n)	Yes	54.8% (190n)
Carbon monoxide detector		Fire blanket	
No	26.2% (91n)	No	22.8% (79n)
No, though I should get this	21.9% (76n)	No, though I should get this	24.8% (86n)
Yes	51.9% (180n)	Yes	52.4% (182n)
First aid kit		Emergency contact information (Paper format)	
No	16.7% (58n)	No	44.1% (153n)
No, though I should get this	19.9% (69n)	No, though I should get this	36% (125n)
Yes	63.4% (220n)	Yes	19.9% (69n)
Torch		Extra batteries	
No	12.1% (42n)	No	19.6% (68n)
No, though I should get this	12.4% (43n)	No, though I should get this	16.7% (58n)
Yes	75.5% (262n)	Yes	63.7% (221n)
A protective container for documents		Emergency evacuation smoke mask	
No	48.4% (168n)	No	64% (222n)
No, though I should get this	38.9% (135n)	No, though I should get this	34% (118n)
Yes	12.7% (44n)	Yes	2% (7n)

Notes: N=347

Given that fire preparedness actions taken by residents may be influenced by perceived responsibility for fire safety in the building (Kobes *et al.*, 2010, McLennan *et al.*, 2013) ten chi-square tests of association were completed: four of the ten tests show a significant association with residents' perceived responsibility. These were for having a fire extinguisher, χ^2 (df=1, n=337) = 6.374, p=.012, phi = .14; having a first aid kit, χ^2 (df=1, n=337) = 9.839, p=.002, phi = .17; having a torch, χ^2 (df=1, n=337) = 9.538, p=.002, phi = .17; and having extra batteries, χ^2 (df=1, n=337) = 4.488, p=.034, phi = .12. This indicated the presence of a small, statistically significant association between each of the four emergency resources and residents' perceived responsibility for fire safety in the building.

Hulse *et al.* (2020) found that personal experience of fire was significantly positively associated with a willingness to attempt to extinguish flames. A chi-square test of association was completed to examine whether respondents' experience of a fire (direct or indirect) influenced willingness to fight apartment fires. The test was not significant,

suggesting no significant association between experience of a fire (direct or indirect) and a willingness to fight apartment fires.

Considering fire safety actions taken to protect an apartment, Table 5.4 shows that 33.1% of respondents indicated they had not taken action. When asked why not, 42.8% of those who stated a reason reported they did not know what action they could undertake, suggesting a greater need for preparedness communication messages designed to assist households in understanding what preparedness actions they should take to mitigate the dangers posed by an apartment fire.

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Table 5.4 Household barriers to fire safety actions.

	%(n)
Protective Actions	
Acted to protect apartment = Yes	66.9% (291n)
Stated Reason(s) for Inaction	31.7% (138n)
Don't know what to do	42.8% (59n)
Renting, i.e., the landlord/ management company should take the action	14.5% (20n)
Will cope without needing to prepare	13% (18n)
Don't think it will make a difference	13% (18n)
The building is safe and has a fire system/alarm	9.4% (13n)
Don't want to think about it	8% (11n)
Don't have the time	7.2% (10n)
Others will help me (e.g., emergency services)	7.2% (10n)
Too expensive	4.3% (6n)
Was okay during a previous fire; therefore, I will be okay in the future	0.7% (1n)
No Reason for Inaction Provided	1.38% (6n)

Note: N=435

Respondents were asked how they would react when a fire alarm activation occurs in their building. They could select their answer from several choices, as listed in Table 5.5. If they indicated they would not follow the evacuation policy in response to a fire alarm, they were asked to explain their rationale. In total, 34.6% reported they would not act in line with the fire evacuation policy for their building. 12.4% suggested they first look to neighbours for guidance, and 10.7% suggested they either ignore the alarm or wait until instructed to leave the apartment. For 62.4% of those who did not follow the policy, the reasons given was the “cry wolf” effect; i.e., occupants perceived the fire alarm activation was yet another false alarm.

Table 5.5 Response to a fire alarm.

	%(n)	N
Fire Alarm Activation		355n
Follow building evacuation policy	65.4% (232n)	
Other response to a fire alarm	34.6% (123n)	
Look to neighbours for guidance	12.4% (44n)	
Ignore the alarm / will not leave until instructed	10.7% (38n)	
Check on neighbours	5.4% (19n)	
Investigate / Check fire panel	3.7% (13n)	
Carry on and complete the current task	2.0% (7n)	
No alarm	0.6% (2n)	
The explanation for the “Negative reaction”/outcome		114n
The fire alarm is continually going off, so I believe that it is probably a false alarm	62.3% (71n)	
I wait for instruction from other people	13.2% (15n)	
Unsure what to do or where to go	13.2% (15n)	
Check/investigate	7% (8n)	
I wait for instruction from emergency services	4.4% (5n)	

A point-biserial correlation showed a statistically significant correlation between preparedness and each of the four constructs for actual fire safety preparedness. Perceived preparedness correlated with:

- Having a fire blanket or fire extinguisher $r_{pb} = 0.103, p = 0.054$. Those having such items presented on average with a higher perceived preparedness score of $\bar{x} = 5.10$, with standard deviation s.d. = 2.49, compared to $\bar{x} = 4.55$, s.d. = 2.40, for those who did not have the items;
- Having a household emergency plan $r_{pb} = 0.467, p < 0.001$. Those who had a household emergency plan presented on average with a higher perceived preparedness score of $\bar{x} = 5.86$, s.d. = 2.25, compared to $\bar{x} = 3.48$, s.d. = 2.13 for those who did not have a plan;
- Declaring smoke detector(s) were tested $r_{pb} = 0.220, p < 0.001$. Those who declared the smoke detector(s) were tested presented on average with a higher perceived preparedness score of $\bar{x} = 5.33$, s.d. = 2.43, compared to $\bar{x} = 4.22$, s.d. = 2.37, for those who did not;

- Following the building evacuation policy in response to a fire alarm activation $r_{pb} = .140, p = 0.009$. Those who suggested they would act in line with the fire evacuation policy presented on average with a higher perceived preparedness score of $\bar{x} = 5.18, s.d. = 2.39$, compared to $\bar{x} = 4.45, s.d. = 2.60$, for those who did not.

5.4.2 Regression Analysis Associated with Fire Safety Behaviours

The following section reports the findings relating to objective two by exploring the factors that act as barriers to or facilitators of personal fire safety in residential apartments by applying an extended PMT model. These findings are reported from the five regression models presented in Table 5.6 and Table 5.7.

Table 5.6 Regressions: part 1.

Explanatory Variables	Model 1 Perceived Preparedness				Model 2 Fire Blanket or Fire Extinguisher		
	Coef.	Robust Std. Err.	P	η_p^2	Coef.	Robust Std. Err.	P
Risk Rating	-0.008	0.028	0.777	0.000	-0.044**	0.016	0.007
Concern (Fire Alarm)	0.031	0.068	0.644	0.001	0.043	0.040	0.285
Worry: Low	-0.030	0.427	0.944		-0.054	0.257	0.835
Worry: Moderate	-0.511	0.477	0.285	0.016	0.303	0.292	0.299
Worry: High	-0.961	0.688	0.164		0.154	0.382	0.687
Coping Appraisal	1.533***	0.302	0.001	0.087	0.712***	0.193	0.001
Non-protective Responses	-0.051	0.370	0.890	0.000	-0.217	0.237	0.360
Fire Exposure (Direct)	1.095***	0.299	0.001	0.047	0.180	0.189	0.340
Fire Exposure (Indirect)	0.038	0.368	0.917	0.000	0.585*	0.263	0.026
Residents Perceived Responsibility	0.592*	0.282	0.037	0.016	0.475**	0.181	0.009
Safety Instruction(s): Apartment	0.696	0.542	0.200	0.005	0.298	0.441	0.499
Safety Instruction(s): Workplace	0.479	0.667	0.473	0.002	0.007	0.532	0.989
Willingness to Fight Apartment Fire	0.626*	0.300	0.038	0.017	0.564**	0.194	0.004
Apartment is Insured	0.114	0.311	0.713	0.001	-0.169	0.201	0.401
Displayed Evacuation Map (Aware)	0.363	0.275	0.188	0.006	0.091	0.170	0.592
Female	-0.469	0.297	0.115	0.010	-0.237	0.179	0.185
Age: 35-54	0.830*	0.362	0.023		0.124	0.216	0.567
Age: 55 or Older	1.207*	0.524	0.022	0.029	0.882**	0.331	0.008
Child/Children Living in the Apartment	0.025	0.340	0.941	0.000	-0.248	0.215	0.248
Completed Higher Education	-0.225	0.331	0.496	0.002	-0.106	0.227	0.639
Income: 30,000-70,000	0.236	0.462	0.610	0.001	-0.198	0.318	0.533
Income: Over 70,000	0.190	0.518	0.714		-0.182	0.349	0.601
5 th Floor Apartment, or Above	0.235	0.557	0.674	0.001	0.029	0.316	0.926
Building has 6 or More Floors	0.157	0.428	0.713	0.001	-0.070	0.241	0.772
Constant	1.910	0.942	0.044		0.018	0.687	0.979
R ²	0.243						
R ² (Adjusted)	0.172						
Chi-squared (df = 24)					$\chi^2=60.75***$		
Log Likelihood					-142.859		
Correctly Classified					75.97%		
N	283				283		

Note: *p<0.05, **p<0.01, ***p<0.001

 η_p^2 denotes partial eta-squared as a measure of effect size.

Table 5.7 Regressions: part 2.

Explanatory Variables	Model 3 Household Fire/Evacuation Plan			Model 4 Follow the Building Evacuation Policy			Model 5 Smoke Detector(s) Tested at Least Once a Year		
	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P
Risk Rating	-0.014	0.017	0.402	-0.001	0.017	0.945	-0.044**	0.016	0.006
Concern (Fire Alarm)	0.033	0.040	0.415	0.073 [‡]	0.040	0.066	0.056	0.039	0.150
Worry: Low	0.251	0.232	0.279	-0.093	0.256	0.715	0.284	0.241	0.239
Worry: Moderate	0.036	0.272	0.896	-0.287	0.285	0.315	0.255	0.264	0.333
Worry: High	0.425	0.366	0.245	-0.946*	0.379	0.013	0.733*	0.368	0.047
Coping Appraisal	1.085***	0.192	0.001	0.415*	0.184	0.024	0.353 [‡]	0.182	0.052
Non-protective Responses	-0.265	0.232	0.254	-0.285	0.226	0.207	-0.294	0.223	0.187
Fire Exposure (Direct)	0.070	0.188	0.710	-0.046	0.184	0.804	0.111	0.181	0.538
Fire Exposure (Indirect)	0.235	0.244	0.337	0.106	0.230	0.643	0.086	0.237	0.717
Residents Perceived Responsibility	0.253	0.175	0.148	0.159	0.177	0.368	0.119	0.171	0.485
Safety Instruction(s): Apartment	0.464	0.422	0.271	0.232	0.360	0.519	0.268	0.356	0.451
Safety Instruction(s): Workplace	-0.386	0.465	0.407	0.455	0.430	0.290	-0.256	0.443	0.563
Willingness to Fight Fire	0.461*	0.186	0.013	0.040	0.181	0.826	0.080	0.178	0.654
Apartment is Insured	-0.066	0.195	0.735	0.216	0.187	0.249	0.283	0.175	0.105
Displayed Evacuation Map (Aware)	0.242	0.169	0.152	0.405*	0.174	0.020	0.054	0.164	0.741
Female	-0.133	0.187	0.477	0.065	0.186	0.726	-0.612***	0.177	0.001
Age: 35-54	0.304	0.231	0.190	0.254	0.215	0.236	0.100	0.202	0.619
Age: 55 or Older	0.314	0.304	0.301	0.628 [‡]	0.329	0.056	-0.024	0.288	0.934
Child/Children									
Living in the Apartment	0.101	0.215	0.639	-0.136	0.210	0.517	0.526*	0.214	0.014
Completed Higher Education	-0.409*	0.205	0.046	-0.039	0.201	0.846	-0.009	0.197	0.963
Income: 30,000-70,000	-0.199	0.296	0.500	0.055	0.258	0.831	0.132	0.284	0.642
Income: Over 70,000	-0.236	0.329	0.473	0.379	0.297	0.203	0.043	0.320	0.893
5 th Floor Apartment, or Above	1.029**	0.340	0.003	0.502	0.308	0.103	0.144	0.330	0.662
Building has 6 or More Floors	0.087	0.238	0.714	-0.491*	0.250	0.049	-0.216	0.230	0.349
Constant	-0.421	0.624	0.500	-1.049	0.603	0.082	0.114	0.601	0.849
Chi-squared (df = 24)				$\chi^2=41.33^*$			$\chi^2=48.40^{**}$		
Log Likelihood	$\chi^2=41.33^*$			-157.610			-164.7111		
Correctly Classified	71.38%			71.38%			69.26%		
N	283			283			283		

Note: [‡]p≤0.1, *p≤0.05, **p≤0.01, ***p≤0.001

Examining the overall explanatory power of the regressions, for the OLS regression (Table 5.6) $R^2 = 0.243$, i.e., 24.3% of the variation in perceived preparedness is explained by the model. For the probit models (Table 5.6 and Table 5.7) a relatively high proportion of

observations, between 69.26% and 75.97%, are correctly classified by the models. The marginal effects from the probit analyses are given in Table 5.8, with only significant results shown. Note, marginal effect estimates were calculated with all other explanatory variables held constant at their mean values.

Table 5.8 Marginal effects.

Explanatory Variables	Model 2 Fire Blanket or Fire Extinguisher		Model 3 Household Fire/Evacuation Plan		Model 4 Follow the Building Evacuation Policy		Model 5 Smoke Detector(s) Tested at Least Once a Year	
	dy/dx	P	dy/dx	P	dy/dx	P	dy/dx	P
Risk Rating	-0.015**	0.007					-0.016**	0.006
Concern (Fire Alarm)					0.026 [‡]	0.066		
Worry: Low								
Worry: Moderate								
Worry: High					-0.336*	0.013	0.274*	0.046
Coping Appraisal	0.238***	0.001	0.400***	0.001	0.147*	0.025	0.132 [‡]	0.052
Non-protective Responses								
Fire Exposure (Direct)								
Fire Exposure (Indirect)	0.195*	0.025						
Residents Perceived Responsibility	0.159**	0.008						
Safety Instruction(s): Apartment								
Safety Instruction(s): Workplace								
Willingness to Fight Fire	0.188**	0.003	0.170*	0.014				
Apartment is Insured							0.106	0.105
Displayed Evacuation Map (Aware)					0.144*	0.020		
Female							-0.229***	0.001
Age: 35-54								
Age: 55 or Older	0.295**	0.008			0.223 [‡]	0.056		
Child/Children Living in the Apartment							0.197*	0.014
Completed Higher Education			-0.151*	0.045				
Income: 30,000-70,000								
Income: Over 70,000								
5 th Floor Apartment, or Above			0.379**	0.002	0.178 [‡]	0.103		
Building has 6 or More Floors					-0.174*	0.049		

Note: [‡]p≤0.1, *p≤0.05, **p≤0.01, ***p≤0.001. Marginal effects were estimated using the mean values for all other explanatory variables.

Regarding the core variables of PMT: coping appraisal was significant and positive across all five models, giving support to the contention that a high coping appraisal is an essential contributor to preparedness motivation (Grothmann and Reusswig, 2006; Poussin *et al.*, 2014). The OLS results in Model 1 indicated that having a high, rather than low, coping

appraisal increased perceived preparedness by 1.533 points, all other independent variable values held constant. Coping appraisal had a medium effect size, $\eta_p^2 = 0.087$, the largest effect size among the independent variables. For the probit models, the marginal effects of coping appraisal showed a strong association for each dependent variable in Table 5.8. For example, the probability that a respondent has a household fire/evacuation plan was predicted to be 40 percentage points (pp) higher if the respondent presented with a high coping appraisal.

Different combinations of variables associated with threat appraisal (risk rating, concern, worry) were significant for each model. Risk rating was statistically significant and negative within two of the five models: having a fire blanket or fire extinguisher and declaring the smoke detector(s) were tested at least once a year. Although statistically significant, the coefficient magnitudes and associated marginal effects were small. A one unit increase in risk rating was estimated to decrease the probability that a respondent stated they had a fire blanket or fire extinguisher and declaring the smoke detector(s) were tested at least once a year by 1.5pp and 1.6pp respectively. To contextualise these magnitudes, the results suggest it would require an increase of approximately sixteen points in risk rating to counteract the positive impact of having a high coping appraisal on the probability of having a fire blanket or fire extinguisher. The equivalent for smoke detector testing is an approximate eight-point increase in risk rating. There was no consensus in previous studies on the relationship between preparedness and risk rating (see, Bubeck *et al.*, 2012; Wachinger *et al.*, 2013). This study suggests that a high threat appraisal does not promote fire safety preparedness within the context of an apartment fire. Instead, the results showed a negative relationship, which might reflect a reverse causality, i.e., if a respondent has an extinguisher or blanket, or was conscious of smoke detector testing, and trusts the efficacy

of the equipment, this could result in a lower risk rating. However, further research on this relationship is warranted.

Concern upon hearing the fire alarm had a statistically significant and positive impact on respondents following the evacuation policy in response to a fire alarm activation. The marginal effects showed that a one-point increase in the concern scale increased the probability that respondents stated they would follow fire evacuation policy by an estimated 2.6pp ($p=0.066$). A high level of worry about a fire was also found to influence two of the five dependent variables: acting in line with the evacuation policy in response to a fire alarm and declaring the smoke detector(s) were tested at least once a year. Having a high level of worry about a fire was estimated to increase the probability a respondent declared the smoke detector(s) were tested at least once a year by 27.4pp. This finding is broadly consistent with other research by Miceli *et al.* (2008) and Terpstra (2011), which showed heightened worry and dread was associated with households undertaking flood-related preparedness. In contrast, this data showed that high levels of worry were associated with a 33.3pp reduction in the probability that a respondent declared they would act in line with the evacuation policy in response to a fire alarm activation.

The influences of prior exposure to an emergency on subsequent preparedness levels are unclear (McGee *et al.*, 2009; Stumpf *et al.*, 2017). For example, Stumpf *et al.* (2017, p.95) stated, “a common assumption is that once someone witnessed a disaster, this experience will enhance future preparedness. Yet, findings in research are inconclusive”. Regarding the findings from this study, prior fire exposure (direct/indirect) was only significant within two of the five models: having a fire blanket or fire extinguisher, and perceived preparedness. This supported the observations by Stumpf *et al.* (2017) and Weinstein (1989), suggesting the effect from exposure to a particular risk (in this instance fire) is

limited to only some preparedness actions. The OLS regression result showed a significant positive relationship between prior direct exposure to fire and perceived preparedness. The estimated marginal impact of prior direct exposure was to increase perceived preparedness by 1.095 ($p \leq 0.001$) compared to someone who had no prior exposure. The effect size of prior direct exposure on perceived preparedness was small-to-medium ($\eta_p^2 = 0.047$). Regarding having a fire blanket or fire extinguisher (Table 5.8), indirect exposure to fire increased the probability that a respondent had a fire extinguisher/blanket in their apartment by 19.5pp.

These findings on prior exposure appear to confirm the research by Allareddy *et al.* (2007) on rural residential fires, which suggested owning a fire extinguisher is positively associated with fire exposure. However, the Allareddy *et al.* (2007) result related to direct exposure, not indirect, as is the case with this study. The data in Table 5.8 shows that those with indirect exposure through family/friends were more likely to be aware of the importance/need for a fire extinguisher or fire blanket within the home. The significance of indirect experience suggests that campaigns aimed at households with no previous experience of a fire could raise preparedness levels if the campaigns featured first-hand accounts from those who had experienced a household fire. However, further research is required to support this assumption, especially as safety instructions within the workplace and apartment were non-significant across all models.

When studying wildfires, Beringer (2000), McCaffrey *et al.* (2011) and McNeill (2013) found perceived responsibility to be significantly associated with an individual's motivation to take preparedness actions. Concerning residential apartment fires, this paper found similar results where respondents who perceive they have responsibility for fire safety within the building were more likely to have a fire blanket or fire extinguisher within

the apartment, and reported higher perceived preparedness. The marginal impact of perceived responsibility on perceived preparedness was 0.592, statistically significant ($p \leq 0.05$). The effect size for perceived responsibility was small ($\eta_p^2 = 0.016$). Likewise, the probit analysis marginal effects revealed that the probability a respondent is prepared for a fire (i.e., has a fire extinguisher or blanket within the apartment) increased by 15.9pp if they perceived they have some responsibility for fire safety in the building. While occupants' perceived responsibility had a motivating effect on having a fire blanket or fire extinguisher, and perceived preparedness, it did not influence smoke detector testing, responding (evacuating) following a fire alarm activation, or establishing a household fire/evacuation plan. There is, however, a link between coping appraisal and smoke detector testing, which suggests that preparedness campaigns designed to drive smoke detector testing should focus on the vital role smoke detectors will play in the event of a fire.

Apartment occupants' willingness to fight a fire had a significant positive relationship with having a fire blanket or fire extinguisher, and having a household fire/evacuation plan. Furthermore, awareness of a building's evacuation map being displayed led to a 14.4pp rise in the probability a respondent said they would act in line with the evacuation policy in response to a fire alarm activation.

Alongside the PMT variables, several significant findings were related to socio-demographics. These are all reported within the Tables and a selection discussed here. The results revealed that the probability a respondent declared the smoke detector(s) were tested at least once a year decreased by 22.9pp if they were female. In the case of perceived preparedness, the coefficients on the age variables increased in magnitude from 0.830, $p \leq 0.05$ (Age: 35-54) to 1.207, $p \leq 0.05$ (Age: 55 or older). That is, the older the respondent was, the higher perceived preparedness is predicted to be. The effect size for age was small

($\eta_p^2 = 0.029$). Respondents in a 5th-floor apartment or above were 37.9pp more likely to have a household fire/evacuation plan. Living in a building with six or more floors was also shown to negatively impact the probability that a respondent would follow the evacuation policy in response to a fire alarm activation (decreasing the probability by 17.4pp).

5.5 Limitations

While the study sought to achieve a random sample of Dublin apartments, with representation from high to lower income areas of the city, the use of flyers with an embedded URL linked to the questionnaire, rather than printed questionnaires, resulted in the URL being shared online. As a result, the number of responses increased but some of those who took part may reside in apartments outside of the targeted complexes. To minimise selection bias, considerable effort was placed into distributing the flyer at each apartment complex. A control question, asking in which county respondents lived, was used to exclude non-Dublin apartments (Daniel, 2012).

Alwin (2016) highlights that objective questions can be considerably more reliable than subjective questions. Where possible, factual information was gathered, such as do you have a fire extinguisher, rather than asking respondents if they felt prepared to fight a fire. That said, several of the questions are based on subjective content related to perception and judgment. At all times, however, construction of these measures was linked to the theoretical framework on which this study is based.

Given that context can affect results (Alwin, 2016), it is important to note that at the time of data collection fire in high-rise buildings had featured heavily in the Irish news media due to the Grenfell Tower fire in London and a fire in the Metro Hotel and Apartment complex in Dublin in March 2018 (Young and McKeown, 2018). While there were no

fatalities, the Metro Hotel and Apartment fire was technically challenging and severely damaged the building. The extensive media coverage of these two incidents, occurring within months of each other, amplified concerns about fire safety in Irish apartment buildings, bringing it to prominence in the public consciousness. We cannot rule out that this coverage influenced responses by amplifying concerns.

5.6 Conclusions

As a result of a call for research to determine “the extent to which fire safety measures are in place in peoples’ homes and the public’s understanding of risk in the domestic setting with a view to informing further fire safety campaigns” (NDFEM, 2018, p.24), this study examined the factors which influenced fire safety preparedness in Irish apartments following the Grenfell Tower fire; at a time when there was heightened awareness of the risk posed by apartment fires. To contribute to this call for research, the first objective was to examine the level of fire safety awareness and preparedness within residential apartments. Given the national focus on smoke detector installation and testing, it was alarming that while 97.4% of respondents had a smoke detector, only 6.8% declared that the smoke detector(s) were tested more than once a month and nearly 40% of respondents reported their smoke detector(s) were not tested at least once a year.

Under Irish legislation rental properties within multi-unit buildings must include a suitably located fire blanket. 52.4% of respondents indicated they knew of a fire blanket within their apartment, with no significant association found between renters and owner occupiers. Furthermore, 31.7% of respondents had taken no fire safety actions to protect their apartment, with 42.8% suggesting they did not know what to do. 34.6% indicated that they would not follow the building evacuation policy in the event of a fire alarm activation. These findings, along with the findings reported earlier, suggest that further engagement

with apartment occupants and owners is required to raise the level of fire safety awareness and preparedness.

The second objective of this study was to determine the factors that motivate or deter apartment residents from adopting fire safety measures by applying an extended PMT model. To summarise these findings, Table 5.9 compares the hypothesised outcomes with the key findings.

Table 5.9 Comparing hypothesised outcomes with the key findings.

Hypothesised Outcomes Per the Literature Review	Key Findings
A higher threat appraisal leads to an increased motivation to prepare and a greater likelihood of protective action.	Results showed a negative relationship between risk rating for fire and (i) owning a fire blanket or fire extinguisher, and (ii) testing of smoke detector(s) at least once a year. While this is contrary to expectations, Poussin, Botzen, and Aerts (2014) found a similar relationship between perceived risk of flooding and mitigation behaviours. Concern upon hearing a fire alarm was shown to have a positive relationship with following the building evacuation policy. However, a high level of worry had the opposite effect. A high level of worry was found to positively influence frequency of smoke detector(s) testing.
A higher coping appraisal results in greater motivation to prepare and a higher likelihood of taking protective action.	The results show a significant positive relationship in each of the five models in line with the hypothesis.
Prior risk exposure positively influences motivation to prepare and a higher likelihood of protective action.	Results showed indirect exposure had a positive relationship with having a fire blanket or fire extinguisher while direct exposure had a positive relationship with perceived preparedness.
Taking personal responsibility for fire safety has a positive relationship with protective actions.	Testing confirmed taking personal responsibility had a positive relationship with perceived preparedness and having a fire blanket or fire extinguisher.
Awareness of a displayed evacuation plan positively influences: following the building evacuation policy; having a household fire/evacuation plan; and perceived preparedness.	Results confirmed a positive relationship between awareness of a displayed evacuation plan and following the building evacuation policy.

Figure 5.1 summarises the regression results, with a plus (+) indicating a statistically significant positive relationship and a minus (-) indicating a statistically significant negative relationship with taking a protective response. Non-significant results are not reported.

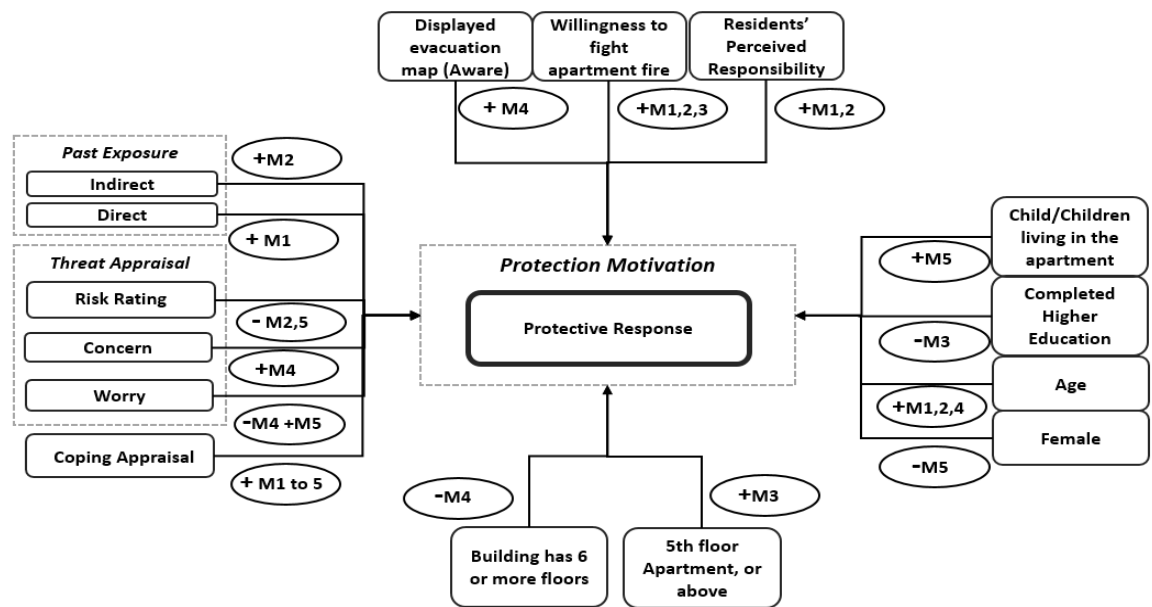


Figure 5.1 Significant factors across all five regression models.

- Figure 1 Key
- M1 = Model 1: Perceived Preparedness
 - M2 = Model 2: Fire Blanket or Fire Extinguisher
 - M3 = Model 3: Household Fire/Evacuation Plan
 - M4 = Model 4: Follow Building Evacuation Policy
 - M5 = Model 5: Smoke Detector(s) Tested at Least Once a Year

The results support, in part, the theoretical contention that in the context of apartment fires PMT should be extended to include individuals’ perceived responsibility for fire safety within their building. Occupants’ perceived responsibility for fire safety in the building was positively associated with having an extinguisher or fire blanket, and an increased perceived preparedness. On the other hand, no relationship was found between perceived responsibility and the presence of household fire plans, declaring the smoke detector(s) were tested at least once a year, or taking the appropriate response upon a fire alarm activation.

Apart from the theoretical contribution, this study has practical implications for policy-makers, enforcers of legislation, those designing public fire safety campaigns, and informing targeted preparedness messaging. For example, the findings of this study suggest that smoke detector testing campaigns for apartment occupants in Ireland should be targeted at encouraging women, and apartments without children, to test their smoke detectors. The data also showed the importance of apartment occupants' threat appraisal and coping appraisal in influencing smoke detector testing. Apartment occupants who present with a higher risk rating or a high coping appraisal were more likely to test their smoke detectors. These results illustrate the importance of communicating the risk of an apartment fire, explaining the difference a smoke detector will make in the event of a fire, how to test smoke detectors, and the related low cost (positive cost efficacy) involved in testing.

To encourage an appropriate response to a fire alarm activation, fire safety campaigns designed to improve evacuation rates in apartments should not attempt to raise the level of worry about fire. Instead, these campaigns should explain how robust fire safety systems and following procedures will improve occupants' safety in a fire, as there is a link between high coping appraisal and following the recommended response to a fire alarm activation. Fire safety campaigns should also be targeted at occupants of buildings with six or more floors as they are less likely to follow the fire evacuation policy.

Recent years has seen a strengthening of Irish legislation around fire safety and the protection of occupants in rental properties within multi-unit buildings. The results of this study, however, reveal that poor compliance with the requirement to have fire blankets in a prominent position within rental apartments and the duty to display a fire evacuation plan in multi-unit buildings requires urgent attention.

This research adds to the body of fire safety knowledge by applying an extended version of PMT to five factors relevant to fire safety preparedness. The findings reveal that fire safety preparedness motivation is complex and that campaigns designed to drive fire safety actions must be targeted at specific population segments in order to achieve optimum results. Informed by PMT research, the application of these findings ought to enhance the effectiveness of fire safety campaigns by identifying the barriers to, and drivers of, fire safety preparedness.

6. Chapter Six – Paper 5

Weathering the storm: Developing a user-centric weather forecast and warning system for Ireland

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<https://doi.org/10.1016/j.ijdr.2023.103687>

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6.0 Abstract

This paper appraises current usage and future weather service needs in Ireland. The data for this study were collected using a household preparedness questionnaire and focus groups with urban communities, rural dwellers, marine users, farmers, students, and an island community. The questionnaire was used to collect data on weather warnings and preparedness following a category red severe weather warning. Data on participants' need for weather forecasts and warnings, current and future weather service requirements, and the effectiveness of the National Meteorological and Hydrological Service (NMHS) were collected from the focus groups.

Our analysis identifies the importance of accurate weather forecasts to the public and groups such as farmers as they plan their professional and private lives. Participants were aware of the weather warning system's color-coded structure, with the highest-level warnings considered most effective in capturing attention. Most participants spoke negatively about category yellow warnings, as they perceived them to be issued too frequently. Experience of warnings being issued and threats failing to materialize caused a minority of participants to ignore warnings and not take preparedness action. The

professionalism of the NMHS was praised by focus group participants, and there was a high level of overall satisfaction with the quality of the national weather warning system (75.1% of survey participants were mostly or extremely satisfied).

Opportunities to improve weather services included enhanced communication with service users, improved web and app interfaces, a move to probabilistic forecasting, and weather warnings that encompass calls to action.

6.1 Introduction

Island nations, such as Ireland, which experience rapidly changing weather systems, are particularly reliant on accurate weather forecasting and an effective weather warning system. Hydrometeorological services must, therefore, provide necessary weather and preparedness information through these forecasts and warnings to enable communities and partners prepare for and respond to extreme weather events (Uccellini and Hovee 2019). These hydrometeorological services also play a vital role in motivating citizens' adaptation and promoting resilience to severe weather (Uccellini and Hovee 2019). To support users in their decision making, the World Meteorological Organization (WMO) (2015a) emphasized the need for a user-centric model of weather forecasts and warnings: an approach which aligns with The First Mile concept that places users at the beginning, rather than the end, of the weather forecasting and warning design process (Fearnley 2011; Loster 2012; Kelman and Glantz 2014).

The purpose of our study was to determine the current and future weather service needs of the general public and specialist interest groups, with particular emphasis on the effective communication of weather forecasts and weather warnings. The findings will underpin the delivery of the Strategic Plan (2017-2027) of Met Éireann, the Irish National

Meteorological and Hydrological Services (NMHS), to improve customer services and inform the development of impact-based forecast services.

6.1.1 Background

Weather forecasting has a degree of uncertainty in relation to location, timing, intensity, and level of impact. To help quantify this uncertainty and determine the most likely scenario, the Irish NMHS utilizes an Ensemble Prediction System (Met Éireann 2021a). This scenario is then provided to the public as a single predicted weather forecast, with no reference to the probability of occurrence.

Research examining US weather forecasts has shown that when people are provided with a forecast without uncertainty information, they attempt to estimate uncertainty; perhaps inaccurately (Morss *et al.* 2008; Joslyn and Savelli 2010). Morss *et al.* (2008) found that as the lead time for a forecast increased, respondents' confidence in the forecast reduced and concluded this "suggests that many respondents have a general sense of the relative accuracy or uncertainty in different types of weather forecasts" (Morss *et al.* 2008, p.987). Uncertainty in weather forecasting, and confidence in the weather forecasts, will also be explored in our study.

Providing uncertainty information could improve understanding of the forecast and assist service users in making more effective decisions (Nadav-Greenberg *et al.* 2009; Kox *et al.* 2015; Carr *et al.* 2018). Kox *et al.* (2015) established that in Germany emergency service personnel had less confidence in deterministic forecasts, which give a single prediction, when compared to forecasts which report probabilistic information. Just as Irish warnings include general statements such as "Storm Barra is expected to bring severe and damaging wind gusts" (Met Éireann 2023), Kox *et al.* (2015) noted that Germany's weather warnings also use qualitative statements about uncertainty (e.g., very likely). They found that German

users would prefer warnings to contain a range of values and probabilities in addition to the deterministic statements (Kox *et al.* 2015). The preferences of Irish service users will be determined in this paper.

In a US study conducted by Carr *et al.* (2018), information about a hypothetical hurricane scenario was presented to focus group participants to examine how they used and interpreted an ensemble flood forecast. They found the different clusters of users (water resource managers, emergency managers and residential users) reacted differently to the forecast information, and that changes in how the graphics were presented, e.g., “a detailed legend with range of probabilities”, appeared to improve “the ability of residents to understand uncertainty” (Carr *et al.* 2018, pp.1369-1370). Their findings highlighted the importance of reducing uncertainty in forecasting and the need to gain a greater understanding of how forecasts are perceived and acted upon. A key focus of our paper will be to add to this understanding of how forecasts and weather warnings are perceived and acted upon by the general public and specialist service users in Ireland.

Once a warning is issued, several outcomes can occur: a false alarm; an over-warning (less severe than forecast); an accurate warning; or an under-warning (more severe than forecast) (Barnes *et al.* 2007). False alarms or over-warned events are more likely to occur than missed warnings (Simmons and Sutter 2009) and warnings are issued to more people than are likely to experience the impacts (Meyer and Kunreuther 2017). The implication of false alarms is that users may not react to future warnings: the cry wolf effect (Meyer and Kunreuther 2017). There are, however, inconsistent results on the existence of this cry wolf effect (Walters *et al.* 2020). Walters *et al.* (2020) in the US found that false alarms did not negatively impact households’ responses to tornado warnings. Likewise, Barnes *et al.* (2007), who also examined tornado warnings in the US, suggested the public could have a

high acceptance of false alarms, while research by Ripberger *et al.* (2015), also in the US, concluded that false alarms and missed events contributed to perceptions of inaccurate tornado warnings, which in turn led to lower levels of trust in the NMHS and reduced compliance and action. LeClerc and Joslyn (2015) who sampled US university students found, however, that the inclusion of estimates of uncertainty within weather warnings associated with low temperature events enhanced credibility, even in the case of a false alarm, as there was transparency from the outset. The cry wolf effect, trust, and the overall impact of false alarms are themes explored in our research.

While the literature review informed the design and focus of our study, the absence of Irish research meant it was not possible to determine if their findings apply in Ireland. The findings of our research will allow us to determine if the US and German results are confirmed in an Irish context.

The NMHS in Ireland provides weather forecasts and warnings via radio and television broadcasts, their website and mobile app, and social media channels. At present, users must opt-in to receive county and national-level weather information (including weather warnings). The Irish NMHS uses a threshold weather warning system with three escalating categories (Met Éireann 2021b):

- Status Yellow: Be Aware
- Status Orange: Be Prepared
- Status Red: Take Action

These warnings, which are mapped and described in a mix of prose and thresholds (see Figure 6.1 and Table 6.1), are issued by county or sea area, even though the severe weather may not impact the entire area equally; reflecting Meyer and Kunreuther's (2017) observation that a wider area will be covered by the warning than will be impacted.

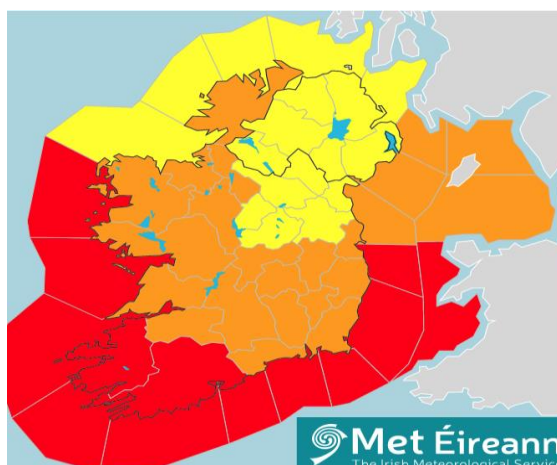


Figure 6.1 Sample Warning Showing Weather Warnings Issued Across Ireland

Table 6.1 Weather Warning Thresholds

Warnings Levels	Warning Criteria
Status Yellow	Weather that does not pose a threat to the general population but is potentially dangerous on a localised scale. For example: - despread mean speeds between 50 and 65km/h - despread gusts between 90 and 110km/h - ow/Ice: 3cm or more in 24 hours - w Temperature/Ice: Air minima of minus 3C or minus 4C expected over a wide area (localised lower values will occur). Dangerous surfaces due to ice and/or lying snow. Situation improving.
Status Orange	Infrequent and dangerous weather conditions which may pose a threat to life and property. For example: • Widespread mean speeds between 65 and 80km/h • Widespread gusts between 110 and 130km/h • Snow/Ice: ○ 3cm or greater in 6 hrs ○ 5cm or greater in 12 hrs ○ 10cm or greater in 24 hrs • Low Temperature/Ice: Air minima of minus 5C to minus 10C (or lower) expected over a wide area. Dangerous surfaces due to ice and/or lying snow/freezing rain. Situation stable.
Status Red	Rare and very dangerous weather conditions from intense meteorological phenomena. For example: • Widespread mean speeds in excess of 80km/h • Widespread gusts in excess of 130km/h • Snow/Ice: ○ 10cm or greater in 6 hrs ○ 15cm or greater in 12 hrs ○ 30cm or greater in 24 hrs • Low Temperature/Ice: Air minima minus 10C (or below) for three consecutive nights or more. Maxima of minus 2C. Dangerous surfaces due to ice and/or lying snow/freezing rain. Situation likely to worsen.

Public warning and alert systems focus public attention on an approaching risk and can afford more time to prepare. However, studies conducted in North America, although not directly comparable to Ireland, have shown that the warnings/terminology related to extreme events such as tornadoes or flash floods are often misunderstood (Ripberger *et al.* 2015; Silver 2015; Morss *et al.* 2016; Williams *et al.* 2017). Taylor *et al.* (2019), in a study of the UK public's interpretation of wind warnings, showed that clarity and ease of understanding built confidence in the warning system and the NHMS (Taylor *et al.* 2019). The Irish NMHS uses color-coding to differentiate between different levels of risk, however, Taylor *et al.* (2019) cautioned that color-coded warnings are not always intuitive, and misunderstandings can occur. Our research will also explore how the public interpret of weather warnings in Ireland, allowing for a comparison with international findings.

To achieve Goal 1 of Met Éireann's strategic plan, "Enhance support for impact-based decision making for weather events" (Met Éireann 2017, p.16), Ireland's NMHS is moving from threshold-based warnings, as described above, to impact-based warnings that consider the vulnerability, location, and weather risk of individuals, communities, and services in line with WMO (2015b) guidelines. During the transition to this impact-based forecasting approach, thresholds are still used to determine warnings, but the likely impacts of any weather event will increasingly inform the severity of each warning issued (Hally 2022). According to the International Federation of Red Cross and Red Crescent Societies (IFRC) and UK Met Office (2022, p.13), "Impact-based forecasting enables anticipatory actions and revolutionizes responses to weather and climate crises: turning forecasts and warnings from descriptions of what the weather will be ... into assessments of what the weather will do enables organizations and individuals across the world to anticipate and take action to mitigate the impacts brought by weather and climate events". Understanding location-specific weather-related vulnerabilities, such as each local community's unique

environmental and societal characteristics, is an important aspect of achieving a user-centric approach to warnings (Kelman *et al.* 2018). These observations are echoed by Potter *et al.* (2021) who examined the benefits and challenges of impact-based forecasting and warning systems for severe weather by interviewing meteorologists in the UK, France, and Switzerland, and holding workshops in New Zealand with government hydrologists and those from the emergency management sector. Potter *et al.* (2021) found that impact-based forecasting and warning systems are often designed for responding stakeholders and not individuals in society and emphasized the need for a deep understanding of local vulnerabilities and coping capacities to improve warnings effectiveness, and the need to collect and store impact data as events occur to inform future warnings.

To improve the communication of a warning, Bostrom *et al.* (2018) suggested that vulnerabilities and impacts need to be emphasized in warnings. Failure to do so may result in appropriate protective actions not being taken (Weyrich *et al.* 2018; Casteel 2016) because people may not know how to respond. Including a call to action or guidance in a warning increases the likelihood that the public will act (Mileti and Darlington 1997), especially where warnings also emphasize impacts (Casteel 2018; Morss *et al.* 2018). Warnings must be viewed as personally relevant and action-orientated (Mileti 1999).

For warning systems to be most effective at encouraging action, they must integrate the elements of “detection of extreme events, management of hazard information, and public response and also maintain relationships between them through preparedness” (Mileti *et al.* 1999, pp.174–175). Ongoing engagement with the public, using preparedness messaging for example, provides a platform for household preparation and pre-warning awareness (Kelman *et al.* 2018). This ongoing engagement aligns with the view that the warning system does not simply begin when the risk first materializes (Mileti *et al.*, 1999; Fearnley

and Kelman 2021). Education, public engagement, and outreach activities should continuously encourage household preparedness behaviors and actions (Fearnley and Kelman 2021).

The purpose of a warning system is to encourage individuals to take the best possible preparedness actions given their circumstances. Protection Motivation Theory (PMT) suggests once individuals are aware of a risk, their decision to take protective action is primarily influenced by two appraisals: threat and coping (Rogers and Prentice-Dunn 1997). In the threat appraisal, an individual performs a risk assessment to ascertain the level of threat a risk poses based on its likelihood of occurrence and associated impacts (Rogers and Prentice-Dunn 1997). However, the effectiveness of the threat appraisal in prompting preparedness action has had mixed results (Zaalberg *et al.* 2009; Bubeck *et al.* 2012; Poussin *et al.* 2014; Dittrich *et al.* 2016; Tang and Feng 2018; Twerefou *et al.* 2019; Babicky and Seebauer 2019; Budhathoki *et al.* 2020; Brown *et al.* 2022). During the coping appraisal, the individual weighs the effectiveness of proposed protective measures, their capacity to take protective action, and the expected costs (time and money) against the magnitude of the threat (Rogers and Prentice-Dunn 1997). For warnings to be most effective at promoting action, they should focus on enhancing households' coping appraisal (Scovell *et al.* 2020). This can be achieved by providing information about what preparedness actions to take, along with how these actions can make a difference, and ultimately working to build households' confidence in their ability to take the actions (Grothmann and Reusswig 2006; Poussin *et al.* 2014; Brown *et al.* 2022).

Following on from PMT, Mileti and Sorensen (1990, p.5-1) describe a “social-psychological process that people go through in a warning situation from the time a first warning is heard to the time people respond”. The process known as warning response

comprises several stages, but not all are required for protective actions to be taken (Mileti and Sorensen 1990). These stages are summarized: (1) people must realize the threat—“hearing the warning”; (2) they must understand the threat and the corresponding warning—i.e., they must relate to the message, perceive the risk to be high (which relates to PMTs threat appraisal) and have knowledge of what action can be taken; (3) they must have confidence in the warning's accuracy, belief in the warning's credibility; (4) they must assess how the threat will impact them, enabling a response to the corresponding warning; (5) decide whether to take action; and (6) constantly validate the information received and source new information as required (Mileti and Sorensen 1990; Mileti 1995; Mileti 1999). Our research will also explore how weather warnings influence preparedness action and how the effectiveness of warnings can be enhanced.

Risks arising from severe weather dominate the socio-natural risk classification of the Irish National Risk Assessment (NRA). The reasonable worst-case scenarios documented in the NRA (2020) are:

A) Storm: “equal to the magnitude of Storm Ophelia which triggered a nation-wide red level warning and made landfall over Ireland on 16 October 2017. Winds reached an observed wind speed of 156 km/h and a mean of 60 km/h” (NRA 2020, p.24).

B) Snow and Ice: A snowstorm of the magnitude of Storm Emma (28 February and 4 March 2018): “According to the analysis report of Storm Emma and the cold spell which struck Ireland by Met Éireann, this was one of the most significant snowfall events of recent years saw temperatures plummet with widespread snowfall across the country” (NRA 2020, p.24).

C) Flood: “of the magnitude of the 2015/16 Shannon river flood, when one third of river-level gauges recorded their highest readings ever. The assessed impact reflected sustained duration flooding, impacting severely on communities with significant disruption to daily life and access to services” (NRA 2020, p.25).

The NRA (2020) also addressed the cross-border dimension of each of these risks and acknowledged the importance of cooperation between the NMHS in Ireland and the UK and coordination in terms of managing the consequences of severe weather on the island of Ireland.

6.2. Research Methodology

To inform the delivery of user-centric national weather services, this study, the first of its kind in Ireland, (1) captured the public’s use of weather forecasts; (2) investigated public confidence in weather forecasting; (3) examined public perception and reaction to weather warnings; and (4) identified future weather service needs.

Data were gathered using a questionnaire, administered in May-June 2018, and a series of focus groups with members of the Irish public in February-March 2021, approved by the University Ethics Committee. A volunteer sampling method was used to recruit participants via social media posts and email contacts.

6.2.1 Data Collection Procedures

An online questionnaire, issued between May and June 2018, approximately eight weeks after a severe weather warning associated with Storm Emma, was used to collect data on household preparedness, including respondents’ satisfaction with the NMHS weather warning system and their response to weather warnings. Storm Emma was a severe weather event which occurred towards the end of the winter of 2018, causing record low

temperatures, blizzard conditions and widespread disruption. A nationwide red weather warning and curfew was issued in response (Met Éireann, 2019; NDFEM, 2019). The weather conditions Ireland experienced during Storm Emma had not been experienced for almost 36 years (NDFEM, 2019; Met Éireann, 2019).

The questionnaire was shared on social media (Twitter; Facebook; LinkedIn) and was retweeted by a wide range of individuals and organizations such as the NMHS, Local Government, and the national Office of Emergency Planning.

Anonymized responses were received from 4451 households whose socio-demographic characteristics were in line with the 2016 Irish census data; 64.9% earned less than €70,000 (nationally 62.6% had a gross income of less than €60,000), and 70.1% owned their home compared with 67.6% homeownership across Ireland (CSO 2016a; 2016b). Furthermore, the Central Statistics Office reported that 31.4% of people in Ireland lived in a rural area, closely matching the sample data of 30% (CSO, 2019).

Eight focus groups, conducted via Zoom, were carried out from February to March 2021 to gather data on participants' need for weather forecasts and warnings, current and future weather service requirements, and the effectiveness of the NMHS. Four focus groups drew participants based on geographic location (two urban, two rural), and four from special interest groups (marine recreational users, the agricultural sector, 3rd level students, and those living in a small island community). A total of 53 members of the public took part in the eight focus groups, comprising 25 females and 28 males. The number of participants per group ranged from 4 to 8 and lasted approximately 90 minutes. Figure A1 within the appendix provides a map showing locations of the focus groups. To recruit participants, advertisements were shared on social media and targeted messages were sent to groups such as sailing clubs, community groups and farming organizations. Interested participants

were grouped by geographic location or special interest. From these clusters people were randomly selected and invited to participate in a focus group. Details of the focus groups and coding used in presenting quotes are documented in Table 6.2. Focus groups were conducted using a semi-structured approach using open questions so as not to stifle dialogue (Patton, 2002), and each lasted approximately 90-minutes. A copy of the focus group questions is provided in the Appendix.

Table 6.2 Focus Groups

Focus Group	Code	Date (2021)	Participants	Unique Identifiers	Gender
Geographic Urban Regions					
Dublin	U1	February 26 th	Eight	U1P1 to U1P8	5 Females; 3 Males
Cork	U2	March 15 th	Seven	U2P1 to U2P7	3 Females; 4 Males
Geographic Rural Regions					
Rural 1: Donegal / Mayo / Leitrim / Sligo	R1	March 10 th	Seven	R1P1 to R1P7	3 Females; 4 Males
Rural 2: Westmeath / Cavan / Monaghan / Louth	R2	March 12 th	Eight	R2P1 to R2P8	3 Females; 5 Males
Special Interest Groups					
3 rd Level Students	S1	February 19 th	Eight	S1P1 to S1P8	4 Females; 4 Males
Marine (Recreational) Users	S2	March 3 rd	Six	S2P1 to S2P6	3 Females; 3 Males
Agriculture	S3	March 8 th	Six	S3P1 to S3P6	2 Females; 4 Males
Island (Inishbofin)	S4	March 18 th	Four	S4P1 to S4P4	2 Females; 2 Males

Note: Focus group participants were given an alphanumeric pseudonym to preserve their anonymity (e.g., U1P1 = Urban 1-Participant 1).

Questionnaire respondents were also given an alphanumeric pseudonym to preserve their anonymity. QR represents a Questionnaire Response – followed by a unique identifier (e.g., QR334).

6.2.2 Data Analysis

Analysis of the questionnaire data on satisfaction with the NMHS weather warning system and preparedness action was conducted using descriptive statistics, t-tests, and chi-square tests in STATA (StataCorp-16.1/SE). The focus group transcript data were uploaded to NVivo R1.4.1 and analyzed using Braun and Clarke's (2006; 2021) 6-phase thematic analysis technique.

6.2.3 Research Limitations

Although an open invitation to participate in this study was issued to any user of Twitter, Facebook, and LinkedIn, as well as the targeted groups outlined above, participants were with a particular interest in the topic of weather and forecasting were more likely to respond in the first instance, which introduces the potential for bias. That said, participants exhibited a variety of opinions and responses appeared to be diverse and not prone to social desirability bias. For example, focus group participants were not quick to agree with each other, and discussed topics from various viewpoints.

For the purposes of this research, the focus groups were selected based on specific criteria: geographic location and special interest. While participants were taken at random based on these specific criteria, the findings associated with the focus groups were not intended to be generalizable to the general population and instead allowed for more in-depth probing into the attitudes, experiences, and behaviors of the participants. To counterbalance for the lack of generalizability, the large number of questionnaire respondents (4451) provided broader and more representative data.

6.3 Findings: Results & Discussion

A summary of the thematic analysis is provided within the Appendix in Tables A1 to A7. Themes and sub-themes were coded into clusters. Relating to forecasting (Table A1 to A4) nine major themes emerged: how participants accessed the forecast, why they checked the forecast, the importance of accuracy, the importance of the forecast, their confidence in the forecast, frequency of use, which weather apps were used and why, marine services and the NMHS roles and services. Table A5 sets out five major themes related to weather warnings, namely: notification sources of the alert, declared familiarity with the warnings color scheme, familiarity with the weather warnings in practice, perceived effectiveness of the system, and suggestions for improvement. Table A6 sets out the questionnaire respondents' satisfaction with the Weather Warnings under negative and positive sentiment. Table A7 outlines three major themes regarding how participants responded to the weather warnings: changes in behavior, protective action taken, and no action or behavioral change.

6.3.1 Forecast Sources & Preferences

As a result of the growth of the private meteorology sector, people can source their forecasts from various providers and are not limited to the NMHS (Pettifer 2015; Thorpe 2016). The focus groups confirmed this with the most frequent services mentioned being: Met Éireann (Irish NMHS), Google, iPhone, Yr, Windguru, BBC, XC Weather, AccuWeather and Magicseaweed. While focus group participants had their preferred forecast sources, confidence in the information provided by the NMHS was high, especially among the Agricultural and Student Groups.

Those who preferred the NMHS generally selected the NMHS for its accuracy, ease of accessibility (access on phone/computer and via broadcasts on television and radio), its rainfall radar feature, professionalism, and reliability:

I think that actually Met Éireann presents a very professional, if you watch them on screen, ... they're very professional. (R2P8)

I think Met Éireann does a particularly good job. I mean, probably everybody in Ireland will watch the RTÉ news service every night and I have, the Met Éireann app on my phone, which I check ...regularly. (U2P3)

When participants spoke of their satisfaction with the forecast provided by other providers, not the NMHS, six focus groups highlighted accuracy, five groups highlighted the importance of ease of interpretation and accessibility (e.g., app design: interface and visuals) Participants seldom mentioned the characteristics of the service provider such as “professionalism”.

In cases where the coded themes associated with choosing the NMHS, or not, were similar, for example accuracy or accessibility, preference appeared to be driven by judgements on the quality of one service over another, the availability of specific features, or sometimes simply convenience (e.g., the default weather app supplied on the phone). These findings emphasize the importance of engaging with people to understand their needs and wants. For example, the user interface of the NMHS app was criticized by several people the Agriculture, Marine Users, Students, Dublin, and Cork groups; with Marine Users and Students most vocal. In contrast, they praised the interface of some competitor apps for being user-friendly with their use of graphics and probability percentages making them easier to read:

One of the only differences I could note from looking at what the Met Éireann app looks like, it's quite wordy like they will have the weather forecast in sentences, as well as actually a map of Ireland, whereas ...the iPhone one has percentages and it'll have a rain cloud or like my one, I think it just goes by the hour and if there's just a cloud if it's cloudy, if there's a sun it's just sunny, that sort of thing. You kind of just get it from pictures or like little icons, rather than actually reading sentences. Maybe

as a generation we're just lazy but like it's just kind of easier just to see.
(S1P4)

The accuracy and usefulness of the NMHS Rainfall Radar was specifically praised in three focus groups: Agriculture, Marine Users and Dublin groups. It provides users with real-time rainfall data and, as a result, the ability to determine when rainfall may reach their area. Real-time data reduces the need for service users to estimate the likelihood of the risk occurring in their locality. As one person noted:

... the radar is always going to give you a better picture of the risk, not necessarily whether it would rain or not. (S3P3)

It was described as an essential aid to farmers' decision-making regarding spraying pesticides, mowing, or bagging grass for silage. The Marine Users and Student Groups also spoke favorably about this feature:

So, I think the rainfall radar is a great asset, and it is live, and it's probably the most accurate forecast you can get in that respect. If there was only something of equivalent nature for the wind it'd be excellent. (S2P5)

Irrespective of which forecast provider they used, participants in all eight focus groups underlined the need for accurate weather forecasts to plan for work and leisure activities. Reasons for checking the weather forecast were scheduling exercise and social activities or for choosing clothing on a particular day. For others, the prominent reasons for checking the weather forecast were safety concerns or planning work. For these people, accuracy was essential to inform decision making where livelihoods depended on weather conditions and those living in remote island communities. These individuals needed to be aware of any upcoming unusual weather to change their planning, sometimes before a weather warning was issued.

Residents of Inishbofin Island rely on accurate forecasts for their safety and when planning their daily activities, particularly for trips to the mainland. They also recognized the vital role accurate forecasts and the regular broadcasts by the NMHS have played in reducing weather-related disasters:

It's enormously important. ...because it's not only just a rural community, it's also an island community, and weather has an enormous effect on what you do. And the accuracy of forecasts is hugely important. ...Since the infancy of weather forecasting, it's hugely important to anyone that's involved in anything such as fishing or ferrying or operating any sort of a vessel or any sort of a marine life at all. Forecasting is enormously important and always has been. Traditionally like, there's been a lot of disasters in the past that have happened here, historically, and most were down to the lack of a forecast; storms blow up on people, unpredictable storms. No matter how skilled you are, stuff will happen ...When the forecasts came along, and accurate forecasts came along, and Met Éireann and regular broadcasts, a lot of those sudden storm type disasters stopped. (S4P3)

Similar points were reflected by marine leisure users and farmers, where safety and planning relied on accurate weather forecasts:

Well, an inaccurate weather forecast can be deadly ... (R1P6)

If you're spraying on agrochemicals, you just can't afford to have it washed off. (S3P3)

6.3.2 Confidence in Weather Forecasting

Participants across all eight focus groups expressed a lack of confidence in weather forecasting. The lack of accuracy was discussed in all but the Inishbofin group, and participants in all but the 2nd Rural focus group lacked confidence in the information they received:

Sometimes the forecast can be "fairly" accurate, but I generally find that there is a lot of variance in what is being said. For example, showers with

sunny spells or sunshine with scattered showers. You can't really go wrong with these types of statements. (R2P4)

Taylor *et al.* (2018) highlighted the difficulty in maintaining confidence in forecasting, given that a forecast often changes depending on the lead time. In the focus groups, participants understood how lead times affect accuracy in forecasting. For example, more participants were confident in the forecast three days out or sooner, but no participants described long-range forecasts (greater than one week) as accurate. They also appreciated that certain weather conditions are easier to predict with certainty over longer time frames:

Once you go beyond the two or three days, it is more shaky, and everything else, because you can often see quite a bad forecast has been given. And, you know, after a couple of days, it just may change around completely, and an opportunity may present itself in relation to getting the work done. (S3P2)

To improve confidence in the NMHS forecast, several participants within six focus groups (excluding Students and Marine User groups) suggested it needed to become more localized:

A very local forecast would be great, to within a few miles radius. (S3P5)

... [greater] localization and by localization, I mean, within a certain kilometer of where you are, you know. (R1P3)

A desire for greater reliability beyond a three-day timeframe was also expressed across all focus groups, and some participants, most especially in the 2nd Rural focus group, hoped technological developments in the forecasting may lead to greater accuracy in longer-range forecasting.

As the NMHS provides a single forecast detailing the most likely predicted outcome, with no probability data, all eight focus groups called for a move to probabilistic forecasting

focused on occurrence and magnitude. While some preferred detail, many expressed a preference for shorter, more factual forecasts:

I would like to see the probability being introduced. It works in many other countries. And it would help, you know, if you have the rain on the forecast. Well, is it a 10 percent chance of rain or a 90 percent chance of rain? It influences the risk you'll take. And that's useful in so many different corners. And I think when they get there, I would love to see them put in probability on their monthly forecast, because in a few years' time, they may very well have a reasonably good handle on what's going to happen in week three and week four. (S3P3)

People now want precise information, ... there's a 70 percent chance it's going to rain at 11 o'clock in the morning tomorrow. (R2P3)

The focus groups confirm previous US and European based studies that providing uncertainty information within a forecast can inform users' decision making (Gigerenzer *et al.* 2005; Nadav-Greenberg *et al.* 2009). However, this does not suggest ambiguity may be removed entirely, as probabilistic forecasting still requires the users' interpretation (Handmer and Proudley, 2007). Given that the Ensemble Prediction Systems used by the NMHS already generate uncertainty estimates for each scenario, the NMHS could and should switch to the presentation of probabilistic forecasts.

Discussions on a lack of confidence in weather forecasting also highlighted that some participants from five of the focus groups (Dublin, Marine Users, Students, Agriculture, and the 2nd Rural group) crosschecked multiple weather forecasts to determine what they believe to be the most likely scenario:

I use a combination of every available weather forecast and make me mind up from them all, basically! Got to do with looking on my phone, got to do with BBC weather forecast, got to do with RTÉ, and I make an assumption based on all. If two out of the three are predicting something and the other isn't... it's more liable that that's going to happen. And that's how I base my assumptions upon. (R2P6)

Prior research from the US has suggested that conflicting and contradictory information across forecasts can lower users' confidence (Kox *et al.* 2018; Losee and Joslyn, 2018), which can be a barrier to effective decision-making (Kox *et al.* 2018). Yet, in these focus groups, some participants appeared to expect, or at least accept, inconsistencies between the forecasts, hence their use of multiple sources. These verification actions are documented by Mileti (1999) and provide evidence that as part of the weather warning process, some users will continue to crosscheck information by conferring with others and consulting several sources, a behavior comparable to “milling” (DeYoung *et al.* 2019, p.1; Wood *et al.* 2018, p.537). In the absence of greater localized forecasting technology becoming immediately available to all forecasting services, and given the range of forecast providers, it is probable conflicting and contradictory information will continue. As part of the user-centered approach, the NMHS could engage with local communities to improve their understanding of how local environmental factors affect their weather, thus working to improve confidence in the NMHS forecasts: e.g., how local mountains affect precipitation levels in certain areas. That information could be attached to the NMHS weather app using location data.

6.3.3 Weather Warnings: Information Sources, Perception & Reaction

Survey respondents were asked to identify the information sources they used during major emergencies in Ireland. These sources were news media (92.76%), Government Authorities (52.66%), social media or websites (41.31%) and word of mouth from family and friends (40.05%). All focus groups reported similar sources of information when discussing weather warnings, with the most common source mentioned again being various news media bulletins: news broadcasts on TV and radio and warnings received via pop-up notifications from a news app. Other frequently discussed methods included social media (six focus groups), the Irish NMHS (five focus groups) and word of mouth, typically

involving a friend or family member, (four focus groups). A few participants from three of the focus groups mentioned receiving notifications of weather warnings through work or text/email alerts.

Survey respondents rated their satisfaction with the NMHS weather warning system from extremely dissatisfied (coded as 1) to extremely satisfied (coded as 7). Most respondents (88.2%, 3416n) were at least somewhat satisfied with the system, see Figure 6.2.

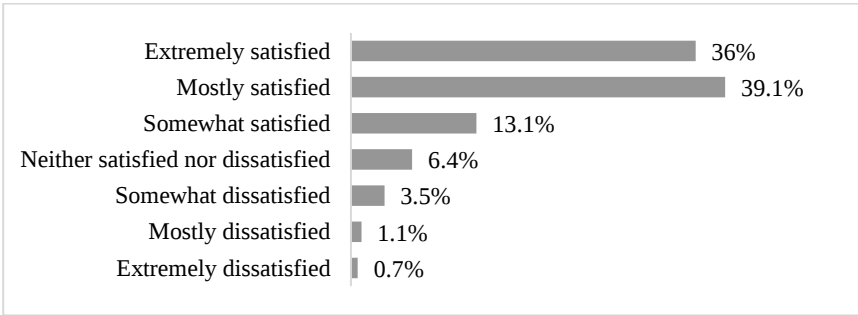


Figure 6.2 Satisfaction with the NMHS weather warning system

The overall satisfaction with the Met Éireann weather warning system was 5.91. Average satisfaction decreased with urbanicity. Respondents from rural settings gave the weather warning system a higher average satisfaction rating (6.01) than respondents living in a city (5.69). This difference is highly significant based on a t-test ($t = 4.50$, $p=0.001$). See Supplementary Material 5 for results related to a difference by gender.

Survey respondents who were not “Extremely Satisfied” with the NMHS weather warning system provided additional feedback. 38.5% (953n) suggested warnings were issued too frequently, while 14.7% (363n) indicated they were challenging to understand. These respondents were invited to expand upon their quantitative responses and 818 respondents provided 1,008 statements concerning their satisfaction with the weather warnings. It was evident from the outset of the analysis that respondents were divided with 44.05% (444n) of the comments being positive in nature. The prevalent themes that emerged are discussed

below, along with an overview of these themes provided in Table A6 of the appendix. Further, Table A8 reports the gender balance in both positive and negative themes related to respondents' sentiment concerning weather warnings.

When discussing the positive aspects of weather warnings, those most frequently mentioned in the questionnaires and subsequent focus group discussions were that overall the system worked well (emerged in all but the Marine Users focus group), increased awareness of the forecasted severe weather (emerged in the Agriculture, Cork and both Rural focus groups), and the warnings were clear (discussed in Dublin, Agriculture, and 1st rural focus groups):

Very easy to understand and only issued when necessary (QR677)

Helpful to people to give advance warning of potentially dangerous weather which allows them to prepare for same (QR3315)

A small number of participants across the Agriculture, Dublin, Cork, and Rural focus groups also emphasized that the weather warnings provided critical information:

I think largely they are a great tool to give people advanced notice (R2P4)

The most prevalent negative aspects mentioned in the questionnaires and subsequent focus group discussions were that warnings, especially yellow, were issued too frequently (discussed in all eight groups), lacked accuracy (emerged in all eight groups), and were not taken seriously or understood fully (mentioned within six focus groups – excluding Cork and the Agriculture focus groups). When discussing a lack of accuracy, some participants suggested the warnings were poorly timed, but most referenced weather events that did not materialize as forecast. Linked to a lack of confidence in the accuracy of a warning, participants suggested the warnings were too generalized:

...I do think that it can be also very generalized and, you know, because even within a county, I think you can have different weathers on the same day. And if you're going to apply it, don't apply it in a generic way. (R1P3)

Yeah, I would agree with you that they are fairly generalized. Like in Leitrim, there could be a hell of a difference between the weather in Kinlough in the north end and Carrick-on-Shannon in the south. I mean, it's more than an hour's drive, so an awful lot can be happening there. (R1P6).

They should be more specific to local areas... (QR3771)

Drawing on the questionnaires, some respondents raised problems with understanding the color-coded system, suggesting the threat posted or actions needed were not clear:

I think that people don't really understand what they mean and so there is confusion behind why a certain weather warning is in place. There is an expectation that if we have a red weather warning that the weather will be very severe without an understanding that the risks may lie in other factors such as fallen trees fallen electricity wires etc. (QR2609)

Yellow and orange warnings - severity difficult to understand (QR1244)

What does Yellow and Orange even mean? Should we care about Yellow? (QR4662)

While focus group participants were aware of the color coding associated with weather warnings, their knowledge and understanding beyond that was limited. Associating warnings' colors to the alert level was effective in conveying a level of threat, as participants understood the sequence of three warning colors and that a red warning was most severe. But it did not provide the necessary context to understand the specific features of the threat, and after confirming the sequence of the three colors, many participants, including some from the Dublin, Cork, Students, Inishbofin and Rural focus groups, would hurriedly follow up to express feelings of an incomplete understanding:

I think there's nearly a stereotype around that because the system's been here for what seems like a while, that people actually have an

understanding of it, that we're kind of like creatures of habit, that we just know what to do for each sort of weather warning. Whereas, we don't. ...the simplest ways to do it, like from RTE without causing a big, massive panic, like just sort of an explanation of what it is, just a brief education on what the actual system is, rather than just assuming that we know it. (S1P6)

I wouldn't have known the implications of an orange versus a red. You might know a yellow to red is more serious. But the one in between, I have no idea what an orange actually means and how severe it actually is. (R1P3)

The Inishbofin Island Focus Group suggested the color-coded warnings were not as informative as a physical description of the conditions expected:

I think terminology is important, but I think people are far more inclined to heed stuff when they hear about gale force winds or storm force winds or expressions like that would cause far more [heed] than the color codes. And I know storm force winds, gale force winds from whatever direction, you certainly pay more heed to that and act on something like that before you will about an orange, red or whatever. (S4P3)

I would think that the color-code system has lost its, its authority, I wanted to go for a better word. As S4P3 said there, the gale force, the storm force winds, that's what we would have grown up listening to. Like, you know if its storm force wind or violent storm force winds it's serious, rather than orange or red. It doesn't give specifics, whether it's 100 miles an hour or 50 miles an hour. At least the gale force and storm force winds are defined by their strength. (S4P4)

The message and risk posed by severe weather must be clear to motivate the appropriate response (Mileti's 1999; Rogers and Tsirkunov 2011; DeYoung *et al.* 2019). For many, these warnings lacked some clarity and necessary information concerning what actions to take, and as a result, there seemed to be less personalization, which lowered the chances of an individual taking appropriate action (Mileti and Sorensen 1990; UNISDR 2006; Vihalemm *et al.* 2012; Mayhorn and McLaughlin 2014). For weather warnings to be most effective, our findings emphasize the need to move away from a threshold-based weather warning system reporting only on the hydrometeorological conditions anticipated (e.g., low

temperatures) to impact-based warnings, which highlight resulting conditions (e.g., slippery surfaces) (Kaltenberger *et al.* 2020; WMO 2018). Given participants' feelings of an incomplete understanding of the warnings, this move should enable a greater understanding of severe weather events than traditional systems (Potter *et al.* 2021).

While participants generally approved of the weather warning system, some participants from the Students, Agriculture, Marine Users, Dublin and Rural focus groups, as well as questionnaires respondents criticized the yellow warnings because the conditions they represented were indistinguishable from typical bad weather:

Is there really a need to issue a yellow warning for a bit of rain? (QR547)

Most yellow are irrelevant or not worth worrying about (QR4671)

I do find that sometimes the yellow weather warnings can [be too frequent]. I'm starting to ignore them because it just gives regular weather.
(U1P4)

For some, the issuing of yellow warnings for what they regarded as usual Irish weather seemed to create frustration towards the entire weather warning system. The results suggest the threshold was viewed as too low, and thus the warnings were issued too frequently. Importantly, these warnings have utility for some users, e.g., farmers, and the challenge rests on how these warnings are communicated to different societal groups.

When a weather warning was issued, but the severe weather event did not materialize, some people suggested they ignore the following warnings, validating the limited number of empirical findings on the effects of false alarms (Ripberger *et al.* 2015; LeClerc and Joslyn 2015). These previous studies found evidence of false alarms related to specific warnings, such as tornadoes and low temperature events, however, our results suggest this is applicable to a range of warnings for various weather-related risks.

The theme of false alarms emerged in questionnaire responses and in five of the focus group discussions (Agriculture, Dublin, Inishbofin, Marine Users and 1st Rural focus groups), and was sometimes directly referenced as the “cry wolf” effect:

For example, if an orange alert has been issued many times and you never have experience of anything happening then you get somewhat immune to hearing orange alert and neglect to hear it as the caution it is meant to be and may not take adequate preparations. Feels a little bit like a boy who cried wolf scenario (QR3282)

Well, it means people, you know, the boy cried wolf thing. Even though intentions are good, if you’ve been warned about structural damage over and over again and whatever, and then and it’s not happening, then you’re going to get complacent. (S4P3)

For others, the “cry wolf” effect was implied:

The yellow warning level alert is issued so frequently that people now ignore it and sometimes other alerts. (QR2296)

Constant yellow/orange rain warnings in Ireland are a bit of a joke so people just don't listen (QR2583)

Consistent with Mileti and Sorensen (1990), the findings underscored the importance of believing that the message is accurate if individuals are to heed the warning. The results also contribute to a limited but growing number of empirical studies that demonstrate repeated false alarms can lead to a lack of confidence in a warning system and have negative impacts on their reactions (Ripberger *et al.* 2015; LeClerc and Joslyn 2015; DeYoung *et al.* 2019; Losee and Joslyn 2018). This study’s analysis confirmed that greater specificity of location and subsequent tailoring of messages could improve action. (Mileti and Sorensen 1990; Rogers and Tsirkunov 2011; Mayhorn and McLaughlin, 2014). This is not straightforward to accomplish as targeted impact-based warnings require ongoing collaboration between local people, the NMHS and other agencies to gather the necessary data on local impacts, geographical information, local vulnerabilities/exposures, and

demographics etc. (WMO 2015b). Advances in statistical models and data-driven approaches, including machine learning, could, however, make localized, tailored forecasting and messaging more achievable and improve future forecasts.

Regarding preparedness action, 34.3% (1326n) of survey respondents stated they would take action at an orange warning, with 55.4% (2143n) waiting until a red warning is issued before taking action. 6.3% (242n) reported they would have taken action at a yellow warning, and the remaining 160 individuals (4.1%) would not take any action on any warning. This data was used to examine preparedness in urban and rural dwellers. A variable ranging from zero to three summarized the warnings to which respondents reacted. It was defined as zero for individuals who did not react to any of the weather warnings, one for those who acted only on red, two for those who first reacted on an orange, and three for respondents who begin to prepare at a yellow. A higher value reflects that an individual acted in response to a less severe warning, which could be interpreted as indicating a higher degree of risk aversion. The overall average for this scale was 1.43. A chi-square test revealed a statistically significant association between action and urbanicity: $\chi^2(12df) = 34.819$, $p < 0.001$. The average is slightly higher for rural dwellers (1.50) compared with city dwellers (1.37), indicating that rural dwellers are more likely to take action in response to lower-level warnings; perhaps pointing to a higher degree of risk aversion. While the difference was not large, an independent-samples t-test determined a statistically significant difference between the means ($t = 3.38$, $p = 0.001$). Finally, females on average take action in response to less severe warnings; indicating a higher degree of risk aversion. The average figure for females (1.47) was significantly different from that for males (1.32) on the basis of a t-test ($t = 5.82$, $p = 0.000$).

When discussing the two lower-level warnings, orange and yellow, most often associated with a snowstorm, focus group participants across all eight focus groups displayed a low threat appraisal, often reasoning that weather events would impact them minimally. This association supports the findings of Reynaud *et al.* (2013), who found a significant association between threat appraisal and perceived flood probabilities. In our study, participant from all eight focus groups stated they would ignore such warnings entirely or described taking only minor protective measures. For a yellow snow or ice warning, little action was taken except to remain vigilant in case the situation deteriorated. Some participants did not act immediately on orange warnings, with some participants from Dublin, Cork, Inishbofin, Marine Users, Students and 2nd Rural focus groups indicating they would ignore or disregard the warnings while others in the Cork, Dublin, Students and 1st Rural focus groups choose to “wait and see” how the situation might evolve:

Probably just wait to see if it actually did snow, like, I'd wait for the evidence probably, and then make changes, if I need to do. (S1P4)

For an orange warning, others increased general alertness (discussed in all but the Inishbofin focus group), made changes to their driving behavior (Cork, Dublin, Marine Users focus groups), or prepared their home and garden (Agriculture, Cork, Students, and 2nd Rural focus group):

I'd put my bins into the shed, I would secure any loose items from around the place. You know, obviously, just make sure that there was nothing lying around outside that could become a projectile in the wind. (R2P7)

I'd possibly have a few bags of salts as well in the garage. (U2P1)

In contrast, participants in all focus groups outlined many specific changes in behavior and preparedness actions they would take in response to a red warning. The most common were gathering essential items and supplies which emerged in six of these focus groups

(Agriculture, Cork, Dublin, Students and Rural focus groups), “Bread and milk and food to tide you over for two, two and a half, three days” (U2P1), avoiding leaving home and altering driving behavior (Agriculture, Cork, Dublin, Students and Rural focus groups), preparing for a loss of electricity, heating or water (Agriculture, Cork, Dublin, Students and 2nd Rural focus group), securing the home/garden/workplace (Agriculture, Inishbofin, Students and 2nd Rural focus group), and checking on vulnerable neighbors or relatives (Students and Cork):

I just make sure I have things handy, torches and, you know, some kerosene lanterns and kerosene heaters, have mobile kerosene heaters, so those could kick in and, you know, we’ve put a lot of things in place in the house to be able to cope, at least for 48 hours. (R2P5)

Previous studies have shown threat appraisal to have a mixed effect on protection motivation (Twerefou *et al.* 2019; Poussin *et al.* 2014). Babicky and Seebauer (2019, p.1515) concluded “coping appraisal is strongly associated with protection motivation, threat appraisal is closely linked to non-protective responses. The effect of non-protective responses on protection motivation is negligibly small”. However, our focus group participants highlighted that their protection motivation was driven by the formal threat appraisal, the red warning, issued by the NMHS, which resulted in their perception that they would be negatively impacted, thus the need to act. This contrasted with the findings of some previous studies, where coping appraisal dictated protective action (Grothmann and Reuswig 2006; Bubeck *et al.* 2013; Babicky and Seebauer 2019; Odidi *et al.* 2020). A possible explanation for this difference could be the level of trust in the NMHS. Prior research in Ireland, using an online questionnaire of 6497 households in 2017, found that Met Éireann, the NMHS, was the second most trusted and acted upon source of information in an emergency, second only to the Emergency Services, with around 65% ‘very likely’ to act on their advice and a further 25% ‘somewhat likely’ (McMullan, Largey and Brown

2020). Although this was not tested within the current study, the impact of trust could be a topic for further investigation.

Only in a very limited number of instances in our study was there evidence of a lack of a protective response because of a low coping appraisal (namely the high monetary costs) despite a high threat appraisal being present:

Not much [preparedness actions taken before a Storm] because I only have a budget per-week, so couldn't really afford to stock up as much as I wished (QR2290)

6.3.4 Future Weather Service Needs

Concerning future weather service needs, the overwhelming view of participants to emerge from all eight focus groups was the key services required from the NMHS were providing the most accurate weather prediction possible and warning of severe weather events. Participants also wanted more accurate localized forecasts (raised in the Agriculture, Inishbofin, Cork, Dublin, Marine Users and Rural focus groups), a more accurate long-term forecast (Marine Users, Agriculture and 1st Rural groups), downloadable GRIBs (Marine Users), reinstatement of the three-hour forecast (Agriculture group), and a forecast for fog (Dublin group).

The NMHS has developed a strong presence on social media; however, this success could become problematic as the volume of messages has become so vast as to irritate rather than inform some followers. The segmentation of social media feeds by topic, such as forecasts, warnings, be winter/summer-ready, and by user group, such as farmers, could help sustain successful engagement through social media (Kox *et al.* 2015) while reducing dissatisfaction with the current high volume of data.

Among students, there was a consensus that the NMHS catered for an older audience. This did not result in the students' disregarding warnings as they felt NHMS was reputable but showed a preference for forecasts provided by other organizations. They suggested increased engagement with younger people:

For example, Ryanair's TikTok, you see a funny video, you click on the link, you look through the content. Next thing you know you're looking at flight prices. It's stuff like that you just engage with ...I wouldn't search Met Éireann on Twitter to see like are they posting anything. (S1P6)

It needs to be quick, easy, flashy, like if they want to keep their kind of reputation. Look, I know that they are very reputable already, but the generations to come might not think that. (S1P2)

Humor can be an effective tool in public messaging campaigns (Gough *et al.* 2017; Fraustino and Ma 2015), and opportunities may exist to increase awareness of upcoming severe weather events using weather-related memes. There are many examples of such memes going viral in Ireland; examples at Extra (2021). However, while humor can grasp public attention and build engagement (Gough *et al.* 2017), it can reduce the perceived severity of the issue being communicated (Moyer-Gusé *et al.* 2011) and may not promote preparedness action (Fraustino and Ma 2015). Further, the focus group data suggested that misplaced humor could reduce respect for the NMHS.

6.4 Conclusions

With a view to increasing national resilience, the purpose of this study was to determine what constitutes a user-centric weather forecasting and warning system for the Irish NMHS. The findings are summarized in Figure 6.3 under the themes: forecasts, warnings, and household action.

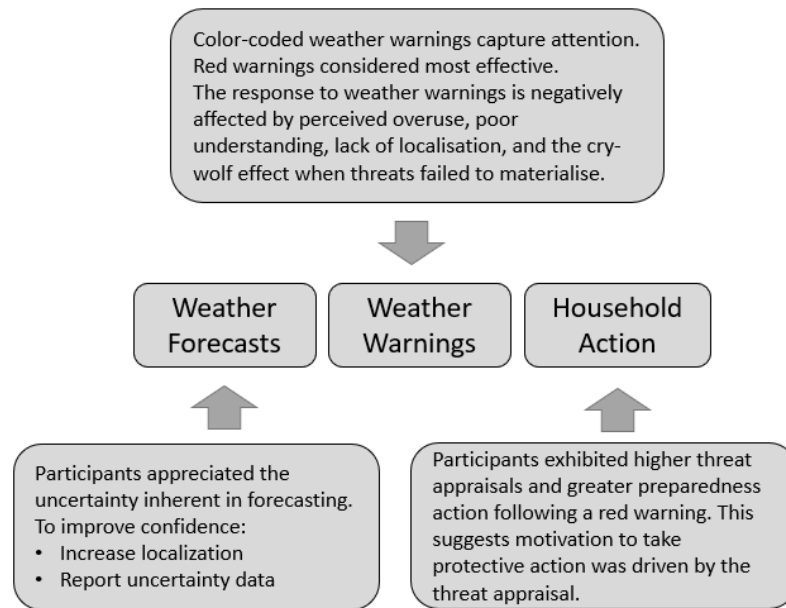


Figure 6.3 Summary of Findings

A main limitation of this study was that participation was internet dependent. Volunteers were recruited using social media, the survey completed using an online platform and the focus groups conducted on Zoom. In-person focus groups and a paper-based postal survey could have reached a wider group.

6.4.1 Weather Forecasts

Participants were influenced by weather forecasts when scheduling activities in their daily life, and especially when faced with work or safety concerns. The results confirm the significance and desire for accurate weather forecasts across all user groups.

Generally, participants exhibited low confidence in the accuracy of forecasts they received, most especially if the forecasted event was over three days out. Several participants, nevertheless, appreciated the uncertainty inherent in forecasting, and how this reduced as lead time reduced, supporting the findings by Morss *et al.* (2008). The findings also

supported a move to probabilistic forecasting and the reporting of uncertainty data as an aid to effective decision making.

There was little indication that participants' use of forecasts decreased if they had low confidence in the forecast; instead, some participants expected inconsistent forecasts and used multiple sources to predict conditions. This finding mirrors the behavior identified by Mileti (1999), where people seek to verify the weather warning information received.

6.4.2 Perception & Reaction to Weather Warnings

While the NMHS weather warning system was generally well-received, the perception that warnings are issued too frequently, challenging to understand, and lacking in accuracy reduced some people's confidence in the system. Color-coded warnings effectively portrayed a level of threat, especially for red warnings; however, the thresholds were not easily understood, which resulted in some users indicating that without an impact-based warning, they did not have a complete sense of the potential threat.

Focus group participants felt that an opportunity to link the warning to recommended preparedness actions was not being exploited. The high level of confidence in the NMHS and the prevalence of emergency information being sourced through the news media, gives the NMHS a powerful platform to influence emergency preparedness and action in Ireland.

Before acting on a warning, people must believe that the message is accurate, true, and applicable to them (Mileti 1999). Our findings support this theoretical stance and highlight the importance of more localized warnings which take account of the variation in risk across a county and describe features of the threat using impact-based warnings. This was especially evident for an island community such as Inishbofin.

It seemed that low confidence in warnings lowered individuals' threat appraisals, which in turn reduced preparedness action. When discussing orange warnings, participants reported low threat appraisals, waiting to see how the situation unfolded before acting. Participants reported higher threat appraisals and greater preparedness action following a red warning. This suggested motivation to take protective action was driven by threat appraisal. The factors driving these threat appraisals are worthy of further investigation.

While previous evidence for the cry-wolf effect was inconsistent, several focus group participants described this effect, some even citing the term cry-wolf, and suggested these false alarms impacted their reaction to subsequent warnings. To preserve confidence and avoid this cry wolf effect, when conditions change and the severe weather does not materialize as predicted, the reasons for this should be communicated by the NMHS. Moving to probabilistic forecasting and conveying uncertainty information will provide an opportunity to study the mitigating effect of clarity, transparency, and the publication of uncertainty data on the cry-wolf effect. We suggest that further research is required across different countries as national culture may influence factors such as the cry-wolf effect.

6.4.3 Future Weather Service Needs

While the NMHS is well respected by the Irish public, who recognized its professionalism and expertise, there is a lack of awareness of the range of services it provides. As part of its renewed focus on a user-centric model of weather forecasts and warnings, the NMHS should improve communication and bottom-up engagement with local communities and publicize its core services. It was telling that new sections of the website and even the launch of the app was missed by many.

Participants wanted to see location-specific information updated hourly, and icons and percentages instead of text. For example, a "lite" version of the app, modelled on some of

the more commercial providers, with increased emphasis on localization and icons could be developed. The more detailed app could be maintained for those with specialist needs.

Finally, the NMHS should encourage a feedback loop with service users. A variety of tools and techniques could be deployed to encourage feedback from users. These could include longitudinal surveys, service-user focus groups, comment upload point on website, and tracking of user feedback on social media sites. It was clear that the public had strong opinions about their services and strategy. Given the stereotypical view that Irish people talk about the weather constantly, and the prominent place of weather in Irish folklore and song, this came as no surprise.

7. Chapter Seven – Paper 6

An assessment of nurses' perceived and actual household emergency preparedness

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7.0 Abstract

Nurses' household preparedness is critical if they are to avoid role conflict and report for duty during an emergency. To date, the alignment between nurses' perceived and actual household preparedness remains under examined. Investigating one of these variables in isolation fails to consider that perceived and actual household preparedness must be high and aligned. If misaligned, vulnerabilities could surface during emergencies, like concerns about family safety, potentially impacting a nurse's commitment to duty during a crisis, or nurses may lack the actual preparedness to continue working long hours during an emergency. An online questionnaire was distributed to registered nurses in Ireland. The questionnaire was informed by a review of the literature and captured nurses' perceived and actual household preparedness, attitudes towards and exposure to a range of emergencies, and pertinent demographic characteristics. The results showed a relationship between how nurses view their household preparedness and their actual preparedness. Regression analyses indicate that while there is an overlap, the factors associated with how prepared nurses think they are and how prepared they are can differ. This means that strategies to boost actual preparedness may differ from those needed to boost perceived preparedness. This finding underscores the importance of psychosocial preparedness. Feeling prepared is crucial as it can influence how one responds in an emergency.

Considering both the perceived and actual aspects of household preparedness can lead to a more effective response during emergencies.

7.1 Introduction

At few times in history has the importance of the role played by nurses been so evident as during the COVID-19 pandemic. Having the correct number of nurses with the required skills mix is vital to a successful response to health-related emergencies or where healthcare is required because of other emergencies. When an emergency occurs, nurses must leave their homes to fulfil a critical role in the response. Nurses are, however, less likely to report for duty if they feel that doing so increases the risk to their own family or household. For this reason, there is some expectation that frontline personnel are personally as well as professionally prepared in advance of any emergency. FEMA (2007) and Landahl and Cox (2009) emphasised the importance of frontline personnel being prepared at home if they are to avoid role conflict: “Without taking the appropriate steps to prepare themselves and their families in advance of a disaster, responders will be hindered in their ability to perform their jobs when a disaster strikes, and will instead be focused on personal and family safety” (FEMA, 2007). Extending this further, Balut *et al.* (2021) research found that healthcare workers who have family emergency plans are more likely to have confidence in their facility's emergency response capabilities and are more likely to view their role as important in responding during an emergency, such as a pandemic. Research has shown, however, that frontline service personnel, including nurses, are not consistently prepared at home (Makama, Joshua and Makama, 2016; Corwin *et al.*, 2017) and that household preparedness is as important as workplace preparedness (Considine and Mitchell, 2009; Jacobson *et al.*, 2010; Smith and Hewison, 2012; Baack and Alfred, 2013; Uhm *et al.*, 2019); Corwin *et al.* (2017) concluded that “response professionals largely mirror laypeople in terms of their

household preparedness levels”, while Uhm *et al.* (2019) stress that to enhance response capacity of EMTs, and other frontline staff, education/training to promote self-efficacy and personal preparedness is required.

The emergence of role conflict among frontline personnel and its impact on an individual’s intention to report for duty during an emergency has been investigated extensively (Quarantelli, 2008; Trainor and Barsky, 2011; Dobalian, *et al.* 2020). Much of this research focused on healthcare professionals and revealed that home and family concerns presented as key barriers to reporting for duty (French, Sole and Byers, 2002; Qureshi *et al.*, 2005; Cone and Cummings, 2006; Smith, 2008; Smith *et al.*, 2008; Ives *et al.*, 2009; Masterson *et al.*, 2009; DeSimone, 2009; Grimes and Mendias, 2010; Barnett *et al.*, 2010; Tippet *et al.*, 2010; Carameli, 2010; Damery *et al.*, 2010; Gershon *et al.*, 2010; Martin, 2011; Stergachis *et al.*, 2011; Adams and Berry, 2012; Goodhue *et al.*, 2012; Arbon *et al.*, 2013; Melnikov, Itzhaki and Kagan, 2014; Shapira *et al.*, 2016; Patel *et al.*, 2017; Taylor, Rutkow and Barnett, 2018; McNeill *et al.*, 2020). These barriers included concern for personal and/or family safety (French, Sole and Byers, 2002; Qureshi *et al.*, 2005; Dimaggio *et al.*, 2005; Smith, 2008; Smith *et al.*, 2008; DeSimone, 2009; Ives *et al.*, 2009; Balicer *et al.*, 2010; Barnett *et al.*, 2010; Damery *et al.*, 2010; Gershon *et al.*, 2010; Grimes and Mendias, 2010; Stergachis *et al.*, 2011; Adams and Berry, 2012; Shapira *et al.*, 2016; Patel *et al.*, 2017; Taylor, Rutkow and Barnett, 2018) transport worries, finding childcare, supporting elderly parents, and/or pet care (Qureshi *et al.*, 2005; Smith, 2007; Smith *et al.*, 2008; O’Sullivan *et al.*, 2009; Stergachis *et al.*, 2011; Melnikov, Itzhaki and Kagan, 2014). Slepiski (2007) reported that several respondents (nurses, physicians, emergency medical technicians) who responded to Hurricane Katrina and/or Hurricane Rita “mentioned the need to be personally ready ... ensuring that their families were equally prepared ... and that those left at home needed to be able to be ‘on their own’”.

Trainor and Barsky's research (2011) on role conflict, strain and abandonment among frontline personnel when faced with an emergency, recommended developing a family support and safety framework similar to the employee household preparedness program proposed by FEMA (2007). Any measure which drives preparedness is to be welcomed given that research has shown that actual preparedness resulted in individuals/homes being more resilient, which in turn increased nurses' willingness to report for duty during an emergency (Arbon *et al.*, 2013; Connor, 2014). Connor (2014) found that healthcare workers' intention to report to work reflected personal preparedness measures such as "vaccinations, supplies, evacuation, and contact plans". In essence, if their household had undertaken emergency preparedness planning activities, emergency medical services workers were found to be "more than twice as willing to mobilize to another, more severely affected community" (Barnett *et al.*, 2010) .

While a number of studies have examined nurses' emergency household preparedness, none have compared how prepared nurses feel (perceived preparedness) and their actual preparedness (checklist preparedness)(Ives *et al.*, 2009; Goodhue *et al.*, 2012; Mercer *et al.*, 2014; Annis, Jacoby and De Mers, 2016; Balut, Der-martirosian and Dobalian, 2022; Wilcox, Heagele and McNeill, 2022) . Wilcox *et al.* (2022) in their analysis of household emergency preparedness, highlight that nurses should prepare emergency overnight bags in case they are unable to leave the hospital due to severe weather or other emergencies. They should arrange, where necessary, backup carers for children or pets in the event of extended shifts or being unable to return home safely (Wilcox, Heagele and McNeill, 2022). Balut *et al.* (2022) found that USA healthcare workers who felt they were not prepared at a household level for major emergencies were more open to receiving preparedness training. They stressed that there was a need to "consider personal preparedness training that encourages [healthcare] employees to put together basic disaster kits at home as well

as written household disaster plans that address the needs of dependents and others whom they may be responsible for in the event that they have to report to work during a disaster” (Balut, Der-martirosian and Dobalian, 2022). Labrague *et al.* (2018) also confirmed that workplace training has been shown to significantly enhance personal preparedness. Furthermore, the training of nurses in emergency preparedness can have a knock-on effect on the preparedness of those under their care. This impact was illustrated by in a paper focused on community health nurses (Glaubergerman and Qureshi, 2021).

While several studies have examined nurses’ household emergency preparedness (Slepski, 2007; Ives *et al.*, 2009; Goodhue *et al.*, 2012; Mercer *et al.*, 2014; Annis, Jacoby and De Mers, 2016; Labrague *et al.*, 2018; Shah *et al.*, 2020; Balut, Der-Martirosian and Dobalian, 2021; Glaubergerman and Qureshi, 2021; Balut, Der-martirosian and Dobalian, 2022; Wilcox, Heagele and McNeill, 2022; Der-martirosian, Balut and Dobalian, 2022; Longo, 2022), comparing how prepared nurses feel (perceived preparedness) and their actual preparedness remains underexamined, with Longo’s (2022) study of student nurses a rare exception. Even when widening the scope to include the general population, only a few studies have examined the alignment of perceived and actual household preparedness (Kapucu, 2008; Ablah, Konda and Kelley, 2009; Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Kyne *et al.*, 2020; Brown, Largey and McMullan, 2021b; Longo, 2022). For example, Kapucu (2008) established that while 61% of respondents felt adequately prepared for an emergency, only 8% had emergency supply kits with three days of food, water and medications. Similarly, Ablah *et al.* (2009) observed that 66.5% of respondents who rated their perceived household preparedness as “somewhat well prepared” or “well prepared” were found to be “unprepared” meaning they were missing 2 or more of the 6 measures of preparedness: an evacuation plan; 3-days of water; 3-days of food; 3-days of medication; radio; flashlight.

This paper examines perceived and actual emergency preparedness of nurses at a household level. Perceived preparedness is a subjective assessment of household preparedness based on how prepared the respondents feel (Kyne *et al.*, 2020). When measuring perceived preparedness, some studies use a binary measure (Basolo *et al.*, 2009; Henly-Shepard *et al.*, 2015; Cope *et al.*, 2018). For example, Cope *et al.* (2018) asked respondents if they thought they were prepared to deal successfully with a serious threat: allowing respondents to indicate yes or no. Other studies use ordinal scales (Bradford *et al.*, 2012; Donahue, Eckel and Wilson, 2014; DeBastiani *et al.*, 2015; Adame and Miller, 2016; Basolo, Steinberg and Gant, 2017; Han *et al.*, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Kruger *et al.*, 2018; Ranjbar *et al.*, 2018; Oriangi *et al.*, 2019) that vary from three-point scales (DeBastiani *et al.*, 2015; Basolo, Steinberg and Gant, 2017; Kirschenbaum, Rapaport and Canetti, 2017), to four-five points scales (Bradford *et al.*, 2012; Donahue, Eckel and Wilson, 2014; Han *et al.*, 2017), and larger (Adame and Miller, 2016; Ranjbar *et al.*, 2018). For example, DeBastiani *et al.* (2015) asked respondents how well prepared they felt their household was to handle a large-scale emergency: allowing respondents to indicate “well prepared, somewhat prepared, not prepared at all”.

Determining actual preparedness involves asking the respondent if one or more measures to prepare for an emergency have been undertaken within the household (Kyne *et al.*, 2020). These measures are defined by taking account of the needs of the household when faced with an emergency (Kapucu, 2008) and are commonly drawn from preparedness guidelines (Ablah, Konda and Kelley, 2009; Basolo *et al.*, 2009; McNeill *et al.*, 2013; Jassemppour *et al.*, 2014; Corwin *et al.*, 2017; Bodas *et al.*, 2018; Donner and Lavariega-Montforti, 2018; Wirtz, Rohrbeck and Burns, 2019) or previous preparedness studies (Nguyen *et al.*, 2006; DeYoung and Peters, 2016; Wei and Lindell, 2017; Wu *et al.*, 2017; Ranjbar *et al.*, 2018; Hung, 2019). When measuring emergency preparedness, some studies use a single binary

measure (Jassempour *et al.*, 2014; Annis, Jacoby and De Mers, 2016), for example, asking respondents if there is a 72-hour emergency kit in their home (Annis, Jacoby and De Mers, 2016). To maintain measurement validity, household preparedness measures should include measures which are not focused solely on supplies (Brown, Largey and McMullan, 2021b), because as Mileti (1999) noted “the purpose of preparedness is to anticipate problems in disasters so that ways can be devised to address the problems effectively and so that the resources needed for an effective response are in place beforehand”. Preparedness measures can be grouped into categories such as:

- emergency resources, equipment and supplies such as a first aid kit and fire extinguisher (Knuth *et al.*, 2017), a disaster survival kit (Jassempour *et al.*, 2014), or radio with spare batteries (Wei and Lindell, 2017).
- planning measures (Basolo *et al.*, 2009; Corwin *et al.*, 2017), such as creating a communication plan (Annis, Jacoby and De Mers, 2016) or gathering important documents (Wei and Lindell, 2017), and
- preparedness actions (McNeill *et al.*, 2013; Oral *et al.*, 2015) such as buying insurance (Wei, Sim and Han, 2019) or securing furniture (Nguyen *et al.*, 2006; Kirschenbaum, Rapaport and Canetti, 2017).

In some cases, these preparedness measures are then compiled into scales (Nguyen *et al.*, 2006; Wood *et al.*, 2012; Bodas *et al.*, 2015; Oral *et al.*, 2015; Bodas *et al.*, 2018; Espina and Teng-calleja, 2015; Henly-Shepard *et al.*, 2015; Baytiyeh and Naja, 2016; DeYoung and Peters, 2016; Ejeta *et al.*, 2016; Wei and Lindell, 2017; Mabuku *et al.*, 2018; Wei, Sim and Han, 2019; DeYoung *et al.*, 2019), with each measure equally weighted and summed (Prati, Pietrantonio and Zani, 2011; Wood *et al.*, 2012; Espina and Teng-calleja, 2015; Kirschenbaum, Rapaport and Canetti, 2017; Xu *et al.*, 2018; DeYoung *et al.*, 2019; Wei, Sim and Han, 2019). For example, DeYoung and Peters (2016) used an adapted version of the Mulilis-Lippa Earthquake Readiness Scale, which contained 12 equally weighted measures: meeting place, fire extinguisher, decide where to live, water, battery radio, food,

medicine, cooking source, CPR training, first aid, attended preparedness meeting, and flashlight. Others have chosen to examine each measure separately (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Stumpf *et al.*, 2017; Xu *et al.*, 2018; Hung, 2019); for example, Hung (2019) studied specific preparedness behaviors that included having an electric generator, evacuation plan, emergency contact and insurance.

The motivation for this study was twofold: firstly, while studies associated with frontline responders' household preparedness have been undertaken (Landahl and Cox, 2009; Makama, Joshua and Makama, 2016; Corwin *et al.*, 2017), there has been a call for more research on nurses' household preparedness (Hutchison, 2017; Baduge, Morphet and Moss, 2018). For example, Baduge *et al.* (2018) stressed “the personal preparedness of emergency nurses has been under-examined and requires more evidence for strategy”. In Ireland, the setting of this study, McMullan *et al.* (2016) found that nurses' homes were underprepared for influenza outbreaks; however, limited data was available on household preparedness for other types of emergencies. Secondly, a review of the literature examining both perceived and actual household preparedness, revealed no comparison of nurses' perceived and actual household preparedness had been undertaken. See Appendix 1 for a summary of the literature review and its outputs. Household preparedness is an important foundation for resilience. If there is a mismatch nurses' perceived and actual household preparedness this may have significant negative effects on nurses' capacity to work during an emergency. For instance, during Storm Emma, which hit Ireland from 28 February to 4 March 2018, there were extensive disruptions that greatly affected transport, water, power, and food supplies. During the emergency, some nurses could not get to work due to the weather or did not want to leave their homes because of competing priorities. Others, who reported for duty, were unable to return to their homes. These nurses faced difficult conditions, often sleeping in crowded spaces with limited facilities, privacy and access to hot food (Schiller,

2018). Storm Emma emphasized the need for greater personal emergency preparedness supports and for nurses.

The outputs from Appendix 1 Table A1 also demonstrated that risk rating, prior exposure to emergencies, and a set of socio-demographic factors were commonly used in studies of perceived or actual preparedness, but the extent to which these factors align in the influence of perceived and actual preparedness remained unclear. For example, Basolo *et al.* (2009) found that owning a home had a significant positive effect on stocking emergency supplies but had no significant effect on levels of perceived preparedness. To address these gaps in the research, the following research questions were examined:

1. How aligned are nurses' perceived and actual household preparedness?
2. To what extent do risk rating, prior exposure to emergencies, and socio-demographic factors influence perceived and actual preparedness among nurses?

By targeting this specific group, our study brings a unique perspective to the field and contributes to a better understanding of the household preparedness of nurses' who are pivotal in emergency response. This assessment of perceived and actual household preparedness provides a more nuanced understanding of the factors influencing nurses' preparedness. This knowledge can guide tailored interventions to enhance their preparedness for future emergencies.

We expected differences between perceived and actual preparedness to map the research into risk perception which has shown subjective perceptions of risk do not match objective/expert risk assessments (DeYoung *et al.* 2016; Wachinger *et al.* 2013; Bourque 2013; Slovic *et al.* 2005) For example, Slovic *et al.* (2005) showed that the public's perception of risk was often based on feelings, suggesting "risk as feelings refers to our fast, instinctive, and intuitive reactions to danger"; as opposed to the mode of thinking

known as “risk as analysis” which “brings logic, reason, and scientific deliberation to bear on hazard management”. Following this logic, nurses’ perceptions of their household preparedness will be based on preparedness as a feeling. This is different to actual preparedness, where the person completes an assessment against a given checklist of items and actions; thereby reducing subjectivity.

Risk compensation theory suggests those who perceive a reduced level of risk are less likely to adapt their behavior and become less careful because they feel more protected (Hedlund, 2000; Levym and Miller, 2000; Hillman and Adams, 2001). Similarly with preparedness, a high level of perceived preparedness may result in less protective action being taken. Unless this high level of perceived preparedness is matched by a high level of actual household preparedness, vulnerabilities may emerge during an emergency. Given that home and family concerns can present as key barriers to nurses reporting for duty, the effects of not having perceived and actual household preparedness high and aligned could be detrimental to the continuity of services during an emergency. Informed by Kyne *et al.* (2020), Figure 7.1 illustrates the possible combinations for perceived and actual preparedness, with the optimum outcome being Think-Yes: Actual-High.

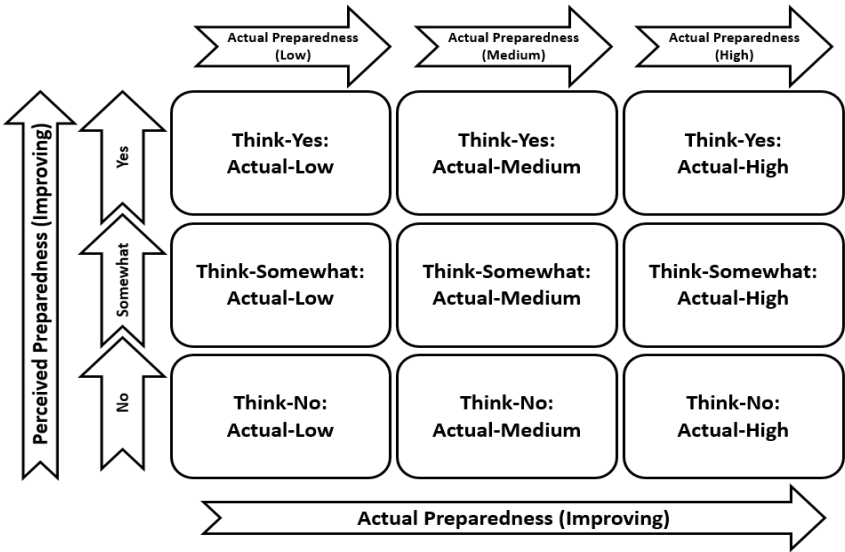


Figure 7.1 The possible combinations of perceived and actual preparedness

Role conflict is most likely to occur when a nurse falls under one of the “Think-No” categories. In these instances, a nurse perceives they have low household preparedness and that leaving home during an emergency may put their household at additional risk; as a result, they may choose not to report for duty. Role conflict may also occur when a nurse falls under one of the other “Actual-Low” categories. For example, if a nurse leaves their home thinking their household can cope with the impending emergency, but later finds they were unable to cope due to a lack of actual preparedness, they may decide not to return to work the following day.

A decision not to report for duty is especially critical in Ireland where there are already low nursing staff numbers. For example a Health Information and Quality Authority's (HIQA) report on University Hospital Limerick in March 2022 found “nurse staffing levels were insufficient, which was having an impact on the safe provision of care at the time of inspection” (Independent, 2022).

7.2 Literature Review on Perceived & Actual Preparedness

Ten studies examined the empirical differences between perceived preparedness and actual preparedness (Nguyen *et al.*, 2006; Ablah, *et al.* 2009; Basolo *et al.*, 2009; Rebmann *et al.*, 2013; DeBastiani *et al.*, 2015; Basolo, Steinberg and Gant, 2017; Kirschenbaum, Rapaport and Canetti, 2017; Kyne *et al.*, 2020; Brown, Largey and McMullan, 2021b; Longo, 2022). Longo, who utilized dichotomous variables for perceived and actual preparedness, and odds ratios to undertake the analysis, discovered that nursing students who felt prepared for earthquakes were in fact more than twice as likely to have a family emergency plan in their household, and nearly five times as likely to have accumulated emergency supplies (Longo, 2022). Studies which examined these differences among the general population using correlation analysis reported relatively weak positive correlations between perceived and

actual preparedness (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Kirschenbaum, Rapaport and Canetti, 2017), which ranged from $r=0.156$ to $r=0.401$. Basolo *et al.* (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017) reported that perceived preparedness was not correlated with some measures of actual preparedness, such as having emergency supplies (Basolo *et al.*, 2009). In a 2020 study, Kyne *et al.* (2020) defined respondents as being prepared for an emergency if they had eight or more items from a checklist of nine and perceived themselves as prepared if they stated they were at least somewhat prepared. Based on a paired t-test analysis, significant differences between perceived preparedness and actual preparedness were reported. The remaining studies examined actual preparedness using regression analysis, with perceived preparedness as an explanatory variable and controlling for other factors. The results were mixed (Nguyen *et al.*, 2006; Ablah, *et al.* 2009; Rebmann *et al.*, 2013; DeBastiani *et al.*, 2015). Nguyen *et al.* (2006) found the association between perceived and actual preparedness non-significant. They suggested, however, that respondents who “had done some of the ‘easier’ things” relating to earthquake preparedness, such as gathering preparedness items like canned food, bottled water, and a first-aid kit, and who perceived they were prepared were less likely to undertake any further preparedness actions (Nguyen *et al.*, 2006). In contrast, Rebmann *et al.* (2013), DeBastiani *et al.* (2015), and Ablah *et al.* (2009) found that perceived preparedness was positively and significantly associated with actual preparedness. For example, DeBastiani *et al.* (2015) suggested that people who reported feeling well prepared were 4.2 times more likely to have a 3-day supply of food kept in the home, but this association reduced to 2.3 times more likely to have a flashlight. Table 7.1 provides a summary of the perceived and actual preparedness measurements used along with the findings related to their association. The combined findings from these studies suggested

that assessments of perceived preparedness to some extent reflected actual household preparedness, but the association is neither consistent nor strong.

Table 7.1 Association Between Perceived and Actual Preparedness

Source	Analysis	Emergency	Measurement of Actual Preparedness	Measurement of Perceived Preparedness	Result
(Longo, 2022)	Odds ratios	Earthquake	Has a family plan or not (dichotomous)	Felt prepared vs Felt unprepared	2.75 times more likely to have a plan**
			Has emergency supplies or does not (dichotomous)		4.83 times more likely to have supplies***
(Basolo <i>et al.</i> , 2009)	Correlations	Earthquake	Has a family plan or not (dichotomous)	Perceived level of preparedness 1 = high level; 0 = low level	r = .33*
			Has all 11 items (supplies) or does not (dichotomous)		NS
			Did three mitigation measures or not (dichotomous)		r = .21*
			Knows how to shut off utilities or not (dichotomous)		r = .25*
		Hurricane	Has a family plan or not (dichotomous)	Perceived level of preparedness 1 = high level; 0 = low level	r = .23*
			Has all 11 items (supplies) or not (dichotomous)		r = .18*
			Knows how to shut off utilities or not (dichotomous)		NS
(Basolo, Steinberg and Gant, 2017)	Correlations	Hurricane	Intend to evacuate or not (dichotomous)	Perceived household preparedness 3-point scale: low-to-moderate, moderate-to-high, and fully prepared.	NS
			Availability of sandbags (dichotomous)		NS
			Has a family plan or not (dichotomous)		r = .156**
			Has all 11 items (supplies) or does not (dichotomous)		r = .279**
(DeBastiani <i>et al.</i> , 2015)	Adjusted Odds Ratio	Public Health Emergencies	Has 3-day supply of food	Perceived household preparedness: well prepared, somewhat prepared, not prepared at all	Respondents who reported feeling their households were well prepared were: 4.2 times more likely to be prepared
			Has 3- day supply of water		4.0 times more likely to be prepared
			Has written evacuation plan		3.1 times more likely to be prepared
			Has working battery-operated radio and batteries		2.6 times more likely to be prepared
			Has working flashlight and working batteries		2.3 times more likely to be prepared
			Number of preparedness items - increase		As the number of preparedness items increased, respondents were more likely to report feeling their households were well prepared: 0 items, 4.2%; 1 item, 4.2%; 2 items, 8.2%; 3 items, 15.4%; 4 items, 35.1%; 5 items, 56.5%
(Kirschenbaum, Rapaport and Canetti, 2017)	Correlations	Earthquake	Actual preparedness: 17-items scale	1= not prepared at all; 3 = fully prepared	r = .401**

(Kyne <i>et al.</i> , 2020)	Paired t-test	Hurricane	Actual preparedness: nine action statements	1 = not prepared at all, 2 = somewhat well prepared, 3 = well prepared	t = 2.9814**
(Nguyen <i>et al.</i> , 2006)	Logistic Regression	Earthquake	preparedness activities - some (1–5) vs. no preparation	Perceived pre-quake preparedness: 0 = unprepared; 3 = well prepared	NS
			preparedness activities - many (6 or more) vs no preparation		NS
(Rebmann <i>et al.</i> , 2013)	Linear Regression	"Natural Disasters" and Pandemics	Disaster Preparedness (20 indicators)	Perception of personal preparedness for:	"Natural disaster" $\beta = 3.1$ ***, S.E. (0.48) "Pandemic" $\beta = 1.8$ ***, S.E. (0.51)
			Pandemic Preparedness (9 Indicators)		"Natural disaster" $\beta = 3.0$ ***, S.E. (0.24) "Pandemic" $\beta = .7$ **, S.E. (0.51)

Notes: *p < .05, **p < .01, ***p < .001, NS = not significant

Differences in the level of emergency preparedness can be attributed to “human, social, economic and demographic factors [that] influence the ability and desire of individuals and families to prepare for emergencies” (Levac, Toal-Sullivan and O’Sullivan, 2012). Similarly, social and demographic factors, along with experiences of risk, have been found to play a major role in shaping risk perception (Lechowska, 2018). The wide range of factors that have been examined in relation to perceived and actual preparedness, and the methods employed, are reported in Table A2, Appendix 2. While the number of papers is relatively small, the findings highlight differences in the factors that predict both perceived and actual preparedness.

Table 7.2, which summarizes the factors that were included in the analyses of perceived and actual preparedness, shows inconsistencies in the selection of demographic factors between studies, with Basolo *et al.* (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017) using the most comprehensive range of socio-demographic factors. Basolo *et al.* (2017) found that age was significant and positive for perceived preparedness. The presence of children in the home, home ownership, identifying as male, and marital status were significant and positive for at least one actual preparedness variable (having a family plan, having sandbags on-site, or having all recommended preparedness items on hand). Kirschenbaum *et al.* (2017) showed that gender (being female) and age were significant

and positive for perceived preparedness, while education was non-significant. For actual preparedness, this was reversed, with gender and age becoming non-significant and education becoming significant and positive.

The literature review by Wachinger *et al.* (2013) suggested experiencing an emergency had an effect on promoting household preparedness. An examination of the models in Table A3 revealed that the significance of exposure to emergencies was inconsistent depending on the preparedness measure. For example, Basolo *et al.* (2017) found that exposure to hurricanes significantly and positively impacted family emergency planning, but no other actual preparedness measure (for example, having sandbags on-site) or perceived preparedness. Kirschenbaum *et al.* (2017) similarly found that exposure to earthquakes positively and significantly affected actual household preparedness but not perceived preparedness.

Wachinger *et al.* (2013) noted that while people may report high risk perception scores, this did not necessarily translate into preparedness action. Bourque (2013) suggested that “although risk perception may be a necessary predictor of preparedness, it is not a sufficient predictor and is, in fact, largely mediated or moderated by other factors”. As can be seen from Table 7.2, only two studies, both by Basolo *et al.* (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017), included a measure for risk. Their analyses, however, did not identify a discernible pattern in the significance of risk perception on perceived and actual preparedness (see Table A3 for their results). For example, Basolo *et al.* (2017) found that higher levels of risk perception positively and significantly influenced perceived preparedness and having sandbags on-site (actual household preparedness) but were non-significant for other actual household preparedness measures.

The remaining factors within Table 7.2 were considered more relevant to a single risk, or one classification of risk, rather than all-hazard studies (confidence in relevant officials, access to relevant guidance, and community) or in a more multi-cultural society than Ireland (race, religion, immigrant).

Table 7.2 Variables included in both the perceived and actual preparedness regressions

	Basolo <i>et al.</i> 2009	DeBastiani <i>et al.</i> 2015	Henly-Shepard, <i>et al.</i> 2015	Basolo <i>et al.</i> 2017	Kirschenbaum <i>et al.</i> 2017	Ranjbar <i>et al.</i> 2018
Emergency (Context)	Hurricane & Earthquake	Public Health Emergencies	Natural Hazards	Hurricane	Earthquake	Earthquake
Gender	Male/ Female	Male/ Female	Male/ Female	Male/ Female	Male/ Female	
Age	Age in years	Age in categories		Age in years	Age in categories	
Children	Child present in home			Child present in home		
Income	Ranges from less than \$10,000) to greater than \$120,000 (Interval)		Categories: Low, Medium and High	Ranges from less than \$10,000) to greater than \$120,000 (Interval)		
Race	White/Other	White non-Hispanic Black non-Hispanic Hispanic Other non-Hispanic		White/Other		
Home	Home Ownership Tenure/Other			Home Ownership Tenure/Other		
Household size						Number of family members
Years of residence			< 1 year residence 1-5 years residence 5-10 years residence 10 - 20 years residence			
Marital status	Married/Other			Married/Other		
Region			Origin: Mainland Origin: Kauai Origin: Hanalei			Residence region
Religion					Jewish	
Education	Graduated from high school	Less than high school; High school diploma; Some college; College or more.		Graduated from high school	Educational status: academic	

Immigrant		Not born in the United States		
Hazard Exposure (experience)	Experienced major earthquake Experienced major hurricane	Experienced major hurricane	Experience	Experience
Risk	Dread Fatal Happen	Risk Perception	Living in risk zone	
Confidence in relevant officials	High level; Low level	No confidence to total confidence (scale)		Trust in Emergency authorities
Access to relevant guidance	Number of Disaster Preparedness Information Sources used (scale)	Know of public awareness programs Think early warning systems are effective	Received some emergency preparedness information Received a lot of emergency preparedness information	Trust in information source
Community		Participation in a Community Group Feel the community is prepared		

Note: Factors that were not tested in both regressions are not listed.

7.3. Methodology

7.3.1 Questionnaire Design & Dissemination

This study examined the household emergency preparedness of State Registered Nurses in Ireland. The questionnaire asked nurses to rate a range of risks drawn from the Irish National Risk Assessment (NRA), measured their perceived and actual household preparedness, identified exposure to a range of emergencies, and captured a variety of demographic characteristics.

To test the reliability, content validity and face validity of our measures, we pilot tested with a smaller, similar group of specialists working in emergency management and registered nurses. This allowed us to gauge the clarity (where they correctly understood), appropriateness, and relevance of the questions (Taherdoost, 2016).

Under our university regulations, this study qualified as a low-risk social research project and was approved by the Research Ethics Committee at DCU Business School. Participants were over the age of 18, their participation was voluntary, and the data were collected using an anonymous online questionnaire. Before commencing the questionnaire, participants were provided with a plain language statement explaining the purpose of the study and offered an opportunity to contact the research team with any questions. To consent, participants clicked a button on the online questionnaire indicating they read the plain language statement and consented to take part in the study. It was made clear to participants that once their responses were submitted, they could not withdraw from the study, given the anonymous nature of the online questionnaire.

According to the Central Statistics Office (CSO) Ireland, there were 41,077 registered nurses working in the country at the time of data collection (Central Statistics Office Ireland, 2016), 35,873 of whom worked for the Health Service Executive (HSE) in 2016 (HSE, 2016). A clustering approach was taken to draw the sample, where a link to the questionnaire was circulated online in May and June 2016, across the Health Service Executive (HSE) email system. It was also posted on the Nurses and Midwives in Ireland private Facebook group which had approximately 15,000 members at that time to capture those not working in the HSE. Using the Qualtrics sample size calculator (Qualtrics, 2023) to achieve a confidence level of 95% with a 5% margin of error required ideal sample size was 381, and we achieved a sample of 557 nurses. We also ensured proportionate representation of subjects based on gender; the CSO Ireland noted that in 2016 8.2% of registered nurses were male (Central Statistics Office Ireland, 2016). Our respondents are consistent with this gender breakdown, with 9.1% of respondents being male.

7.3.2 Variables: Perceived & Actual preparedness

Perceived preparedness was captured early in the questionnaire by asking respondents, in the context of household preparedness, were they prepared to deal with an emergency using a 3-point scale (No, Somewhat, or Yes) aligning with DeBastiani *et al.* (2015). Actual preparedness measured the number of emergency resources, planning measures and preparedness actions a respondent reported. As our study was based in Ireland, we used 24 items from the Irish preparedness guidelines (Office of Emergency Planning, 2013) and checked these against other established guidelines prepared by FEMA and the American Red Cross to ensure commonality (FEMA, 2007, 2016; American Red Cross, 2016b, 2016a). Use of the Irish list of items was in line with the Kohn *et al.* (2012) recommendation that studies of household preparedness should use the relevant national guidelines to assess preparedness.

A Household Preparedness Score was calculated by merging the three constructs (resources, planning, and actions), which was comparable with the American Red Cross preparedness campaign “Get a Kit; Make a Plan; Be Informed” (American Red Cross, 2016b) and the work of Corwin *et al.* (2017). This resulted in 24 indicators of preparedness (see Table 7.4). To achieve equal standardized weighting, the scores for resources, planning and action were z-transformed separately (Corwin *et al.*, 2017), which allowed the scores to be compared to one another more accurately as the number of items within each construct would not inflate the score. These standardized z-scores were averaged to give the Household Preparedness Score. This resulted in the following minimum and maximum scores for each scale:

- Preparedness Planning (a 5-item construct) min = -1.92; max = 2.13
- Preparedness Action (a 3-item construct) min = -1.90; max = 1.17
- Preparedness Resources (a 16-item construct) min = -2.63; max = 2.23

- Household Preparedness Score (the combined 24-item construct) min = -1.82; max = 1.84

The four preparedness indicators were checked for reliability and validity using Cronbach's α and Spearman correlation coefficients with acceptable results. Kohn *et al.* (2012), in their review of emergency preparedness studies reported a Cronbach's α variance of between $\alpha=.42$ and $\alpha=.99$ depending on the study and items selected. The results of our tests are Preparedness Planning $\alpha=.55$; Preparedness Action $\alpha=.47$; Preparedness Resources $\alpha=.73$; Household Preparedness Score $\alpha=.80$. The correlations showed that all four preparedness indicators were significantly ($p<.01$) and positively correlated with one another. Individual correlations ranged from weak for "action – planning" ($r=.362$, $p<.01$), to strong for "Household Preparedness Score – planning" ($r=.820$, $p<.01$).

7.3.3 Variables: Risk Rating, Exposure, Self-efficacy & Socio-demographics

Respondents' prior exposure to, and risk rating of, 17 risks from the NRA were gathered (McMullan *et al.*, 2018; Brown, Largey and McMullan, 2021a). Aligned with the NRA, the 17 risks were clustered into three risk groups:

- civil: foodborne disease outbreak, infectious disease affecting humans, infectious disease affecting livestock, loss of critical infrastructure, terrorism, and waterborne disease;
- socio-natural: drought, flooding, high temperatures, low temperatures, snow, and storms;
- technological: cyber incidents, disruption to the energy supply, fire, nuclear incident (abroad), and radiation (domestic).

Nurses' exposure to prior emergencies was measured by asking whether they had experienced each of the 17 risks as emergencies using a self-reported yes/no measure. Responses were summed by classification to create three measures each ranging from 0 to 6: exposure to socio-natural emergencies, which had a mean 2.49 with a standard deviation

of 1.47, technological emergencies, which had a mean 1.07 with a standard deviation of 0.76, and civil emergencies, which had a mean 1.34 with a standard deviation of 1.38.

Risk rating was measured using the five-point likelihood and impact Likert scales from the Irish NRA (McMullan *et al.*, 2018), which was identified, from the literature review (Appendix 1 Table A1), as a common method used to measure risk (Prati, Pietrantonì and Zani, 2011; Han *et al.*, 2017; Kerstholt, Duijnhoven and Paton, 2017; Xu *et al.*, 2018; Wei, Sim and Han, 2019; Wirtz, Rohrbeck and Burns, 2019). These scales are multiplied to give a risk rating score for each risk which ranged from 1 to 25. To provide a measure of risk rating for each risk category either an average value across the risk category or the maximum risk rating value from within the risk category can be used. The average risk rating measure for each risk classification is calculated as the arithmetic mean of risk ratings for risks within the classification. The model was run twice, once using the average risk ratings for each classification and a second time using the highest risk ratings. This allowed us to examine whether the highest risk score within the risk classification influences perceived and actual preparedness (using maximum risk) or a combined risk rating for the risk classification (using mean risk). The outputs of the regression models were compared, and no changes in significance, the direction of the effect, or meaningful change in the size of the effect were found. As a result, we report our findings using the outputs from the average risk rating for each classification and provide the models using the highest risk ratings in Appendix 3. This results in three averaged risk rating variables for each model: socio-natural risks, which had a mean 8.38 with a standard deviation of 3.21 and a Cronbach's α value of .80; technological risks, which had a mean 11.51 with a standard deviation of 3.79 and a Cronbach's α value of .78; civil risks which had a mean 11.62 with a standard deviation of 4.41 and a Cronbach's α value of .89.

Self-efficacy gauges an individual's perceived capability to cope with an emergency. It is assessed by inquiring if respondents believed they would need help from neighbors, non-profit organizations, emergency services, local, or national governments during an emergency. Respondents rated each of the six assistance sources on a scale where "no assistance required" scores a 6 and "substantial assistance required" scores a 1. A self-efficacy measure is derived by averaging the five scores, with 1 being the lowest score and 6 the highest. The mean score for self-efficacy stands at 3.40, with a standard deviation of 1.19 and a Cronbach's α value of .87.

The literature reviews by Levac *et al.* (2012) and Kohn *et al.* (2012) concluded that the effects of socio-demographic factors differ across studies. However, as noted in the literature review, it was unclear if the preparedness measure used may have contributed to this variance. At the time of the study, Basolo *et al.* (2009) analysis of perceived and actual preparedness was most extensive and had examined gender, marital status, annual household income, age, race, children, education, owns the home. As the respondents were nurses, all of whom had a tertiary qualification, the education factor was excluded and instead working full-time, and years of experience were included. Cohabitation was captured using the number of adults living in the household. Finally, the data from a previous Irish study showed that urbanicity was significantly related to actual household preparedness (Brown, Largey and McMullan, 2021b); hence this variable was included. A detailed summary of respondent demographics is presented in Table 7.3.

As outlined in the literature review, and evident in Appendix 3, the significance and direction of influence of perceived and actual preparedness are both varied and inconsistent across studies.

Table 7.3 Summary Characteristics

Characteristic		Description
Gender (430n)		
Female	90.9% (391n)	Coded 1 if female, 0 otherwise
Aged (430n)		
34 or under	32.8% (141n)	Coded 1 if aged 34 or under, 0 otherwise
35-44	40.2% (173n)	Coded 1 if aged 35-44, 0 otherwise
45 or older	27% (116n)	Coded 1 if aged 45 or older, 0 otherwise
Lives in a: (430n)		
City	14.2% (61n)	Coded 1 for city, 0 otherwise
Suburb/city outskirts	17.2% (74n)	Coded 1 for Suburbs, 0 otherwise
Town	26.7% (115n)	Coded 1 for town, 0 otherwise
Village	13.5% (58n)	Coded 1 for village, 0 otherwise
Rural area	28.4% (122n)	Coded 1 for rural area, 0 otherwise
Own vs Rent Home (430n)		
Own Home	74.2% (319n)	Coded 1 for homeownership, 0 otherwise
Years living at current address (427n)		
Mean (SD)	9.94 (8.46)	Variable Ranged from 1 to 57
Adults (age>18) living at the address (428n)		
Mode	2	Variable Ranged from 1 to 7
Children (age<18) living at the address (419n)		
Mode	0	Variable Ranged from 0 to 5
Household Income (360n)		
Below 30,000	8.6% (31n)	Coded 1 for income below 30,000, 0 otherwise
30,000-70,000	64.2% (231n)	Coded 1 for income 30,000-70,000, 0 otherwise
Over 70,000	27.2% (98n)	Coded 1 for income over 70,000, 0 otherwise
Nursing Work (430n)		
Full-time nurse	79.3% (341n)	Coded 1 if working full-time, 0 otherwise
Years of experience (393n)		
Mean (SD)	14.59 (9.17)	Variable Ranged from 1 to 42

7.3.4 Quantitative Analysis: Descriptive & Inferential Statistics

The analysis was carried out using the statistical software package STATA (StataCorp; Release 14.2/SE). To conduct essential model diagnostics, we initially inspected the correlation matrices to identify possible multicollinearity and to examine the pairwise relationships between the variables. Subsequently, we employed the variance inflation factor (VIF) to determine the extent to which the variance of a given regression coefficient was inflated by collinearity.

In line with the research questions, the analysis was divided into stages. First, descriptive statistics were used to examine nurses' perceived and actual household preparedness. Chi-square tests of association, Spearman's correlations, and a partial generalization of ordered probit analysis with marginal effect calculations were then used to examine how the measures for nurses' perceived and actual emergency preparedness were related. In line

with research question one, the hypothesis was to test whether a positive association existed between perceived and actual preparedness.

Hypothesis 1: There is a significant positive alignment between nurses' perceived household preparedness and their actual household preparedness.

The second stage of the analysis addressed research question two. Regression techniques were employed to examine the relationship between risk rating, prior risk exposure, socio-demographic factors and the dependent variables of perceived and actual preparedness. These regressions are summarized in the following function:

$$\begin{aligned} & \textit{Preparedness (Y)} \\ & = f[\textit{risk rating (socio-natural, technological, civil), exposure to emergencies(socio-natural,} \\ & \quad \textit{technological, civil), years practicing, socio-demographics}] \end{aligned}$$

Based on the literature, it was hypothesized:

Hypothesis 2: Risk rating is positively and significantly associated with higher levels of perceived and actual preparedness. High risk ratings suggest awareness of risks and potential vulnerability, which should prompt preparedness action.

However, there is a potential for reverse causality. Hypothesis 3: If a respondent has undertaken the identified preparedness measures, this may result in a lower assessment of risk [106]. If this is the case, we may see low levels of risk rating associated with high levels of perceived preparedness. This could lead to nurses not reviewing or revisiting their household preparedness or they may ignore public awareness campaigns designed to drive household resilience.

Hypothesis 4: Exposure to an emergency is associated with higher levels of actual preparedness as experiencing an emergency leads to the taking of measures to increase household preparedness.

Conversely, Hypothesis 5: direct exposure to emergencies may lead to a non-protective response (denial, fatalism) and feelings that it is not possible to protect against future emergencies. In such circumstances exposure to an emergency is associated with lower levels of perceived preparedness.

Hypothesis 6: Socio-demographic factors significantly impact both perceived and actual preparedness among nurses.

Actual preparedness was analyzed using a standard OLS regression. The results showed that the VIF scores were within acceptable limits ($VIF < 5$) (O'Brien, 2007), having a maximum VIF of 3.71 and a mean VIF of 1.91. Furthermore, the analysis used robust standard errors to control for possible heteroscedasticity.

The ordinal measure of perceived preparedness has three categories, No, Somewhat and Yes, with the observed variable Y coded as 0, 1 and 2, respectively. Underlying the observed response, there is assumed to be a latent variable Y^* , modelled as $Y^* = X\beta + \varepsilon$, which is a continuous measure of preparedness perception. Two cut-off points μ_1 and μ_2 exist on the latent scale, with $\mu_1 < \mu_2$, such that $Y = 0$ if $Y^* \leq \mu_1$, $Y = 1$ if $\mu_1 < Y^* \leq \mu_2$ and $Y = 2$ if $Y^* > \mu_2$. Thus, for example, it is assumed that an individual stated No, they are not prepared if their assessment of preparedness falls below the threshold μ_1 . At the other extreme, they state Yes, they are prepared when their underlying perception of their preparedness is high enough on the scale ($Y^* > \mu_2$). This study examined perceived preparedness using a partial generalization of ordered probit that allows the impact of an independent variable to change over the underlying scale. The probability of each outcome is shown in the equation set (Eq. 1) below:

$$\left. \begin{aligned} P(Y = 0) &= \Phi(\mu_1 - X\beta_1) \\ P(Y = 1) &= \Phi(\mu_2 - X\beta_2) - \Phi(\mu_1 - X\beta_1) \\ P(Y = 2) &= 1 - \Phi(\mu_2 - X\beta_2) \end{aligned} \right\} \quad (\text{Eq. 1})$$

where $\Phi(\cdot)$ is the cumulative normal distribution. This formulation differs from the standard ordered probit model, which invokes the parallel regressions assumption, where the coefficient matrices β_1 and β_2 are constrained to be equal. The user-written `gologit2` command in STATA (Williams, 2006) with a probit link function was used, with the `auto-fit` option invoked to identify independent variables which violated the parallel regressions assumption of the standard ordered probit. The coefficients on these variables differ between matrices β_1 and β_2 , and in these cases, both values are presented in the results. Robust standard errors are computed in the analysis to address any concern of heteroscedasticity. Marginal effects, calculated at the means of independent variables, are also reported to indicate the magnitude of the effects.

7.4. Results

7.4.1 Nurses' Household Preparedness

In the context of household preparedness, many nurses (60.8%) considered themselves to be somewhat prepared, or prepared (15.5%), while 15.3% stated no, they were not. The remaining 8.4% of nurses were unsure and were excluded from the remainder of the analyses.

Considering actual preparedness on the 24-item Household Preparedness Score, nurses scored between 3 and 24 items, with a mean value of 13.46 and a standard deviation of 4.36. The breakdown by specific item/task is given in Table 7.4, Preparedness Items and Actions. Over half of nurses had an emergency plan in place for a specific situation (57.1%), while 13.1% had an emergency plan that would cover all situations. Regarding

resources in their home, less than half of the nurses had enough water for 3+ days (40.3%), and 45.6% had medications for 8+ days. On the other hand, more than three-quarters of respondents (85.9%) had enough food for 3+ days. In addition, 19.4% of nurses said they kept the resources solely for an emergency, and 39.7% said they regularly check these resources.

Table 7.4 Preparedness Items and Actions

	% (n)	Total
Planning		
Emergency plan - all situations	13.1% (61)	467
Emergency plan - specific situations*	57.1% (267)	468
List of emergency contact numbers	47.9% (224)	468
Important documents kept in the home	84.6% (396)	468
Cash kept in the home	41.9% (196)	468
Action		
Acted to protect self or home in case of an emergency	60.2% (327)	543
Household insurance	82.5% (378)	458
Flood insurance**	51.7% (233)	451
Resources		
Smoke detector	99.4% (465)	468
Fire extinguisher	59.8% (280)	468
Fire blanket	55.3% (259)	468
Carbon monoxide detector	57.9% (271)	468
Generator	8.5% (40)	468
Gas Grill (with spare gas)	32.5% (152)	468
Tank of fuel (small can, etc.)	29.9% (140)	468
Tool set	82.3% (385)	468
Axe/Chain saw	53% (248)	468
First aid kit	89.3% (418)	468
Batteries	82.5% (386)	468
Torch	89.1% (417)	468
Battery powered radio	27.4% (128)	468
Enough water for 3+ days	40.3% (188)	467
Enough food for 3+ days	85.9% (402)	468
Enough meds for 8+ days	45.6% (213)	467

Notes:

* In line with the Irish preparedness guidelines [94] a distinction is made between a plan for all situations and specific situations (e.g., house fire). Fifty-five nurses indicated they had a plan that covered specific situations in addition to an all-situation plan, while six indicated they had an all-situation plan, but did not have a plan for any specific situation.

** Flood insurance identifies those whose household insurance covers flooding.

Overall, 327 (60.2%) nurses reported taking at least one household preparedness action. Of the 216 nurses who reported taking no action, the two most common reasons given were that they “don’t know what to do” (23.6%), or they “do not want to think about it” (23.1%).

Other reasons were: “I don’t think it will make a difference” (17.1%), “the expense factor” (14.4%), “I think the emergency services will help” (13.4%) and “I haven’t had time” (9.3%).

7.4.2 Nurses’ Perceived & Actual Household Preparedness

Three tests were performed to explore the extent to which the measures of perceived and actual household preparedness were interconnected. Firstly, chi-squared (χ^2) tests of association were conducted between perceived preparedness and planning ($\chi^2 = 78.440$ $df = 10, p < 0.001$), action ($\chi^2 = 43.193$ $df = 6, p < 0.001$) and resources ($\chi^2 = 56.458$ $df = 6, p < 0.001$).

The results in Table 7.5, the Cross-tabulation of perceived and actual household preparedness, indicate a significant association between perceived and actual preparedness. For example, 73.3% of nurses who perceived they were not prepared had less than three of the five items included in the Planning portion of the 24-item Household Preparedness Score (see Table 7.4), while 80.4% of nurses who felt they were prepared had three or more items.

Table 7.5 Cross-tabulation of Perceived and Actual Preparedness

		Actual Preparedness Number of Planning Preparedness Items/Actions Taken						n
Perceived Preparedness	Planning	[0]	[1]	[2]	[3]	[4]	[5]	
	No	7 (9.9%)	27 (38.0%)	18 (25.4%)	11 (15.5%)	7 (9.9%)	1 (1.4%)	71
	Somewhat	15 (5.3%)	64 (22.7%)	70 (24.8%)	74 (26.2%)	49 (17.4%)	10 (3.5%)	282
	Yes	1 (1.3%)	3 (4.0%)	8 (10.7%)	20 (26.7%)	28 (37.3%)	15 (20.0%)	75
	Action	[0]	[1]	[2]	[3]			n
	No	11 (15.5%)	20 (28.2%)	31 (43.7%)	9 (12.7%)			71
	Somewhat	23 (8.5%)	59 (21.8%)	95 (35.1%)	94 (34.7%)			271
	Yes	2 (2.8%)	8 (11.1%)	16 (22.2%)	46 (63.9%)			72
	Resources	[1-4]	[5-8]	[9-12]	[13-16]			n
	No	11 (15.5%)	32 (45.1%)	26 (36.6%)	2 (2.8%)			71
	Somewhat	11 (3.9%)	99 (35.1%)	133 (47.2%)	39 (13.8%)			282
	Yes	1 (1.3%)	10 (13.3%)	38 (50.7%)	26 (34.7%)			75

Note: $p < 0.001$

Secondly, Spearman's correlations showed weak, but statistically significant, positive correlations between each of the four constructs for actual preparedness and perceived preparedness. Perceived preparedness correlated with action ($r = 0.301, p < 0.01$), resources ($r = 0.319, p < 0.01$), planning ($r = 0.382, p < 0.01$) and Household Preparedness Score ($r = 0.419, p < 0.01$). These results are in line with the findings of Kirschenbaum *et al.* (2017) and Basolo *et al.* (2009), who found perceived and actual preparedness were significantly, if weakly, correlated: $r=.401, p<.01$ and $r=.18$ to $r=.33, p=.05$ respectively.

To provide a comprehensive analysis of the relationship between perceived and actual preparedness, two ordered probit regression models were estimated (see Table 7.6, Ordered Probit Analysis with Marginal Effects). Perceived preparedness was chosen as the dependent variable in the regressions without implying a causal relationship exists.

For the ordered probit analysis, variables were tested for adherence to the parallel regressions assumption, using the auto fit procedure in the `gologit2` command. For those independent variables which violate the parallel regressions assumption, coefficients are permitted to vary across the levels of the dependent variable, as shown in Eq. 1, resulting in two coefficients reported in the tables below. Only one coefficient exists for those variables that satisfy the parallel regressions assumption.

Model 1 reports standard ordered probit results, as the parallel regressions assumption was not violated; that is, the chi-square test for equality of the independent variable coefficients was not rejected ($\chi^2_1 = 2.18, p = 0.139$). In Model 2, the planning preparedness variable violated the parallel regressions assumption, while the other two independent variables did not.

Table 7.6 Ordered Probit Analysis with Marginal Effects

Explanatory variables	Dependent Variable: Perceived Preparedness				
	Coef.	Robust Std. Err.	Marginal effects (dy/dx)		
			No	Somewhat	Yes
Regression Model 1					
Household Preparedness Score (Z-Score)	0.706***	0.084	-0.157***	-0.001	0.158***
Cut 1	-1.007	0.081			
Cut 2	1.154	0.082			
Wald Chi-squared (df =1)	$\chi^2=70.43***$				
N	412				
Regression Model 2					
Planning Preparedness Scale (Z-Score)	0.222***	0.069	-0.055**	-0.045**	0.097***
	0.468***	0.094			
Resources Preparedness Scale (Z-Score)	0.154*	0.078	-0.036	-0.004	0.032*
Action Preparedness Scale (Z-Score)	0.200**	0.070	-0.046**	-0.005	0.041**
Cut 1	0.980	0.078			
Cut 2	-1.238	0.103			
Wald Chi-squared (df =4)	$\chi^2=71.59***$				
N	412				

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results in Table 7.6, Ordered Probit Analysis with Marginal Effects, show a significant positive relationship between actual preparedness and perceived preparedness. The marginal effects for Regression Model 1 show a one-point increase in the Household Preparedness Score increased the probability that nurses stated they were prepared for an emergency by 0.158 (i.e., a 15.8 percentage point (pp) change for Think-Yes). Regression Model 2 shows a significant positive effect of actual measures of planning, resources and action on perceived preparedness. Of the three factors used to measure preparedness, planning was shown to have the largest positive effect on nurses' perceived preparedness, with the marginal impact of planning estimated as an increase of almost 0.1 (9.7 pp) in the probability nurses stated they are prepared (Think-Yes). These results confirmed that perceived and actual preparedness are not independent of one another among nurses.

7.4.3 Risk Rating, Exposure & Preparedness

The results in Table 7.7, Regression Analysis of Perceived and Actual Preparedness, and Table 7.8, the marginal effects of the ordered probit model, illustrate the relationship

between risk rating, prior exposure to emergencies, socio-demographic factors and the dependent variables, perceived and actual preparedness.

The regression analysis of perceived preparedness reveals four independent variables for which the parallel regression assumption was violated: living in a town, exposure to socio-natural emergencies, and exposure to civil emergencies. At a 5% significance level, the coefficients on these variables were found to vary over the latent perceived preparedness scale.

Table 7.7 Regression Analysis of Perceived and Actual Preparedness

Explanatory variables	Dependent Variable: Household Preparedness Score (Z-Score) †			Dependent Variable: Perceived Preparedness ‡		
	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P
Female	0.038	0.149	0.798	0.244	0.258	0.345
Age 35-44	0.035	0.117	0.767	-0.054	0.226	0.811
Age 45 & Older	-0.094	0.161	0.562	-0.444‡	0.259	0.086
Live – village	-0.193	0.139	0.165	-0.244	0.267	0.360
Live – town	-0.028	0.111	0.801	-0.397‡	0.229	0.083
Live – suburbs/outskirts of a city	-0.370**	0.127	0.004	0.455*	0.214	0.034
Live – city	-0.398**	0.147	0.007	-0.073	0.229	0.751
Owns home	-0.604*	0.246	0.014	-0.073	0.229	0.751
Years at address	0.525****	0.110	0.001	-0.604*	0.246	0.014
Number of adults at household	0.003	0.006	0.655	0.418*	0.177	0.018
Number of children (age <18) at household	0.059	0.046	0.204	0.010	0.009	0.304
Income 30,000-70,000	0.028	0.108	0.813	0.019	0.082	0.813
Income Over 70,000	-0.028	0.037	0.444	-0.179**	0.068	0.008
Years practicing	0.465**	0.160	0.004	0.341	0.284	0.230
Self-efficacy	0.674***	0.177	0.001	0.272	0.322	0.398
Risk rating: socio-natural	0.004	0.006	0.577	-0.002	0.011	0.832
Risk rating: technological	0.045	0.035	0.196	0.121‡	0.064	0.058
Risk rating: civil	-0.013	0.016	0.426	-0.029	0.029	0.310
Exposure to socio-natural emergencies	-0.012	0.019	0.530	-0.004	0.033	0.905
Exposure to technological emergencies	0.009	0.016	0.573	-0.016	0.030	0.601
Exposure to civil emergencies	0.080**	0.034	0.020	0.304***	0.083	0.001
Constant	0.10	0.080	0.223	0.10	0.080	0.223
Cut 1	0.074	0.064	0.247	0.116	0.102	0.258
Cut 2	0.018	0.035	0.609	-0.119	0.080	0.137
R ²	-0.868***	0.302	0.001	0.085	0.077	0.270
F						
Wald Chi-squared (df = 24)						
N						

Notes: † OLS Regression; ‡ Ordered Probit Regression; ‡ $p \leq 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7.8 Marginal Effects

	Dependent Variable: Perceived Preparedness					
	Marginal Effects (dy/dx)					
	No	P	Somewhat	P	Yes	P
Female	-0.050	0.349	-0.006	0.576	0.056	0.346
Age 35-44	0.011	0.812	0.001	0.813	-0.012	0.811
Age 45 & Older	0.091‡	0.095	0.010	0.521	-0.101‡	0.088
Live – village	0.050	0.362	0.006	0.581	-0.056	0.359
Live – town	0.081‡	0.079	-0.185***	0.001	0.104*	0.035
Live – suburbs/outskirts of a city	0.015	0.751	0.002	0.771	-0.017	0.750
Live – city	0.124*	0.017	0.014	0.513	-0.138*	0.015
Owns home	-0.086*	0.018	-0.010	0.529	0.095*	0.022
Years at address	-0.002	0.309	0.000	0.558	0.002	0.302
Number of adults at household	-0.004	0.813	0.000	0.822	0.004	0.813
Number of children (age <18) at household	0.037**	0.008	0.004	0.520	-0.041**	0.009
Income 30,000-70,000	-0.070	0.235	-0.008	0.538	0.078	0.225
Income Over 70,000	-0.056	0.399	-0.006	0.586	0.062	0.394
Years practicing	0.000	0.832	0.000	0.840	-0.001	0.832
Self-efficacy	-0.025‡	0.065	0.003	0.519	0.028‡	0.060
Risk rating: socio-natural	0.006	0.310	0.001	0.573	-0.007	0.309
Risk rating: tech.	0.001	0.905	0.000	0.906	-0.001	0.905
Risk rating: civil	0.003	0.600	0.000	0.687	-0.004	0.602
Exposure to socio-natural emergencies	-0.062***	0.001	0.040‡	0.053	0.022	0.223
Exposure to tech. emergencies	-0.024	0.268	-0.003	0.551	0.026	0.261
Exposure to civil emergencies	0.024	0.137	-0.044*	0.028	0.019	0.269

Notes: Marginal effects are estimated using the mean values for all other explanatory variables

‡ p≤0.1, *p<0.05, **p<0.01, ***p<0.001

Overall, risk rating of socio-natural, technological, and civil risks was not significantly related to either perceived or actual preparedness. Regarding exposure, while prior exposure to technological and civil emergencies did not affect perceived or actual preparedness, the results indicate a significant positive relationship between exposure to socio-natural emergencies and both preparedness measures. This supported the findings from the literature review, which suggested exposure to some types of emergencies would have a significant positive effect on household preparedness (Basolo *et al.*, 2009; Muttarak and Pothisiri, 2013; Donahue, Eckel and Wilson, 2014; Espina and Teng-calleja, 2015; Henly-Shepard *et al.*, 2015; Hoffmann and Muttarak, 2017; Knuth *et al.*, 2017; Stumpf *et al.*, 2017; Xu *et al.*, 2018; Donner and Lavariega-Montforti, 2018; Chen *et al.*, 2019). The results obtained from the generalized ordered probit model revealed a more nuanced influence between exposure to socio-natural emergencies and perceived preparedness, suggesting exposure to socio-natural emergencies had a significant impact on perceived preparedness only at the lower levels of the scale. The associated marginal effects show

exposure to socio-natural emergencies leads to an estimated decrease of 6.2pp ($p \leq 0.001$) in the probability that a nurse stated they were not prepared (Think-No) and increased the probability a nurse stated they are somewhat prepared (Think-Somewhat) by 4pp ($p = 0.053$). There is no significant impact on the higher level of perceived preparedness (Think-Yes).

Gender, years of residence, age and the number of adults in the household were not significant in either the perceived or actual preparedness models. Conversely, homeownership and living in a city were significant in both models. Confirming prior studies, this study found homeownership presented as a positive predictor of nurses having higher levels of actual (see (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Knuth *et al.*, 2017)) and perceived (see (Donahue, Eckel and Wilson, 2014; Cope *et al.*, 2018)) preparedness, while living in a city, rather than a rural setting, was found to be a negative predictor of both. As previously noted, the studies on perceived and actual preparedness have not examined this urban/rural divide.

Nurses who had children were less likely to consider themselves prepared. The marginal effects showed that for each additional child in the household, the probability that nurses felt prepared (Think-Yes) decreased by an estimated 4.6pp ($p \leq 0.01$). This finding differed from previous studies of general households, which suggested that the relationship between children's presence in the home and perceived preparedness was non-significant (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Cope *et al.*, 2018; Kruger *et al.*, 2018). The results in Table 7.7 also show that living in a town leads to greater polarization of opinion on preparedness than living in a rural setting; i.e., those living in a town are less likely to perceive themselves as somewhat prepared and more likely to state either a definite yes or no. Similarly, nurses' self-efficacy was significant only in the context of perceived

preparedness, with a higher likelihood of providing a definitive answer, either "yes" or "no". The related marginal effects demonstrated that for each increment in self-efficacy, the likelihood of nurses feeling prepared (categorized as "Think-Yes") rose by an estimated 2.8 percentage points ($p = 0.06$). Nurses aged 45 and older, compared to 34 or under, were less likely to indicate higher levels of perceived preparedness. The associated marginal effects show that nurses aged 45 and older were less likely to state they were prepared (Think-Yes) by 10.1pp ($p \leq 0.1$). The remainder of the factors for perceived preparedness were non-significant. For actual preparedness, in addition to the previously mentioned relationship to urban/rural factors, there is evidence of a positive relationship with household income. This finding was in line with some studies on preparedness (Ablah, Konda and Kelley, 2009; Donner and Lavariega-Montforti, 2018; Xu *et al.*, 2018; Chen *et al.*, 2019). However, others had suggested a non-significant effect (Basolo *et al.*, 2009; Moher *et al.*, 2009; Rebmann *et al.*, 2013; Basolo, Steinberg and Gant, 2017).

7.5 Discussion & Recommendations

As evident from the COVID-19 pandemic, frontline health workers accomplish indispensable work in the face of “added clinical activity and increased demands on the workforce and available resources” (McMullan, Brown and O’Sullivan, 2016). As well as being professionally prepared, there is an expectation that outside the clinical setting they are personally prepared in advance of an emergency (FEMA, 2007; Landahl and Cox, 2009).

The literature review revealed only a limited number of studies examined the influence of risk rating, prior exposure to emergencies, and socio-demographic characteristics on both perceived and actual household preparedness within a single study (Basolo *et al.*, 2009; Basolo, Steinberg and Gant, 2017; Kirschenbaum, *et al.* 2017; Kyne *et al.*, 2020). Moreover,

none of these studies had examined frontline healthcare personnel. Therefore, with prior research showing that a lack of household preparedness can become a barrier to healthcare staff reporting to work during an emergency (Kapucu, 2008; Grimes and Mendias, 2010; Trainor and Barsky, 2011; Basolo, Steinberg and Gant, 2017), this study investigated nurses' household emergency preparedness.

A key finding of this study was that perceived and actual household preparedness were not independent of each other among nurses. The marginal effect estimations showed that a one-point increase in the Household Preparedness Score led to a 15.8pp rise in the probability that a nurse feels prepared. This indicates that nurses associate their perception of preparedness with the protective actions taken. This connection between perceived and actual household preparedness is critical if nurses are to feel confident to leave their homes and families and report for duty during an emergency.

To maximize attendance during an emergency, healthcare management should train nurses on ways to prepare their households for an emergency. Evidence from the literature review suggests household preparedness campaigns are the most effective way to promote preparedness. Campaigns such as the "Ready Responder Toolkit" by FEMA (2007) could be used to raise nurses' actual household emergency preparedness. These campaigns could include checklists of preparedness items/actions, such as the list given in Table 7.4, and remind nurses to keep a list of emergency contact numbers (which 52.1% of the sample did not have), enough water for 3+ days (absent in 59.7% of nurses' homes), and enough medication for 8+ days (not present in 54.4% of nurses' homes). However, building actual preparedness is only one dimension. It's equally crucial that nurses feel confident in their ability to handle emergencies. Even with the most effective training and guidance, if nurses do not believe they are prepared, it could affect their performance and decision-making

during an emergency. As such, once actual preparedness has been built, a more psychosocial approach should be adopted to help ensure personnel feel prepared. After nurses have been trained and have taken necessary protective actions, healthcare management could engage in activities that boost morale, confidence, and the internal belief of being ready. This could include debriefing sessions where nurses can discuss their feelings in post-training workshops that address emergency-related anxieties.

Providing checklists of preparedness items/actions and encouraging the need to evaluate household preparedness against the checklist, for example in a workshop, should improve household preparedness and assist in the alignment of perceived and actual preparedness (Figure 7.1: Think-Yes & Actual-Yes). Without this two-pronged approach, as noted by Kohn *et al.* (2012) and Martin (2011), a lack of preparedness could negatively impact the capacity and functioning of a healthcare system during an emergency.

In addition to establishing that none of the previous studies examining both perceived and actual household preparedness had studied a sample of nurses, the literature review revealed inconsistent results between studies on the relationship between perceived and actual preparedness and socio-demographic factors. The design of this study allowed us to test for differences in the factors influencing perceived and actual preparedness using one sample. The findings support the contention that differences exist.

A deeper understanding of the factors which influence perceived and actual preparedness should assist with the promotion of both perceived and actual preparedness. The analysis showed that homeownership (positive) and living in a city (negative) were the only two significant socio-demographic variables in both models. Additionally, exposure to socio-natural emergencies was positive and significant in both preparedness measures. The impact of exposure to socio-natural emergencies did not, however, extend to the higher

levels of perceived preparedness. To maximize effectiveness, the household preparedness campaign should target information towards specific demographics. For example, campaigns focused on building perceived and actual preparedness should target nurses who live in urban areas and those who rent their homes. The analysis showed that nurses with children had lower perceived preparedness, while nurses in lower-income roles had lower actual preparedness. From an emergency preparedness perspective, it would seem wise that both cohorts are supported to avoid them feeling, or being, underprepared at home. As the factors influencing actual preparedness were not always the same as those influencing perceived preparedness, preparedness campaigns should be designed with both perceived and actual preparedness in mind.

7.5.1 Limitations

Though the data, collected in 2016, might be perceived as having dated over the past few years, it's crucial to highlight that in the subsequent seven years, there have been no initiatives to enhance the household preparedness of nurses or other frontline responders. Furthermore, hospitals continue to grapple with overcapacity, staff burnout, and overwhelming workloads (Conlon, 2023). Consequently, the operational setting of this research has remained largely consistent in Ireland.

As noted within the methodology, respondents reported perceived preparedness before actual preparedness. This was seen as vital to mitigate the effects of common method bias by having respondents provide an instinctive and intuitive assessment of their household preparedness before being shown a list of recommended measures that could alter the assessment. That said, this method is not without limitations, we do not know on what information respondents drew to answer this question nor if they provided the answer which they thought we wanted to hear (social desirability bias). Future studies could mitigate these

limitations by gathering data using an interview methodology and exploring the answers in greater depth.

Actual preparedness was measured using a set of items/actions that are in line with national and international preparedness guidelines. However, this list does not account for everything a household may have which could help them cope in an emergency. Furthermore, there is a reliance on an accurate assessment by the respondent. A household audit would close this gap but would limit the scope of the study and may pose challenges when gaining ethical approval.

The independent variables included within the regression models do not account for all the factors which may influence perceived and actual preparedness. For example, protection motivation variables such as perceived self-efficacy, response cost, and worry could be included in future models.

This study was restricted to Ireland, limiting the generalizability of the findings to nurses in other countries. To address this and build confidence in our results, we suggest replicating the study in other countries.

As this marks Ireland's first in-depth study into nurses' household preparedness, our study acts as a baseline for future research. This will allow for comparisons to be made, especially as new preparedness strategies are rolled out to enhance household preparedness for nurses in Ireland.

7.6 Conclusion

This research used an online questionnaire to assess nurses perceived and actual household preparedness while controlling for factors such as, risk rating, exposure to prior

emergencies, and self-efficacy. Perceived preparedness was evaluated based on each nurse's subjective feeling of preparedness for potential emergencies affecting their home. Actual preparedness, on the other hand, was quantified through an assessment of 24 specific preparedness measures and actions undertaken within their households, including the development of an emergency plan and maintaining a sufficient food supply for more than three days.

The research questions and the findings linked to each of these are reported in Table 7.9 below.

Table 7.9 Key findings.

Hypothesised Outcomes Per the Literature Review	Key Findings
Research Question 1: How aligned are nurses' perceived and actual household preparedness	
Hypothesis 1: There is a significant positive alignment between nurses' perceived household preparedness and their actual household preparedness.	Hypothesis confirmed. Results showed a positive relationship between nurses' perceived household preparedness and their actual household preparedness
Research Question 2: To what extent do risk rating, prior exposure to emergencies, and socio-demographic factors influence perceived and actual preparedness among nurses?	
Hypothesis 2: Risk rating is positively and significantly associated with higher levels of perceived and actual preparedness. High risk ratings suggest awareness of risks and potential vulnerability, which should prompt preparedness action.	Hypothesis rejected. High Risk ratings for socio-natural, technological, and civil risks were not significantly related to perceived or actual preparedness.
Hypothesis 3: If a respondent has undertaken the identified preparedness measures, this may result in a lower assessment of risk. If this is the case, we may see low levels of risk rating associated with high levels of perceived preparedness. This could lead to nurses not reviewing or revisiting their household preparedness or they may ignore public awareness campaigns designed to drive household resilience.	Hypothesis rejected. Low Risk ratings for socio-natural, technological, and civil risks were not significantly related to either perceived or actual preparedness.
Hypothesis 4: Exposure to an emergency is associated with higher levels of actual preparedness as experiencing an emergency	Hypothesis confirmed. Testing confirmed a significant positive relationship between exposure to socio-natural emergencies and actual preparedness.

leads to the taking of measures to increase household preparedness.

Hypothesis 5: direct exposure to emergencies may lead to a non-protective response (denial, fatalism) and feelings that it is not possible to protect against future emergencies. In such circumstances exposure to an emergency is associated with lower levels of perceived preparedness.

Hypothesis 6: Socio-demographic factors significantly impact both perceived and actual preparedness among nurses.

Prior exposure to technological and civil emergencies did not affect actual preparedness,

Hypothesis rejected. Results showed exposure to socio-natural emergencies had a significant positive impact on perceived preparedness only at the lower levels of the scale. There was no significant impact on the higher level of perceived preparedness.

Prior exposure to technological and civil emergencies did not affect actual preparedness.

Hypothesis confirmed. Results confirmed homeownership and living in a city significantly impacted both perceived and actual preparedness among nurses.

This deeper understanding of the factors that influence perceived and actual household emergency preparedness among nurses is required to facilitate higher levels of emergency preparedness in healthcare facilities. Within the Irish context, the Nursing and Midwifery Board of Ireland could collaborate with the Be Winter and Be Summer Ready Campaigns to initiate a nationwide campaign emphasizing the emergency preparedness of nurses' households. Integrating with a national campaign would reduce expenses for the health sector and promote a consistent strategy across all hospitals. Aligning with Trainor and Barsky's (2011) suggestion, special rates on preparedness items and measures could be arranged for nurses to help alleviate the cost of household preparedness. Ensuring nurses actual household preparedness and perceived preparedness are aligned and high means that they are prepared, and feel prepared, for an emergency. Preparedness actions, such as those listed in Household Preparedness Score, should ease concerns and allow nurses to concentrate on their professional responsibilities during an emergency.

8. Chapter Eight – Discussion & Conclusion

8.1 Introduction

This thesis addressed the question: What are the factors that influence household emergency preparedness in Ireland? Acknowledging the shifting significance of certain variables across the six published papers and providing a more comprehensive answer to the research question. This conclusion brings all the findings together into a combined model and focuses on one specific emergency type in order to test for relative influence.

Each paper explored specific aspects of household preparedness that contributed to the formation of the proposed overarching model of preparedness behaviour, the Protection Action Theory (PAT). The proposed model is outlined below.

8.2 Introducing the Protection Action Theory (PAT)

The findings from the six papers presented within this thesis, plus additional factors linked to the risk context, were brought together to form the Protection Action Theory (PAT) model. These factors are summarised in Table 8.1. This Table provides a concise overview of how findings from the earlier chapters contributed to an understanding of the factors that influence household emergency preparedness.

Table 8-1 Factors Influencing Baseline Household Emergency Preparedness

Hypothesis	Description	Outcome
H-0a	Higher Threat Appraisal (Risk Rating) is positively associated with higher household preparedness.	Chapter 3 – Rejected: Risk Rating of socio-natural risks was significant but negative for Perceived Preparedness Chapter 5 – Partly Confirmed: Worry had a significant positive effect on testing smoke detectors, but it also had a negative effect on following the building evacuation policy. Risk Rating was significant but negative for preparedness. Chapters 4 & 6 – Confirmed: Risk Rating influenced protective behaviours. Chapter 7 – Rejected: Not Significant

H-0b	Coping Appraisal is positively associated with higher levels of household preparedness.	Chapter 3 – Confirmed Chapter 5 – Confirmed Chapter 7 – Significant for Perceived Preparedness
H-0c	Exposure to an emergency is positively associated with higher levels of preparedness.	Chapter 3 – Confirmed Chapter 5 – Confirmed (two models – indirect and direct exposure) Chapter 7 – Confirmed (socio-natural risks)
H-0d	Females are less likely to undertake household preparedness actions.	Chapter 3 – Confirmed Chapter 5 – Confirmed (one model) Chapter 7 – Rejected: Not Significant
H-0e	Expertise is positively associated with higher levels of household preparedness.	Chapter 3 – Confirmed
H-0f	Living in a rural setting is positively associated with higher levels of household preparedness.	Chapter 3 – Partly Confirmed: Significant compared to living in a city. Chapter 7 – Partly Confirmed: Significant compared to living in a city and suburbs.
H-0g	Households with children are more likely to undertake household preparedness actions but are less likely to feel prepared.	Chapter 3 – Partly Confirmed: They are less likely to feel prepared, but there was no significant association with actual preparedness. Chapter 5 – Confirmed (one model) Chapter 7 – Partly Confirmed: They are less likely to feel prepared, but there was no significant association with actual preparedness.

The PAT model contributes to the advancement of knowledge by extending beyond motivation, as outlined in Protection Motivation Theory (PMT), and identifying the factors that influence all elements of emergency preparedness action. It examines the factors that influence household emergency preparedness actions before an imminent emergency and in its immediate aftermath. A particularly distinctive feature of the PAT model is the introduction of a novel factor: a post-event coping assessment.

The literature reviews underpinning this thesis revealed the importance of coping appraisal as an important influence on household emergency preparedness. This connection was tested in Papers 2 and 4 (Chapters 3 and 5) and showed a significant positive relationship with household emergency preparedness. However, in other studies, this coping appraisal was based on an individual's perception of their ability to execute protective action prior to an emergency or as part of a drive for household emergency preparedness. This model

studies preparedness actions taken following a post-emergency coping appraisal – an assessment of actual preparedness (labelled coping assessment). Storm Emma, the severe weather emergency discussed in Paper 5 (Chapter 6), provided an excellent opportunity to test the PAT model. An overview of this Storm is provided in Appendix 1.

The PAT model is structured into four stages: the risk emerging and the issuing of the red warning; pre-storm preparedness action; post-storm assessment; and post-storm action.

Two groups of hypotheses are tested in the PAT model. The first set of hypotheses pertains to factors relevant to a specific stage of PAT, outlined in Sections 8.2.1 to 8.2.4. The second set of hypotheses, applied in each of the four stages of PAT, examine the four socio-demographic factors that emerged as influences on household preparedness in the published papers.

1. Gender: The impact of gender on the rating of 17 involuntary risks (threat appraisal), as reported in Chapter 2, demonstrated that, in general, risks are rated more highly by females than by males. However, there was variation within the 17 risks. Gender was significant in 40 out of the 51 regressions, including those assessing the threat posed by storms. Gender was also found to have a significant association with preparedness actions, as detailed in Chapters 3 and 5.
2. Expertise: As reported in Chapter 3, professionals from the emergency services, the defence forces, crisis management, and health sectors have a deeper understanding of risk and preparedness than non-experts.
3. Households with children: The findings from Chapters 3, 4, 5, and 7 indicated that the presence of children in a household had an inconsistent influence on preparedness actions. For example, the findings reported in Chapter 4 highlighted a heightened protective instinct among EMS first responders who were parents or guardians of young children.
4. Urbanicity: The systematic literature review (SLR) reported in Chapters 1, 3, and 7 identified that urbanicity was often a forgotten element in studies of household preparedness. Of the 69 studies reviewed, only 4 took urbanicity into account, and

these yielded inconsistent results. The research reported in Chapter 3 found that urbanicity (living in a city) was significant and positive for actual preparedness; however, among nurses, living in a city had a significant negative effect on actual preparedness.

As in the published papers, the socio-demographic characteristics, age, income, race, home ownership, household size, length of residence, and education level were tested in every stage of the model. Any one of these factors could emerge as a factor influencing household emergency preparedness.

The hypotheses tested in specific stages of PAT are outlined below.

8.2.1 Stage 1: Threat Appraisal

The first stage of PAT focuses on threat appraisal which refers to the perceived expectation of being exposed to a particular risk (risk rating). During this stage, individuals or households estimate how harmful the consequences of exposure to the risk will be. While risk rating was not consistently identified as a significant influence on preparedness across the six published papers, the results reported in Chapters 4 and 6 revealed that a heightened perception of risk (threat appraisal) promoted increased levels of worry.

In the case of Storm Emma, the threat appraisal process was initiated by the National Weather Service issuing a red-level warning. According to the findings in Chapter 6, weather warnings will increase worry if individuals have confidence in the warning system, are responsive to weather warnings, and find them easy to understand. Conversely, the research confirmed that if warnings are perceived as being issued too often, a lower threat appraisal will be perceived, and this will lower worry levels. Hypotheses 1a through 1d were developed to examine this relationship between severe weather warnings and the level of worry they provoked in the case of Storm Emma. These are detailed in Table 8.1.

Additionally, Hypotheses 1e to 1 h report the four socio-demographic factors that were of interest based on the findings of the published papers.

Table 8.1 Stage 1 Factors Associated with Worry Before the Event

	Hypotheses
H-1a	High responsiveness to weather warnings is associated with increased worry. This hypothesis builds on insights from Chapter 6, which demonstrated that red weather warnings effectively heightened awareness of potential negative impacts on households. Consequently, we hypothesised that individuals responsive to such warnings would exhibit increased worry about the approaching Storm.
H-1b	High confidence in the weather warning system is associated with increased worry. The findings in Chapter 6 revealed that the colour-coded weather warnings effectively captured attention and conveyed the level of threat. This led to the hypothesis that individuals who are confident in the system's effectiveness do not disregard the warnings due to dissatisfaction and respond with appropriate levels of worry.
H-1c	Perception that warnings are difficult to understand diminishes worry. The results in Chapter 6 showed that when individuals find warnings difficult to understand their perception of the potential threat is reduced. This implied that unclear warnings may lead to a lower level of worry among respondents, as the lack of understanding undermines the seriousness of the approaching danger.
H-1d	Belief that warnings are issued too frequently diminishes worry. Chapter 6 indicated that perceptions of warning overuse led to a decreased perception of potential threats. This suggested that when individuals perceive warnings as being issued more often than necessary, they may become desensitised, leading to a reduced level of worry regarding the seriousness of the warnings.
H-1e	Females exhibit more worry about the Storm than males.
H-1f	Households with children experience higher levels of worry.
H-1g	Expertise positively influences worry.
H-1h	Higher levels of urbanicity are negatively associated with levels of worry.

8.2.2 Stage 2: Pre-Event Preparedness Behaviour

Although not always consistent, Chapters 4, 5 and 6 suggest worry can motivate preparedness behaviours. Chapter 4 revealed that worry over the possibility of contracting

and spreading COVID-19 led some EMTs to modify their interactions within their family units. Similarly, Chapter 5 observed that worry and concern related to the risk of fire occasionally served as motivators for taking protective actions, although these findings were not uniformly observed. Given these findings, the Hypotheses related to Stage 2 of PAT are provided in Table 8.2.

Table 8.2 Stage 2: Factors Associated with Pre-event Behaviour

Label	Hypothesis
H-2a	Impact of pre-event worry on following guidance. High levels of pre-event worry positively influence the likelihood of individuals following recommended guidance and acting on the preparedness advice issued.
H-2b	Gender differences in adherence to guidance. Females are less likely to follow the recommended guidance and preparedness advice than males.
H-2c	Role of expertise in adherence to guidance. Expertise leads to better adherence to recommended guidance and preparedness advice.
H-2d	Urbanicity and adherence to guidance. As urbanicity decreases, the likelihood of adhering to guidance and preparedness advice increases.
H-2e	Household composition and adherence to guidance. Households with children are more likely to adhere to guidance and preparedness advice.

8.2.3 Stage 3: Post-Event Coping Assessment

Ogunbode *et al.* (2019) observed that individuals with a higher perceived coping capability were likely to report reduced levels of negative emotional reactions when recalling severe weather events. This emphasised the role of perceived coping ability in mitigating the psychological effects of extreme weather. Building on this finding, undertaking the

recommended preparedness measures before an event should positively affect individuals' post-event coping assessment. Based on this premise, the Hypotheses in Table 8.3 were drafted for testing in Stage 3 of the PAT model.

Table 8.3 Stage 3 Factors Associated with Post-Event Coping Assessment

Label	Hypothesis
H-3a	Effect of preparatory actions on coping assessment. Engaging in recommended preparatory actions before an event enhances the post-event coping assessment.
H-3b	Impact of household emergency preparedness. Greater household emergency preparedness before an event is associated with a more favourable post-event coping assessment.
H-3c	Worry and post-event coping assessment. A decrease in worry during an event correlates with a better post-event coping assessment.
H-3d	Gender differences in post-event coping assessment. Females are less likely to report more positive post-event coping assessments compared to males.
H-3e	Expertise and post-event coping assessment. Experts are more likely to report more positive post-event coping assessments compared to non-experts.
H-3f	Rural vs urban living and coping assessment. Living in a rural setting is associated with more positive post-event coping assessments than those in an urban setting.
H-3g	Household composition and coping assessment. Households with children are associated with more positive post-event coping assessments.

8.2.4 Stage 4: Post-Event Preparedness Action

Chapters 3, 5 and 7 demonstrated that prior experience of emergencies is often associated with higher levels of household emergency preparedness. For example, the results presented in Chapter 3 supported the hypothesis that exposure to natural hazard-related emergencies had a significant and positive effect on both perceived and actual household emergency preparedness. These findings may reflect a cycle of learning and reacting to past events where PAT is more focused on one cycle and the action taken after this single event.

The limited research on post-disaster action indicates that such experiences can prompt households to enhance their preparedness levels (Rözer *et al.*, 2016; Bubeck *et al.*, 2020; Dillenardt, Hudson, and Thieken, 2021). For instance, Bubeck *et al.* (2020) found that in the aftermath of the 2013 flooding in Germany, 14% of households impacted by the flooding had adopted at least 1 of 16 risk-reduction measures within the first nine months. An additional 25% took action between 10 and 18 months post-flooding. The delay in adopting protective measures post-event was attributed to the initial need to focus on repairs and replacing flood-damaged assets. These findings inform hypothesis 4a in Table 8.4.

Table 8.4 Stage 4 Factors Associated with Post-Event Preparedness Action

Label	Hypotheses
H-4a	A negative post-event coping assessment leads to preparedness actions in the short term.
H-4b	Females are less likely than males to engage in protective action.
H-4c	Expertise positively affects engagement in protective actions.
H-4d	Residing in a rural area increases the probability of individuals taking protective actions.
H-4e	Households with children are more likely to undertake protective actions.

8.3 Data Collection Methods

To test the PAT model, the data collected for Paper 5 (Chapter 6) using an online questionnaire administered via Qualtrics from May to June 2018, approximately eight weeks after Storm Emma was utilised.

A volunteer sampling method, attracting respondents through social media platforms, yielded 4,451 anonymised responses with 3,164 completing all questions. Given internet use in Ireland is widespread (82%), with 73% using social networking sites (CSO, 2018), an online questionnaire was circulated via the popular platforms Facebook, Instagram, Twitter (now X), and LinkedIn (Ipsos, 2017) to reach a diverse sample. Paid advertisements and re-shares by individuals and organisations, including the National Meteorological and Hydrological Service (NMHS), Local Government, and the Office of Emergency Planning, bolstered the reach of the campaign.

The questionnaire underwent a pilot test with emergency management specialists and general households to ensure face validity, clear understanding, content validity, and distinguishability between different concepts (Taherdoost, 2016). It was presumed that participants interested in weather and household preparedness were more likely to respond initially, potentially introducing bias. However, socio-demographic characteristics aligned with the 2016 Irish census data, which suggested no bias from the self-selection. Among respondents, 64.9% reported earnings below €70,000, while nationally, 62.6% had a gross income below €60,000 (CSO, 2016b). 70.1% owned their homes, compared to 67.6% homeownership in Ireland (CSO, 2016a). The CSO reported that 31.4% of people in Ireland lived in rural areas, closely matching our sample at 30% (CSO, 2019).

Under university regulations, this study qualified as a low-risk social research project, and after review, it received approval from the Research Ethics Committee. Participants were

required to be 18 or older and were guaranteed anonymity. They received a plain language statement outlining the study's purpose, with the option of contacting the research team if they required additional information. Consent was obtained via a button click, confirming they had read and agreed to the statement. Participants were informed that because of the anonymous nature of the questionnaire, responses could not be withdrawn post-submission.

8.3.1 Measures

8.3.1.1 Weather Warnings

The Irish NMHS uses a threshold weather warning system with three escalating categories: Status Yellow: Be Aware; Status Orange: Be Prepared; and Status Red: Take Action (Met Éireann, 2021). To assess antecedents to protective actions, a series of questions were asked regarding perceptions of this system. Although a Status Yellow does not necessitate action, respondents were asked at which weather warning their household first took action to prepare for severe weather; this was coded using three dummy variables: "Takes action on red" if yes = 1, 0 otherwise; "Takes action on orange" if yes = 1, 0 otherwise; and "Takes action on yellow" if yes = 1, 0 otherwise. The base category comprised those who did not act in response to any level of warning.

Additionally, confidence with the weather warning system was evaluated on a seven-point Likert scale, ranging from extremely satisfied to extremely dissatisfied. Questions also addressed whether respondents perceived the weather warnings as too frequent or difficult to understand, each coded as a binary variable (yes = 1, no = 0).

8.3.1.2 Worry about Storm Emma

Respondents reported their pre-Storm worry levels on a 5-point ordinal scale, from "not at all worried" to "a great deal worried". Respondents also indicated how their worry changed during the Storm, categorised as "worry decreased," "worry stayed the same," or "worry

increased," with no change serving as the reference category. They were asked to explain any changes in worry levels.

8.3.1.3 Recommended Preparedness Actions

In keeping with the guidance issued before Storm Emma arrived (OEP, 2018), respondents were asked if they had:

1. Made plans for losing water supply;
2. Made plans for losing power supply;
3. Purchased additional food supplies;
4. Sought further information on how to prepare.

Each preparedness aspect was measured using a nominal scale (yes = 1, no = 0) and combined to create a 5-point ordinal scale ranging from 0 actions completed to 4 actions completed.

8.3.1.4 Household Preparedness

The Household Preparedness Score is a composite variable used to assess the level of preparedness among households before the Storm arrived. This score was constructed from a list of household preparedness items, taken from established preparedness guidelines, that are appropriate in various emergency scenarios as shown in Table 8.5 (FEMA, 2020; OEP, 2020; Canadian Red Cross, 2022).

Table 8.5 Household Preparedness Items

Variable	Yes (Percent, Frequency)	No (Percent, Frequency)
Water (3 days' supply)	56.11% (2,283)	43.89% (1,786)
Food (3 days' supply)	86.21% (3,508)	13.79% (561)
Medicine (8 days' supply)	44.95% (1,829)	55.05% (2,240)
Alternative Heating	64.19% (2,612)	35.81% (1,457)
Shovel	77.93% (3,171)	22.07% (898)
Bag of Salt	31.26% (1,272)	68.74% (2,797)
First Aid Kit	80.22% (3,264)	19.78% (805)
Large Drinking Water Container	54.14% (2,203)	45.86% (1,866)
Battery-powered or Hand-crank Radio	30.77% (1,252)	69.23% (2,817)
Torch	90.22% (3,671)	9.78% (398)
Extra Batteries	74.10% (3,015)	25.90% (1,054)
Candles & Matches/Lighter	95.26% (3,876)	4.74% (193)
Emergency Contact Information	42.34% (1,723)	57.66% (2,346)
Emergency Cash	50.92% (2,072)	49.08% (1,997)
Emergency Evacuation Kit	9.73% (396)	90.27% (3,673)

The household preparedness score, as provided in Table 8.6, reveals that, on average, respondents reported their households having about 9 out of the 15 measures for preparedness. Specifically, the data shows that the first quartile score is 7, meaning that 25% of households scored seven or lower. On the higher end, the third quartile score is 11, demonstrating that 75% of households have a score of 11 or lower, meaning 75% of these are prepared up to a score of 11.

Table 8.6 Household Preparedness Score

Items	Frequency	Percent (%)	Cumulative Percent (%)
0	7	0.17	0.17
1	35	0.86	1.03
2	48	1.18	2.21
3	88	2.16	4.37
4	152	3.74	8.11
5	238	5.85	13.96
6	309	7.59	21.55
7	376	9.24	30.79
8	512	12.58	43.38
9	494	12.14	55.52
10	510	12.53	68.05
11	470	11.55	79.60
12	382	9.39	88.99
13	260	6.39	95.38
14	128	3.15	98.53
15	60	1.47	100.00

8.3.1.5 Post-event Coping Assessment

An 11-point scale was used to measure the post-event coping assessment, ranging from 0% to 100% at intervals of 10%. Where 0 indicated that, upon reflection, the household felt it had not been at all prepared for the Storm and 100 that it had been completely prepared.

8.3.1.6 Post-event Preparedness Actions

Post-Storm, respondents were asked if they had taken any actions to protect members or their homes against future severe weather events. A binary variable “After-Action” was coded as Yes = 1 if actions were taken and 0 otherwise. Respondents could describe these actions using a text-entry option.

8.3.1.7 Socio-demographics

Table 8.7 presents the socio-demographic variables measured within the questionnaire.

Table 8.7 Socio-demographic frequencies

Characteristic	Values	Description
Gender (3679n)		
Female	75.2% (2766n)	1 if female, 0 otherwise
Age (3687n)		
Mean (SD)	41.97 (12.2)	Range 18-100
House vs apartment (3680n)		
Live in a House	91.8% (3380n)	1 for house, 0 otherwise
Own vs rent home (3675n)		
Own home	70.1% (2576n)	1 for homeownership, 0 otherwise
Years living at current address (3608n)		
Mean (SD)	13.80 (10.8)	Range 0.1-65
Adults (age>18) living at the address (3586n)		
Mode	2	Range 1-16
Children (age<18) living at the address (3453n)		
Mode	0	Range 0-7
Current employment (3687n)		
Working full time	74.9% (2760n)	1 for working full time, 0 otherwise
Race (3648n)		
White	97.8% (3567n)	1 for white, 0 otherwise
Household income (3503n)		
Below 30,000	12.7% (444n)	1 for income below €30,000, 0 otherwise
30,000-70,000	52.2% (1827n)	1 for income €30,000-€70,000, 0 otherwise
Over 70,000	35.2% (1232n)	1 for income over €70,000, 0 otherwise
Type of employment (3687n)		
A farmer	2.8% (102n)	1 for a farmer, 0 otherwise
Expert*	22.1% (814n)	1 for an expert, 0 otherwise
Lives in a... (3687n)		
City	12.8% (471n)	1 for city, 0 otherwise
Suburb/city outskirts	22.2% (819n)	1 for Suburbs, 0 otherwise

Town	22.6% (834n)	1 for town, 0 otherwise
Village	12.4% (457n)	1 for village, 0 otherwise
Rural area	30% (1106n)	1 for rural area, 0 otherwise
At home during the Storm (4451n)	93.6% (4167n)	1 for yes, 0 otherwise
During the Storm was in a... (4451n)		
City	13.5% (600n)	1 for city, 0 otherwise
Suburb/city outskirts	22.8% (1017n)	1 for suburbs, 0 otherwise
Town	23.9% (1063n)	1 for town, 0 otherwise
Village	12% (532n)	1 for village, 0 otherwise
Rural area	27.8% (1239n)	1 for rural area, 0 otherwise

Note: *Experts, defined as individuals associated with emergency services, defence forces, disaster/crisis/business continuity sectors, or health services (nurses or doctors), possess professional expertise pertinent to our study. Their training, education, and experience, along with an extensive understanding of risk, and the Irish emergency management system, differentiate them from non-experts. Such expertise suggests they are likely more knowledgeable about necessary preparedness actions, potentially leading to a more informed assessment of household preparedness.

8.4 Data Analysis

The analysis was carried out using the software packages STATA (14.2/SE) and Nvivo (R1).

8.4.1 Statistical Analysis

PAT was divided into four stages for the analysis:

Stage One: *Level of Worry (Before) (Y₁)* ==
 $f_1[\text{act on weather warnings, perceived understanding of the warnings,}$
 $\text{satisfaction with the warning system, sociodemographics}]$

Stage Two: *Actions (Before) (Y₂)* =
 $f_2[\text{level of worry (before), sociodemographics}]$

Stage Three: *Post Event Coping Appraisal (Y₃)* =
 $f_3[\text{change in worry, preparedness actions (before),}$
 $\text{household preparedness score, socio – demographics}]$

Stage Four: *After Action (Y₄)* =
 $f_4[\text{post event coping appraisal, impacted by the Storm, sociodemographics}]$

The ordinal dependent variables, Level of Worry (Before) - Stage One, and Actions (Before) - Stage Two, are measured on five-point Likert scales. For each one a partial generalised ordered probit model was estimated, using the user-written gologit2 command in STATA (Williams, 2006), involving the normal link function.

Standard ordered probit analysis assumes that each observation of the ordinal variable, y_i , $i = 1, \dots, n$ corresponds to a latent variable value $y_i^* = X_i\beta + \varepsilon_i$, and the parallel slopes assumption holds, i.e., β is assumed constant across all values of y^* . The observed value of y depends on the value of y^* in relation to thresholds $\mu_j, j = 1, \dots, 4$:

$$y_i = \begin{cases} 1 & \text{if } -\infty < y_i^* \leq \mu_1 \\ 2 & \text{if } \mu_1 < y_i^* \leq \mu_2 \\ 3 & \text{if } \mu_2 < y_i^* \leq \mu_3 \\ 4 & \text{if } \mu_3 < y_i^* \leq \mu_4 \\ 5 & \text{if } \mu_4 < y_i^* \leq \infty \end{cases} \text{ for } i = 1, \dots, n$$

In contrast, the generalized ordered probit allows the impact of explanatory variables to vary across the range of y^* by permitting thresholds to respond to the predictor variables: $\mu_{ij} = \bar{\mu}_j + X_i\eta_j$, where $\bar{\mu}_j$ is constant and η_j reflects the impact of the explanatory variables on threshold j . Assuming $\varepsilon_i \sim N(0,1)$, and defining $\beta_j = \beta + \eta_j$, we then have the probabilities for each classification as,

$$P(y_i = 1) = \Phi(\bar{\mu}_1 - X_i\beta_1)$$

$$P(y_i = j) = \Phi(\bar{\mu}_j - X_i\beta_j) - \Phi(\bar{\mu}_{j-1} - X_i\beta_{j-1}), \quad j = 2, 3, 4$$

$$P(y_i = 5) = 1 - \Phi(\bar{\mu}_4 - X_i\beta_4)$$

The generalised ordered probit form allows the possibility of a more flexible relationship between the dependent variable and the explanatory variables than the standard form. We used the autofit option in the `gologit2` command, which automatically tests the parallel slopes assumption on each explanatory variable. Where the parallel slope assumption was violated, four coefficients are presented for the explanatory variable.

In addition, we report the marginal effects, which provide the estimated change in probabilities associated with a one-unit change in an explanatory variable, holding all other variables at their mean values. This helps to interpret the magnitude and direction of the

impact of the explanatory variables on the probabilities of observing different categories of the ordinal dependent variable.

For the continuous dependent variable, post-event coping assessment—Stage Three, an Ordinary Least Squares (OLS) regression was used to estimate the β coefficients. The binary variable, After Action—Stage Four, was estimated using probit analysis. Marginal effects are calculated to facilitate the interpretation of probit regression results.

All four models were estimated with robust standard errors to control any possible heteroscedasticity. The Variance Inflation Factor (VIF) values were examined to assess multicollinearity within the dataset. The analysis was conducted across different stages of the model, with the results indicating that the independent variables were not highly correlated. The VIF scores for each stage were as follows:

- Stage 1: Maximum VIF = 5.74, Minimum VIF = 1.09, Mean VIF = 1.88;
- Stage 2: Maximum VIF = 3.1, Minimum VIF = 1.05, Mean VIF = 1.63;
- Stage 3: Maximum VIF = 1.14, Minimum VIF = 1.06, Mean VIF = 1.72;
- Stage 4: Maximum VIF = 3.12, Minimum VIF = 1.03, Mean VIF = 1.51.

These results suggest that the independent variables across all stages demonstrate low to moderate multicollinearity, as indicated by VIF scores well below the commonly used threshold of 10.

8.4.2 Qualitative Analysis

Qualitative data were analysed using content analysis, following Krippendorff's (2018) 8-phase methodology—Appendix Two, which enables qualitative examination and quantification of results (Vaismoradi, Turunen and Bondas, 2013). Data were imported into NVivo R1 for organisation and interpretation. The process started with data familiarisation and open coding, followed by categorising initial codes into themes and sub-themes. The

number of codes per theme and sub-theme were counted and reported as references. This refining and counting enabled deeper analysis. A self-audit, validation, and revision process led to evidence-based findings. A summary of the themes and sub-themes associated with this analysis can be found in tables in Appendix 3.

8.5 PAT - Results and Discussion

8.5.1 Opinions on Weather Warnings

Confidence with the Irish NMHS weather warning system was high (Table 8.8), as 2,907 (75.1%) respondents were mostly or extremely satisfied. A notable 953 respondents, which represent 24.7% of the total, perceived the warnings to be issued too frequently. Additionally, 363 respondents, making up 9.7% of the respondents, reported finding the warnings difficult to understand.

Table 8.8 Confidence with Met Éireann weather warnings

Scale	% (n)
Extremely dissatisfied	0.7% (28n)
Mostly dissatisfied	1.1% (42n)
Somewhat dissatisfied	3.5% (137n)
Neither satisfied nor dissatisfied	6.4% (248n)
Somewhat satisfied	13.1% (509n)
Mostly satisfied	39.1% (1513n)
Extremely satisfied	36% (1394n)

Respondents could elaborate on their responses, with 818 (21.1%) providing 1,008 coded references concerning the weather warning system's quality. Opinions were split, with 444 positive and 564 negative references recorded. Common positive themes included: the warnings were satisfactory (203-references); not too frequent (91-references); clear (73-references); and accurate (39-references). For instance, under the category of "satisfactory," one comment noted, "They make sense. The red warnings over the last 12 months seemed

to have been issued appropriately" (ID583). Meanwhile, a "clear" feedback example stated, "In the case of Storm Emma, weather warnings were very easy to understand and were issued well in advance of what was to come" (R3211).

Recurring negative themes were that the warnings were too frequent (102-references); not localised enough (101-references); not taken seriously (98-references); not clear (84-references); conditions exaggerated (78-references); inaccurate (53-references); and issued too late (33-references). For example, "not localised enough" category, comments highlighted concerns like: "I believe yellow warnings are unnecessary, and red warnings should be more area-specific. It's unlikely the entire country needed a red warning for Emma" (ID2596). Similarly, the "not taken seriously" feedback included remarks such as: "They issue weather warnings for minor wind, and then when a real storm hits, people don't take it seriously because past warnings have amounted to nothing" (R112).

Considering the three weather warning levels, household members within a warning area are expected to evaluate their preparedness and start preparing upon receiving a Status Orange or Red warning (Met Éireann, 2021). 1,326 respondents (34.3%) reported they would typically act at a Status Orange warning, while 242 (6.3%) stated they would act on a Status Yellow warning. While 2,143 (55.4%) indicated action would only be taken on a Status Red warning. 160 (4.1%) suggested no action would be taken regardless of the weather warnings.

The feedback on the weather warning system highlights the significance of not only providing a weather warning, but also ensuring individuals comprehend when and how the warnings apply. The perceived issues by some such as the over-frequency, lack of localisation, clarity, accuracy, and timing of warnings suggest a risk of desensitisation

towards these warnings, potentially compromising some households' preparedness in the face of upcoming severe weather.

8.5.2 Determinants of Worry Before the Storm (Stage One)

The dependent variable for the Stage One analysis was respondents reported levels of worry about Storm Emma before it arrived, measured on a 5-point ordinal scale:

- Not at all worried: 14.65% (652);
- A little: 38.76% (1,725);
- A moderate amount: 31.59% (1,406);
- A lot: 10.90% (485);
- Worried a great deal: 4.11% (183).

Table 8.9 Worry Before Storm Emma – Stage One

	Coef.	Robust Std. Err.	Marginal effects (dy/dx)				
			Not at all	A little	A moderate amount	A lot	A great deal
Female	0.196***	0.045	-0.043***	-0.035***	0.038***	0.026***	0.013***
Age	0.034**	0.011	-0.007**	-0.006**	0.006**	0.005**	0.002**
Age ²	0**	0	0**	0**	0**	0**	0**
Owns Home	0.080	0.058	-0.017	-0.015	0.015	0.011	0.005
Years at Home	0.002	0.002	0.000	0.000	0.000	0.000	0.000
Live in a House	0.094	0.080	-0.020	-0.017	0.018	0.013	0.006
No. of Children (at household)	0.030	0.018	-0.006	-0.006	0.006	0.004	0.002
No. of Adults (at household)	-0.029	0.020	0.006	0.006	-0.006	-0.004	-0.002
Works full-time	0.255***	0.054	-0.056***	-0.044***	0.051***	0.034***	0.016***
Race (White)	-0.019	0.144	0.004	0.004	-0.004	-0.003	-0.001
Income 30,000- 70000	0.071	0.089	-0.014	0.075**	-0.009	-0.027	-0.025**
	-0.153*	0.077					
	-0.245**	0.092					
	-0.357**	0.132					
Income Over 70000	0.027	0.094	-0.005	0.102***	-0.016	-0.045**	-0.036***
	-0.246**	0.082					
	-0.406***	0.098					
	-0.598***	0.14					
A Farmer	0.238‡	0.129	-0.043*	-0.052‡	0.038*	0.036‡	0.021
Expert	0.065	0.073	-0.013	-0.064**	0.03	0.01	0.037***
	0.195***	0.055					
	0.211***	0.063					
	0.439***	0.09					
Lives in a village	-0.193**	0.065	0.036**	0.040**	-0.033**	-0.028**	-0.016**
Lives in a town	-0.215***	0.053	0.041***	0.044***	-0.037***	-0.031***	-0.017***
Lives in a suburb/outskirt of a city	-0.245***	0.054	0.048***	0.050***	-0.043***	-0.035***	-0.019***
Lives in a city	-0.336***	0.072	0.069***	0.064***	-0.062***	-0.047***	-0.024***
Takes action first on Red	0.359***	0.11	-0.098**	-0.035***	0.08**	0.038***	0.015***
Takes action first on Orange	0.759***	0.12	-0.175***	-0.092***	0.174***	0.075***	0.018**
	0.700***	0.113					
	0.534***	0.119					
	0.375**	0.134					
Takes action first on Yellow	0.365*	0.153	-0.101*	-0.190***	0.142***	0.103***	0.046**
	0.761***	0.142					
	0.747***	0.148					
	0.684***	0.171					
Satisfied with weather warnings	0	0.020	0	0	0	0	0
Weather Warnings Too Frequent	-0.117*	0.049	0.025*	0.021*	-0.023*	-0.016*	-0.008*
Weather Warnings Difficult to Understand	0.201**	0.071	-0.037**	-0.043**	0.034***	0.030**	0.016*
/cut1	0.228	0.294					
/cut2	1.468	0.296					
/cut3	2.513	0.298					
/cut4	3.242	0.299					
χ ² (Chi- squared) (df = 24)	341.58***						
No. Obs	3,228						

‡p<0.1, *p<0.05, **p<0.01, ***p<0.001

The results are obtained from a generalized ordered probit model. Marginal effects are reported having controlled for all other explanatory variables evaluated at the mean values.

The findings related to Hypothesis 1a indicate that responsiveness to weather warnings correlates positively with increased worry levels. Respondents who responded to weather warnings exhibited higher worry levels about Storm Emma compared to those who did not act on any warnings. This suggests that risk adverse respondents tended to have higher worry levels about Storm Emma.

Notably, respondents who acted only on Status Red warnings reported lower worry levels about the Storm than those who responded to warnings of lesser severity (Orange and Yellow). For example, compared to respondents who did not respond to any warnings, those who acted on a Status Yellow warning had a 4.6 percentage point (pp) higher probability of expressing significant worry about the Storm. In contrast, this probability decreased to 1.5pp for respondents acting on a Red warning.

Orange warnings, intended to prompt preparedness actions due to their potentially significant impact (Met Éireann, 2021), were positively associated with increased worry at the lower end of the worry scale, with this association diminishing at higher levels of the worry scale. The analysis indicated those responding to an orange warning were typically more likely to be moderately worried, rather than extremely worried, compared to those who ignore warnings.

Responding to yellow warnings, which indicate localised dangers that might not pose a widespread threat but could impact specific activities or areas, was significantly associated with increased worry levels. Specifically, respondents who reported acted upon yellow warnings were 4.6 percentage points more likely to express "a great deal" of worry about Storm Emma than those who did not heed any warning. This suggests that proactive reactions to warnings, irrespective of their severity, lead to heightened levels of worry among households.

Hypothesis 1b was not supported by the results, the link between confidence in the weather warning system and levels of worry about the severe weather event was found to be non-significant.

Hypothesis 1c, households perceiving weather warnings as difficult to understand, reported lower levels of worry about the Storm was rejected. Contrary to the expectation that households might ignore or disengage from warnings due to misunderstanding, it was found that a lack of understanding leads to increased worry. The marginal effects revealed those who found warnings challenging to understand were 3.7pp less likely to report being "Not at all" worried about the Storm.

In line with Hypothesis 1d, the belief that weather warnings are issued too frequently was associated with reduced worry about the severe weather event. Respondents with this view were more likely to express minimal worry, more likely stating they were "Not at all" or "A little" worried by 2.5pp and 2.1pp, respectively.

These findings align with research by Morss *et al.* (2018), who recognised that warning messages influenced worry. We found that more cautious respondents, on average, exhibited higher levels of worry about the Storm. However, contrary to Hypothesis 1b, higher confidence in the weather warning system did not have a significant impact on worry. This indicates that confidence is not the predominant factor affecting respondents' worry during severe weather events. Instead, it points to the frequency and clarity of warnings as having more substantial effects on worry levels.

Supporting Hypothesis 1e, the results showed that Females exhibited significantly higher levels of worry before the Storm compared with males. Hypothesis 1f, which stated households with children show higher levels of worry about the Storm, was rejected due to the non-significant relationship. Hypothesis 1g, examined through the generalised ordered

probit model, demonstrates that the influence of expertise on worry before the Storm varies across different intensities of worry. Expertise marginally reduces the probability of transitioning from "Not at all" worried to "A little" worried by -0.013, although this effect is not statistically significant. It significantly decreases worry for the transition to "A little" worried by -0.064 ($p < 0.01$), indicating a nuanced understanding of risk at this level. Conversely, expertise significantly increases the probability of experiencing higher levels of worry, with a notable increase of 0.037 ($p < 0.001$) for transitioning to "A great deal" worried. This pattern underscores that while expertise may provide a calming effect at lower levels of worry, possibly by offering a realistic assessment of risk in some instances, it also leads to greater levels of worry, likely due to an acute awareness of the potential severity and implications of the Storm in other cases. Hypothesis 1h proposed that increased urbanicity or would demonstrate a significant negative correlation with worry levels preceding the Storm, which was confirmed. For example, those living in a city were 6.9pp more likely not to undertake any of the four recommended actions compared to those living in rural settings.

In addition to highlighting the significance of relationships for each hypothesis, our results also identify other factors that influenced worry before the Storm. Age, working full-time, and being a farmer are significant factors associated with an increase in worry about the Storm before it arrived. On the other hand, having an income of €30,000 or above showed a significant negative relationship with worry levels. For example, the analysis of urbanicity indicated a trend where worry decreases from more rural to more urban settings, with individuals in cities less likely to experience higher levels of worry about Storm Emma compared to those in rural areas. Other variables such as owning a home, years at the residence, the number of adults in the household, and race did not significantly impact worry levels.

8.5.3 Determinants of Preparedness Actions Before Storm Emma Arrived (Stage Two)

Before the Storm arrived, and in adherence to the preparedness advice provided, the most common action taken in households was purchasing additional food supplies (72.2%, 2,939). This was followed by making plans for potential power loss (59.6%, 2,427). In contrast, less than 50% of respondents reported planning for water loss (45.4%, 1,847) or sought additional information on how to prepare for the Storm (44.9%, 1,828). An action score was developed by combining these four items, resulting in a score ranging from zero to four actions completed. The mean score was 2.22, with a standard deviation of 1.245.

- 10.5% (719) had not undertaken any of the suggested actions;
- 19.5% (794) one action;
- 24.8% (1,010) two actions;
- 27.5% (1,117) three actions;
- 17.7% (719) all four actions;

Details of additional preparedness actions or inaction were provided by 2,220 respondents, see Appendix 3 Table 2 for a complete list of coded references. 99 respondents suggested they charged batteries, while 87 indicated a member of the household prepared to work from home. 463 described not making specific preparations for Storm Emma. The reasons for inaction included a perception that a nationwide Status Red warning was an overreaction, a belief the Storm would not affect their location, or a general lack of concern. For some, not preparing was a source of regret:

"Didn't think it would be so bad so took no action" (ID3662).

"I wasn't expecting that my estate would be so bad as well as roads and did not expect shops to close" (ID1185).

The responses offered evidence to support PAT; perceptions of the Storm's severity and the ensuing worry correlated with preparedness actions. To further explore this relationship within PAT, the second stage of the analysis estimated the connection between worry levels and preparedness actions taken in households before Storm Emma (Table 8.10).

Table 8.10 Influencing Action Before Storm Emma

	Coef.	Robust Std. Err.	Marginal effects (dy/dx)				
			0 - Actions	1 - Actions	2 - Actions	3 - Actions	4 - Actions
Female	0.202***	0.044	-0.033***	-0.036***	-0.01***	0.033***	0.047***
Age	0.048**	0.016	-0.007**	-0.009**	-0.003**	0.007**	0.012**
Age ²	-0.001**	0	0**	0**	0**	0**	0**
Owns Home	-0.044	0.061	0.007	0.008	0.003	-0.007	-0.011
Years at Home	0.003	0.002	0	0	0	0	0.001
Live in a House	0.265**	0.101	-0.047*	0.042‡	0.065*	0.048	-0.107***
	0.017	0.092					
	-0.149	0.092					
	-0.383***	0.104					
No. of Children (at household)	0.045*	0.018	-0.007*	-0.008*	-0.003*	0.007*	0.011*
No. of Adults (at household)	-0.006	0.019	0.001	0.001	0	-0.001	-0.002
Works fulltime	-0.034‡	0.055	0.005	0.006	0.002	-0.005	-0.008
Race (White)	0.188	0.128	-0.033	-0.033	-0.008**	0.032	0.042
Income 30,000-70,000	0.212***	0.063	-0.033***	-0.038***	-0.013***	0.033***	0.051***
Income Over 70,000	0.323***	0.067	-0.047***	-0.057***	-0.024***	0.046***	0.082***
A Farmer	-0.228*	0.103	0.041‡	0.04*	0.008***	-0.039*	-0.049*
Expert	-0.131‡	0.077	0.021	-0.031‡	-0.038*	0.025	0.023
	0.028	0.06					
	0.119*	0.055					
	0.091	0.062					
Lives in a village	-0.091	0.062	0.013	0.016	0.007	-0.013	-0.023
Lives in a town	-0.122*	0.053	0.018*	0.022*	0.009*	-0.018*	-0.031*
Lives in a suburb/outskirt of a city	-0.149**	0.055	0.022**	0.027**	0.01**	-0.022**	-0.037**
Lives in a city	-0.164*	0.068	0.025*	0.029*	0.011**	-0.025*	-0.04*
Worry Before – Little	0.464***	0.061	-0.067***	-0.082***	-0.034***	0.065***	0.118***
Worry Before – Moderate	0.756***	0.063	-0.099***	-0.129***	-0.067***	0.089***	0.206***
Worry Before – A Lot	0.891***	0.08	-0.084***	-0.14***	-0.111***	0.052***	0.283***
Worry Before – A Great Deal	1.02***	0.113	-0.081***	-0.149***	-0.138***	0.025‡	0.343***
/cut1	0.627	0.309					
/cut2	1.406	0.310					

/cut3	2.124	0.311
/cut4	3.006	0.313
χ^2 (Chi-squared) (df = 22)	422.3 ***	
N	3,228	

Notes: ‡p<0.1, *p<0.05, **p<0.01, ***p<0.001

The results are obtained from a generalized ordered probit model. Marginal effects are reported having controlled for all other explanatory variables evaluated at the mean values.

In Stage 2, Hypothesis 2a, that high levels of pre-event worry would positively influence individuals to follow recommended guidance and take preparedness action was supported. The analysis revealed a positive and statistically significant relationship between the level of worry prior to Storm Emma and the number of preparedness actions taken, while controlling for socio-demographic factors. Specifically, respondents which were a little worried about Storm Emma were 11pp more likely to undertake all recommended actions compared to those not worried, increasing to 34.3pp for those who worried a great deal about the Storm.

Previous research by Sutton *et al.* (2018) has shown that worry triggered by warnings doesn't necessarily prevent people from taking protective measures. Our results indicate that a certain amount of worry can actually increase the chances of taking such actions. Yet other research points out that fear may cause individuals to ignore these warnings entirely (Morss *et al.*, 2018). This insight is crucial for tailoring weather warnings to encourage preparedness without inducing counterproductive fear.

Hypothesis 2b which suggested that females were less likely to follow recommended guidance and take preparedness action, compared to males, was not supported. The data revealed that being female significantly increased the likelihood of taking the proactive actions before the Storm, with a decrease in the probability of inaction by 3.3 pp and an increase in the likelihood of taking all four recommended actions by 4.7 pp.

Hypothesis 2c found support in our analysis, showing that expertise indeed enhances adherence to recommended guidance and preparedness advice. However, the relationship between expertise and the propensity to follow such actions was nuanced. Specifically, the analysis showed that experts were statistically more likely to avoid complete inactivity compared to non-experts, as indicated by a significant and negative first coefficient (-0.131) associated with the "Expert" variable.

The assertion in Hypothesis 2d that living in a rural setting increases the likelihood of following guidance and preparedness advice over urban living received mixed results. Residing in a village did not show a significant difference, yet those living in a town, the suburbs or outskirts of a city, or within a city itself, were significantly less likely to follow the recommended actions before the Storm. For instance, the marginal effects suggested that those living in a city were 4pp less likely to have taken all four actions compared to those in a rural setting.

Hypothesis 2e, households with children are associated with a higher likelihood of following guidance and preparedness advice was confirmed. The related marginal effects demonstrated that for each increment in the number of children in the house, the likelihood of having taken all four actions rose by an estimated 1.1pp.

Furthermore, the analysis illuminated the role of other socio-demographic factors. Age and having an income exceeding €30,000 were significant and positively correlated with adherence to taking preparedness action before the Storm. In contrast, full-time employment and being a farmer significantly correlated with a negative likelihood of following such advice. The results in Table 8.10 also show that living in a house leads to greater polarisation regarding following the guidance and preparedness advice before the Storm, i.e., those living in a house are less likely to state they took all four actions when

compared with those living in other types of dwellings (e.g., apartments). Other variables, including homeownership, years at the current home, the number of adults in the household and race, did not significantly influence the likelihood of following the recommended actions before the Storm.

8.5.4 Determinants of the Post-event Coping Assessment (Stage Three)

The post-event coping assessment, measured from 0% to 100%, had a mean of 62.96% with a standard deviation of 24.09pp. Of the 4,216 respondents surveyed on their coping during Storm Emma, the quartile breakdown offers insight into the range of coping assessments. The first quartile (25%) sits at a score of 50, suggesting a moderate level of coping ability at best. The median value (50th percentile) is 70, suggesting a majority felt as though they coped reasonably well. By the third quartile (75%), the score reaches 80, indicating a high portion of respondents viewed themselves as having coped very well during Storm Emma.

With the benefit of hindsight, respondents were asked what else, if anything, they might have done to prepare for the Storm. In total, 2,460 responses were received, with 2,988-references coded. Of these, 589 (23.9%) respondents felt that no additional preparations were needed to cope with the event. One household (ID168) shared, "Not all that much, we survived pretty comfortably, the only real negative effect was the cabin fever of not being able to leave".

Among the remaining responses, 44.9% of the respondents (1,104) expressed regret at not having stocked up with sufficient supplies to prepare for the Storm. One said, "I should have been more worried and therefore filled up water bottles and bought food that didn't require electricity to prepare" (ID446). Other themes included needing shovels to remove snow (148-references), alternative heat sources (111-references), preparing for utility loss

(78-references), alternative cooking methods (72-references), purchasing appropriate clothing (67-references), and sourcing alternative entertainment (65-references).

Regarding how levels of worry changed throughout the Storm, 19.84% (883) reported decreased worry levels, while levels increased for 31.75% (1,413). Respondents were invited to explain what caused their worry to decrease, with 808 providing 985 a rationale. Most, 492 explanations, related to the Storm not being as severe as expected at their location; 240 referenced an over-warning of the event, with the conditions experienced being less severe than forecast for the country. Other reasons were coded as being prepared and safe within the home (109-references), having access to a news source (92-references), not having to travel (85-references), not losing utilities (44-references), and knowing friends/family were safe (39-references).

A total of 1,314 respondents provided an explanation for the increased worry levels in their homes, resulting in 2,121 coded reasons. Among these, 591 reasons were related to travel to or from the home, including the need to commute to work. Other reasons were coded as the amount of snowfall or being trapped in the home (348-references), concerns over friends and family safety (169-references), watching the news/Storm (161-references), lack of preparedness (138-references), loss of utilities (135-references), and the Storm being worse than expected (104-references).

Table 8.11 Influencing Coping Appraisal

Variable	Coef.	Robust Std. Err	95% Conf. Interval
Female	-2.696***	0.855	-4.373 to -1.020
Age	0.775**	0.25	0.285 to 1.264
Age2	-0.007*	0.003	-0.012 to -0.001
Owns Home	-0.912	1.186	-3.238 to 1.415
Years at Home	-0.147***	0.044	-0.232 to -0.061
Live in a House	-6.409***	1.606	-9.558 to -3.261
No. of Children (at household)	0.025	0.349	-0.658 to 0.709
No. of Adults (at household)	-0.641	0.398	-1.422 to 0.139
Works fulltime	-3.107**	1.046	-5.158 to -1.057
Race (White)	5.433	2.849	-0.154 to 11.020
Income 30,000-70,000	0.799	1.398	-1.943 to 3.541
Income Over 70,000	1.815	1.471	-1.069 to 4.699
A farmer	-0.241	2.318	-4.786 to 4.304
Expert	-4.419***	0.914	-6.210 to -2.627
Lives in a village	0.235	1.226	-2.168 to 2.638
Lives in a town	1.084	1.047	-0.968 to 3.137
Lives in a suburb/outskirt of a city	1.308	1.095	-0.840 to 3.455
Lives in a city	1.222	1.403	-1.529 to 3.972
Worry Decreased	5.465***	0.973	3.557 to 7.373
Worry Increased	-11.974***	0.869	-13.677 to -10.271
Actions Before – 1	2.117	1.737	-1.290 to 5.524
Actions Before – 2	3.171‡	1.665	-0.093 to 6.434
Actions Before – 3	5.667***	1.679	2.375 to 8.960
Actions Before – 4	5.056**	1.79	1.547 to 8.565
Household Preparedness Score	2.499***	0.156	2.193 to 2.805
Cons	28.775***	5.997	17.016 to 40.534
Adjusted R ²	0.247		
F	45.94***		
N	3,164		

Notes: ‡p<0.1, *p<0.05, **p<0.01, ***p<0.001. The results are obtained using an OLS regression

The analysis of the OLS results in Table 8.11 provides a more nuanced understanding of how following the recommended actions to prepare for Storm Emma impacted post-event coping assessments as set out in Hypothesis 3a. The results showed that taking 2 to 4 of the recommended actions positively and significantly impacted post-event coping assessment ($\beta=3.171$ for 2 actions, $p=0.057$; $\beta=5.667$ for 3 actions, $p=0.001$; $\beta=5.056$ for 4 actions, $p=0.005$). Taking only 1 action showed a positive but not statistically significant impact ($\beta=2.117$ for 1 action, $p=0.223$). However, the data revealed that the most positive coping

assessments were observed in households that took 3 or 4 of the recommended actions, indicating that engaging in a higher number of preparatory measures is linked to an enhanced sense of having managed the situation effectively during and after the Storm, compared to those who did not engage in any preparatory actions.

Confirming Hypothesis 3b, a significant and positive association was also identified between the household preparedness score and post-event coping assessment. The household preparedness score revealed that higher levels of emergency preparedness were associated with more positive coping assessments. Respondents with higher scores, indicating engagement in a broader range of emergency preparedness measures, reported having coped better during and immediately following the Storm.

In support of Hypothesis 3c, a significant relationship was observed between the change in worry levels during the Storm and post-event coping assessment. Compared to individuals whose worry levels remained unchanged, those who experienced an increase in worry reported a lower coping assessment, with a decrease of 11.97pp. Conversely, individuals who reported a decrease in worry levels felt they coped better, with an increase of 5.46pp in their coping assessment.

In examining socio-demographic factors through our hypotheses, we found mixed results. Hypothesis 3d, which posited that being female negatively impacts post-event coping assessment compared to males, was supported, highlighting a significant gender difference in coping assessments. However, Hypotheses 3e through 3g did not find support. Specifically, experts were significantly more critical of their coping capabilities, as indicated by a negative correlation (-4.419 , $p < 0.001$) with coping assessment. This suggests that experts may judge their coping efforts more harshly than those with less expertise.

Contrarily, living in urban areas and having children did not significantly affect the coping assessment, leading to the rejection of Hypotheses 3f and 3g.

Additionally, the analysis revealed the influence of other socio-demographic factors on the coping assessment. Length of residence, living in a house, and full-time employment all had a significant and negative influence on the coping assessment. While age positively correlated with coping appraisal (0.775, $p < 0.01$), indicating that coping assessments improves with age. However, this trend reverses at higher ages, as evidenced by the negative correlation of age squared with coping appraisal (-0.007, $p < 0.05$), suggesting a nuanced, non-linear relationship where the beneficial effects of age on coping appraisal decrease at older ages. Other factors, such as homeownership, the number of adults in the household, race, income level, and being a farmer, showed no significant impact on coping assessment.

8.5.5 Determinants of After-Action (Stage Four)

Stage Four of the analysis examined whether a relationship existed between the post-event coping assessment and undertaking preparedness actions to protect the household against severe weather in the immediate aftermath of the Storm. Of the 3,685 respondents surveyed, 12.9% (474) had undertaken protective actions within 12 weeks of Storm Emma. These findings align with previous PMT studies on protective action taken after flood events, which found that some respondents invested in additional measures to better prepare for future floods in the months following the emergency (Rözer *et al.*, 2016; Bubeck *et al.*, 2020; Dillenardt, Hudson and Thieken, 2021). Storm Emma was not associated with widespread flooding or major damage to property. Delays due to assessments by insurance companies or waiting for more significant repairs were not a key feature in the aftermath of Storm Emma. This contrasts with the findings of Bubeck *et al.* (2020), which state that

the level of damage respondents experienced after severe flooding delayed the taking of additional protective actions.

Among those who reported taking subsequent protective actions, 415 provided details of 602 action. These could be categorised into two themes: structural and non-structural measures.

Structural measures (229-references) included:

1. Improving insulation within the home, such as pipes, windows, and doors (106-references).
2. Inspecting the home, including gutters and slates (55-references).
3. Undertaking renovation works (22-references).
4. Installing a heating system (25-references).
5. Painting the outside of the house with waterproof paint (18-references).

Non-structural measures (373-references) included:

1. Procuring equipment and supplies (233-references), such as extra fuel (38-references), water (29-references), food (25-references), and buying a shovel (21-references).
2. Making plans for the next Storm and gathering necessary information (39-references).
3. Cutting trees on the property to mitigate risk (39-references).
4. Getting secondary heating sources (29-references).
5. Organising or decluttering the property, for example, removing unnecessary items from the garden (19-references).
6. Buying a generator (13-references).

A small number of respondents (44-references) cited the need to undertake repair works due to damage from Storm Emma. Given the relatively short period after the event, it is clear that in some respondents' households they were quick to prioritise actions to mitigate the effects of another Storm. This suggests a proactive attitude to learning from their experiences during the Storm and building preparedness for future weather events.

Table 8.12 Influencing Protective Actions Post-Storm

	Coef.	Robust Std. Err.	Marginal effects (dy/dx)
Female	-0.087	0.067	-0.017
Age	0.01	0.020	0.002
Age ²	0	0.000	0
Owns Home	0.334***	0.098	0.06***
Years at Home	0.002	0.003	0
Live in a House	0.066	0.124	0.012
No. of Children (at household)	-0.025	0.028	-0.005
No. of Adults (at household)	-0.04	0.031	-0.008
Works fulltime	0.112	0.086	0.021
Race (White)	-0.364*	0.184	-0.086‡
Income 30,000-70,000	-0.282**	0.099	-0.055**
Income Over 70,000	-0.351***	0.108	-0.065***
A Farmer	-0.013	0.169	-0.002
Expert	0.226***	0.068	0.048**
Lives in a village	0.029	0.095	0.006
Lives in a town	-0.041	0.081	-0.008
Lives in a suburb/outskirt of a city	-0.176*	0.087	-0.033*
Lives in a city	-0.144	0.109	-0.028
Coping Appraisal	-0.004***	0.001	-0.001***
Impacted by the Storm	0.22	0.148	0.038
Constant	-0.986	0.445	
Chi-squared (df = 20)	90.86***		
Log Likelihood	-1148.57		
Correctly classified	87.48%		
No. Obs	3,164		

Notes: ‡p<0.1, *p<0.05, **p<0.01, ***p<0.001

The results are obtained using a probit regression. Marginal effects are reported having controlled for all other explanatory variables evaluated at the mean values.

In support of Hypothesis 4a, the probit analysis in Table 8.12 showed a significant negative relationship between the post-event coping assessment and taking protective actions after the Storm. The marginal effect indicates that for every one-point decrease in coping appraisal, the probability of taking subsequent protective action rises by 0.1. This indicates that respondents who perceived their household had coped poorly during Storm Emma were more inclined to undertake additional preparedness actions immediately following the event. This observation aligns with Dillenardt *et al.* (2021), who proposed that the likelihood of undertaking preparedness actions post-emergency increases as household

members can more readily recognise the potential benefits of such actions based on their recent experiences. Our findings reinforce the notion that experience of severe weather, coupled with a post-event assessment of coping outcomes, can drive household members to enhance their preparedness for future weather events.

The qualitative data also validates Hypothesis 4a, showing that household members recognising gaps in their preparedness due to a less than optimal coping experience during the Storm were prompted to adopt additional protective measures in the aftermath. The diversity of actions taken following Storm Emma, ranging from buying snow shovels to insulating pipes, demonstrates a capacity to learn from experience and adapt household preparedness accordingly.

Regarding the additional hypotheses, both Hypothesis 4b, concerning the impact of being female, and Hypothesis 4e, the presence of children in the household, were not supported due to their non-significant effects. In contrast, Hypothesis 4c, which posited that expertise positively influences post-Storm protective actions, was confirmed. The data indicated that experts were 4.8pp more likely to undertake protective actions after Storm Emma compared to non-experts. Hypothesis 4d received partial support; residing in a suburb or in the outskirts of a city significantly reduced the likelihood of taking protective actions post-Storm, whereas living in a city, town, or village showed no significant effect.

In examining the influence of other socio-demographic factors, age, duration at the current residence, living in a house, the number of adults in the household, full-time employment status, and being a farmer were all found to be non-significant. Homeownership emerged as a significant predictor, notably increasing the likelihood of taking protective actions post-storm by 6pp. Conversely, respondents earning an income of €30,000 or above and

respondents identifying as white were found to be negatively associated with the likelihood of taking protective actions after the Storm.

8.6 Limitations & Suggestions for Future Research

Given Chapters 2 to 7 established a set of limitations and suggestions for future research, this section focuses on the overall findings of the thesis.

8.6.1 Limitations

The PAT model used a single scale, expressed as a percentage, to measure households' post-event coping assessment. While Bergkvist & Rossiter (2007) argue that single-item scales can be as valid as multi-item measures, it is accepted that this approach may not capture the nuanced aspects of the coping assessment.

The PAT model is focused on individual and household emergency preparedness without incorporating the potential impact of community dynamics and collective efficacy. The inclusion of these factors in the PAT model could provide a wider understanding of the factors influencing preparedness actions, such as social capital and community resilience (Aldrich and Meyer, 2015).

8.6.2 Suggestions for Future Research

Investigating the application of the PAT model across different emergency contexts could explore its utility and adaptability. Research extending beyond the case study of Storm Emma to include other types of emergencies and geographical areas could validate the model.

Future studies could benefit from implementing multi-dimensional scales to capture the post-event coping assessment. This would allow for enhanced exploration of the various

facets of coping assessment and how they contribute to preparedness actions taken after the emergency.

The importance of mixed methods data collection should not be overlooked. For example, insights gathered from qualitative data on the types of actions households undertook following Storm Emma, or in earlier studies where the importance of threat appraisal in influencing protection motivations was identified, would not have been possible without using mixed methods. This qualitative data, alongside the quantitative data, provided richer insights into understanding the decision making of households which then informed the subsequent data analysis of PAT. For this reason, it is recommended that future studies also use a mixed methods approach when collecting data on household preparedness.

To enhance the PAT model, subsequent research could consider the roles of community dynamics and collective efficacy in disaster preparedness. Examining how community-level factors interact with individual preparedness actions could offer valuable insights into developing the PAT model further.

8.7 Answering the Research Question

To conclude the thesis, Figure 8.1 illustrates the key factors that influence household emergency preparedness in Ireland.

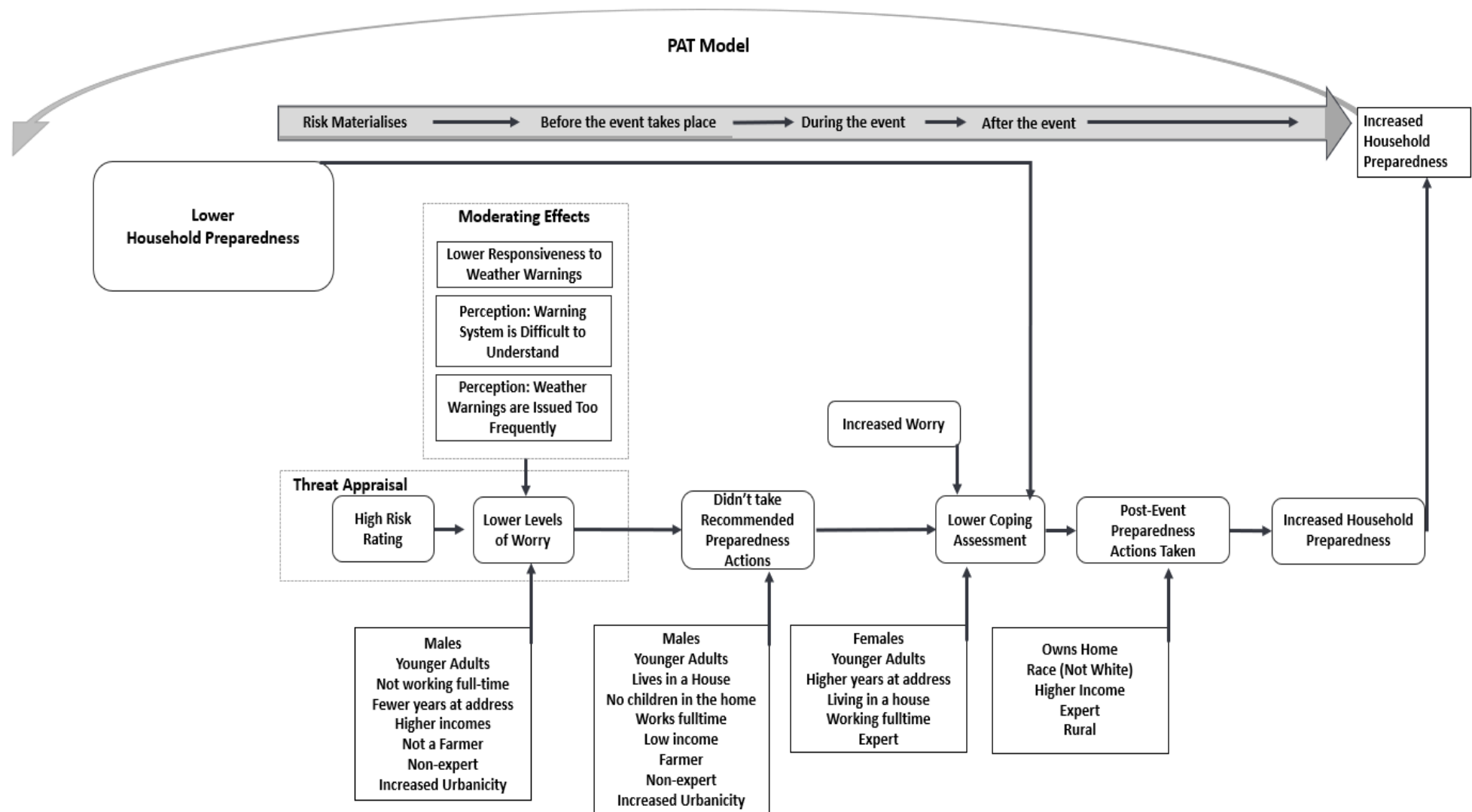


Figure 8.1 PAT Model

The first factor in the PAT model is actual household preparedness, which could be considered a baseline level of preparedness prior to calls for specific action linked to the Storm. Household preparedness was significantly and positively associated with the post-event coping assessment. A lower household preparedness score (checklist preparedness) resulted in a lower post-event coping appraisal.

Finding One: Household preparedness is significantly and positively associated with the post-event coping assessment.

The model then considers threat appraisal. In the case of Storm Emma, the risk rating was effectively determined by the NMHS when a level red weather warning was issued. This is the highest level warning, indicating the Storm was imminent and the impact would be severe. The importance of weather warnings cannot be overstated; the warning triggered a threat appraisal (informed by risk rating and worry) which was moderated by 3 factors. There was a significant and positive correlation between worry and responsiveness to weather warnings and a perception that warnings are difficult to understand. There was a significant and negative relationship between worry and a belief that warnings are issued too frequently.

Finding Two: There was a significant and positive correlation between worry and responsiveness to weather warnings and a perception that warnings are difficult to understand. There was a significant and negative relationship between worry and a belief that warnings are issued too frequently.

The PAT model revealed that effective weather warnings elevate household worry levels, which in turn significantly and positively motivates the undertaking of the recommended four preparatory actions issued with the warning.

Finding Three: There was a significant and positive correlation between pre-storm worry and taking the recommended preparedness actions.

Two additional factors, taking a higher number of recommended actions before the Storm and lower levels of worry during the Storm, significantly and positively influenced the post-event coping assessment.

Finding Four: Greater initial household preparedness, taking more of the recommended actions in advance, and experiencing a decrease in worry levels during the Storm were associated with a more positive post-event coping assessment.

The importance of the post-event coping assessment in influencing future preparedness actions in the weeks after the Storm was evident. Households with a lower coping assessment were more inclined to adopt structural and non-structural emergency preparedness measures in the weeks following Storm Emma. Structural improvements included enhancing home insulation (pipes, windows, and doors) and installing a more effective heating system to build resilience against extreme cold. Non-structural preparedness actions included procuring essential equipment and supplies, such as acquiring additional fuel for heating and purchasing shovels for snow removal.

Finding Five: There was a significant and negative correlation between the post-event coping assessment and taking household emergency preparedness action in the immediate aftermath of the Storm.

The moderating effects on each factor within the PAT model are illustrated in Figure 8.1.

Regarding the four key socio-demographic factors, gender was significant in three of the four stages of PAT:

Finding Six: Females exhibited more worry about the Storm; are more likely to follow recommended guidance and preparedness advice; and provided less positive post-event coping assessments.

The presence of children in the household was significant in just one stage of PAT.

Finding Seven: Households with children are more likely to adhere to guidance and preparedness advice.

Expertise is significant in all four stages of PAT.

Finding Eight: Experts are more likely to experience higher levels of worry; to complete recommended guidance and preparedness advice; to report lower post-event coping assessments compared to non-experts but were more likely to undertake household preparedness action after the Storm.

Urbanicity is statistically significant in three of the four stages in PAT.

Finding Nine: Higher levels of urbanicity are negatively associated with levels of worry. Living in a rural setting is associated with a higher likelihood of following guidance and preparedness action. Residing in a rural area increases the probability of individuals taking protective actions following the Storm.

8.8 Contribution to Knowledge

The overarching research contributions of this thesis are captured in Table 8.15 and discussed below.

Table 8.13 Research Contributions

Contribution Area	Supported	Developed	New
Theory	Synthesised research findings on the range of factors influencing preparedness, including worry, gender, expertise, and urbanicity, and provide a comprehensive overview of their impact on household preparedness.	Analysed the relationship between perceived and actual preparedness, offering insights into how these factors differ and the implications for understanding household preparedness. Tailored PMT to a fire safety context.	Introduced the PAT model, which builds on PMT by incorporating a post-event coping assessment, examining its relationship with preparedness actions before and after a severe weather event. Uncovered unique insights into individual engagement with and responses to weather warnings, expanding the discussion beyond traditional constructs of PMT and revealing new evidence on results such as the cry-wolf effect.

Methodology	A systematic literature review (SLR) PRISM method was applied to organise existing research on perceived and actual preparedness.	Examined various analytical approaches to understanding factors like the relationship between perceived and actual preparedness, enhancing methodological diversity in preparedness research. Utilised a mixed methods approach to combine the strengths of both quantitative and qualitative research. In essence, the quantitative methods provided robust statistical insights and generalisability, while the qualitative data collected offered greater depth and context to the findings. By integrating these methods, the research gained a more comprehensive perspective of the factors that influence protection motivation and action, this was limited in previous studies.	Employed the PAT model as a process for analysing household preparedness immediately before, during and after severe weather events. PhD by Publication: Tested a new model, drawing on previous chapters, in the conclusion to the overall thesis.
Practice	Offered insights into communication strategies tailored to enhance emergency household preparedness, informed by empirical findings on socio-demographic differences and individual engagement.	Emphasised the need for emergency preparedness strategies to account for socio-demographic differences, advocating for targeted interventions to improve campaign efficacy. Highlighted the implications for National Risk Assessment (NRA) focus groups in Ireland, emphasising the necessity of gender representation to ensure balanced risk assessments.	Identified specific gaps in knowledge regarding EMS first responders' experiences during public health emergencies, recommending strategic areas for improvement to enhance future response efforts. Early results shared with EMS National Directors to inform phase two of the COVID-19 response in Ireland.
Context	Reinforced existing research on the factors influencing household emergency preparedness, contributing to a solid foundation for understanding preparedness within various contexts.	Examined household preparedness within Ireland's specific risk profile, providing insights into how contextual factors shape preparedness strategies and public response mechanisms.	Investigated the particular challenges and needs related to weather-related emergencies in Ireland, contributing to a deeper understanding of how to drive preparedness action.

The thesis integrated findings from six published papers to present a cohesive understanding of the factors that influence household emergency preparedness in Ireland.

Each contribution enriched the PAT model and provided a deeper understanding of the factors that influenced household emergency preparedness in Ireland.

This research project contributed to emergency preparedness research by introducing PAT, a novel model that offered an explanation of the factors impacting household emergency preparedness before and after a severe weather emergency. Building upon PMT, PAT incorporated a new post-event coping assessment as well as a range of emergency-specific factors.

The study's exploration of the distinction between perceived and actual preparedness demonstrated a need to understand both elements of emergency preparedness within households. By identifying the specific predictors of perceived and actual preparedness, the research provided insights into how more precise and effective preparedness strategies can be devised.

Another significant aspect of this research was its examination of how worry, gender, expertise, urbanicity, and the presence of children in a household influenced emergency preparedness. This investigation confirmed a need for preparedness communication and interventions to be tailored to the specific needs of different demographic groups, ensuring that strategies were impactful and inclusive.

In the context of emergency management in Ireland, the impact of this research is particularly evident in two key reports published alongside the research papers: "Shaping the Future of Weather & Climate Services in Ireland: A Public Perspective" (McMullan *et al.* 2021) and the "LISTEN: Capturing Learning from the Frontline Response to COVID-19" (McMullan *et al.* 2020). These reports allowed for the rapid dissemination of findings to key stakeholders in Ireland.

Shaping the Future of Weather & Climate Services in Ireland: A Public Perspective (2020) provided a comprehensive evaluation of public perspectives on weather and climate services in Ireland. For example, the research highlighted the public's desire for more focused, impact-based warnings. This feedback was provided via the report to Met Éireann, who, as part of their Strategic Plan 2017-2027, set a key goal to enhance their impact-based decision-making for weather events (Met Éireann 2017).

Similarly, the "LISTEN: Capturing Learning from the Frontline Response to COVID-19" report captured the experiences and challenges faced by EMS first responders during the pandemic. The insights gained led to improvements in emergency management practices, including enhanced protocols for personal protective equipment (PPE), the implementation of decontamination facilities, and better organisational communication strategies. These findings were rapidly disseminated to key stakeholders, such as the HSE and Fire Services, ensuring that the opportunities for learning could be incorporated into the ongoing response to COVID-19. This swift dissemination of findings ensured that EMS first responders' perspectives were heard by those who could take swift action. In conclusion, this PhD contributes to the emergency management field by providing a well-grounded theoretical model and practical insights for improving emergency preparedness. The PAT model encapsulated the project's systematic approach to understanding and enhancing household emergency preparedness, marking a novel contribution to the research area. This thesis paves the way for future development and elaboration of the PAT model.

9. References

- Ablah, E., Konda, K. and Kelley, C.L. (2009) 'Factors predicting individual emergency preparedness: A multi-state analysis of 2006 BRFSS data', *Biosecurity and Bioterrorism*, 7(3), pp. 317–330.
- Abunyewah, M., Gajendran, T. and Maund, K. (2018) 'Conceptual Framework for Motivating Actions towards Disaster Preparedness Through Risk Communication', *Procedia Engineering*, 212(2017), pp. 246–253.
- Acharya, S. *et al.* (2020) 'Non-COVID and COVID emergency department healthcare workers' perception of COVID-19 at Patan Hospital, Nepal', *Journal of Patan Academy of Health Sciences*, 7(1), pp. 42–47.
- Adame, B. and Miller, C.H. (2016) 'Vested interest: developing scales for assessing flooding preparedness', *Disaster Prevention and Management: An International Journal*, 25(3), pp. 282–297.
- Adams, L.M. and Berry, D. (2012) 'Who will show up? Estimating ability and willingness of essential hospital personnel to report to work in response to a disaster', *OJIN: The Online Journal of Issues in Nursing*, 17(8), p. e-copy.
- Aghili, S.M. and Arbabi, M. (2020) 'The COVID-19 Pandemic and the Health Care Providers; What Does It Mean Psychologically?', *Advanced Journal of Emergency Medicine*, 4(2), p. e63.
- Akompab, D.A., Bi, P., Williams, S., Grant, J., Walker, I.A. and Augoustinos, M. (2013) 'Heat waves and climate change: Applying the health belief model to identify predictors of risk perception and adaptive behaviours in Adelaide, Australia', *International Journal of Environmental Research and Public Health*, 10(6), pp. 2164–2184.
- Aksoy, Y.E. and Koçak, V. (2020) 'Psychological effects of nurses and midwives due to COVID-19 outbreak: The case of Turkey', working paper, Department of Midwifery, Health Sciences Faculty of Selcuk University, Konya, Turkey, 3 July.
- Aldrich, D.P. and Meyer, M.A. (2015) 'Social Capital and Community Resilience'.
- Allareddy, V., Peek-Asa, C., Yang, J. and Zwerling, C. (2007) 'Risk factors for rural residential fires', *The Journal of Rural Health*, 23(3), pp. 264–269.
- Alsahafi, A.J. and Cheng, A.C. (2016) 'Knowledge, attitudes and behaviours of healthcare workers in the Kingdom of Saudi Arabia to MERS coronavirus and other emerging infectious diseases', *International Journal of Environmental Research and Public Health*, 13(12), pp. 1–8.
- Alwin, D. (2016) 'Survey data quality and measurement precision'. In: *The SAGE Handbook of Survey Methodology*. SAGE Publications, pp. 527–557.
- American Red Cross (2016a) *Emergency Plan - Prepare 2016*. Available at: <https://www.redcross.org/get-help/how-to-prepare-for-emergencies/make-a-plan.html> (Accessed: 1 September 2016).

American Red Cross (2016b) *How to prepare for emergencies*. Available at: <http://www.redcross.org/get-help/how-to-prepare-for-emergencies#About> (Accessed: 1 September 2016).

Angelos, P. (2020) 'Surgeons, Ethics, and COVID-19: Early Lessons Learned', *Journal of the American College of Surgeons*, 230(6), pp. 1119–1120.

Annis, H., Jacoby, I. and De Mers, G. (2016) 'Disaster preparedness among active duty personnel, retirees, veterans, and dependents', *Prehospital and Disaster Medicine*, 31(2), pp. 132–140.

Appleby-Arnold, S. *et al.* (2018) 'Applying cultural values to encourage disaster preparedness: Lessons from a low-hazard country', *International Journal of Disaster Risk Reduction*, 31(October 2018), pp. 37–44.

Arbon, P. *et al.* (2013) 'Australasian emergency nurses' willingness to attend work in a disaster: A survey', *Australasian Emergency Nursing Journal*, 16(2), pp. 52–57.

Armaş, I. (2006) 'Earthquake risk perception in Bucharest, Romania', *Risk Analysis*, 26(5), pp. 1223–1234.

Baack, S. and Alfred, D. (2013) 'Nurses' preparedness and perceived competence in managing disasters', *Journal of Nursing Scholarship*, 45(3), pp. 281–287.

Babcicky, P. and Seebauer, S. (2019) 'Unpacking Protection Motivation Theory: evidence for a separate protective and non-protective route in private flood mitigation behavior', *Journal of Risk Research*, 22(12), pp. 1503–1521.

Baduge, M.S.D.S., Morphet, J. and Moss, C. (2018) 'Emergency nurses' and department preparedness for an ebola outbreak: A (narrative) literature review', *International Emergency Nursing*, 38(December 2017), pp. 41–49.

Balicer, R.D. *et al.* (2010) 'Characterizing hospital workers' willingness to report to duty in an influenza pandemic through threat- and efficacy-based assessment', *BMC Public Health*, 10(436), pp. 1–10.

Balut, M.D., Der-Martirosian, C. and Dobalian, A. (2021) 'Determinants of Workforce Preparedness during Pandemics Among Healthcare Workers at the U.S. Department of Veterans Affairs', *Journal of Primary Care and Community Health*, 12, pp. 1–8.

Balut, M.D., Der-martirosian, C. and Dobalian, A. (2022) 'Disaster Preparedness Training Needs of Healthcare Workers at the US Department of Veterans Affairs', *Southern Medical Journal*, 115(2), pp. 158–163.

Barberi, F., Davis, M.S., Isaia, R., Nave, R. and Ricci, T. (2008) 'Volcanic risk perception in the Vesuvius population', *Journal of Volcanology and Geothermal Research*, 172(3-4), pp. 244–258.

Barlow, D. (2002) *Anxiety and its disorders: The nature and treatment of anxiety and panic*. New York: Guilford Press.

- Barnes, L.R., Grunfest, E.C., Hayden, M.H., Schultz, D.M. and Benight, C. (2007) 'False alarms and close calls: A conceptual model of warning accuracy', *Weather and Forecasting*, 22(5), pp. 1140–1147.
- Barnett, D.J. *et al.* (2010) 'Gauging US emergency medical services workers' willingness to respond to pandemic influenza using a threat-and efficacy-based assessment framework', *PLoS ONE*, 5(3), pp. 1–10.
- Basolo, V., Steinberg, L.J. and Gant, S. (2017) 'Hurricane threat in Florida: examining household perceptions, beliefs, and actions', *Environmental Hazards*, 16(3), pp. 253–275.
- Basolo, V., Steinberg, L.J., Burby, R.J., Levine, J., Cruz, A.M. and Huang, C. (2009) 'The effects of confidence in government and information on perceived and actual preparedness for disasters', *Environment and Behavior*, 41(3), pp. 338–364.
- Baytiyeh, H. and Naja, M. (2016) 'The effects of fatalism and denial on earthquake preparedness levels', *Disaster Prevention and Management: An International Journal*, 25(2), pp. 154–167.
- Becker, J.S. *et al.* (2012) 'A model of household preparedness for earthquakes: How individuals make meaning of earthquake information and how this influences preparedness', *Natural Hazards*, 64(1), pp. 107–137.
- Becker, J.S. *et al.* (2017) 'The role of prior experience in informing and motivating earthquake preparedness', *International Journal of Disaster Risk Reduction*, 22(June 2017), pp. 179–193.
- Becker, J.S. *et al.* (2020) 'Scoping the potential for earthquake early warning in Aotearoa New Zealand: A sectoral analysis of perceived benefits and challenges', *International Journal of Disaster Risk Reduction*, 51, p. 101765.
- Becker, J.S., Paton, D., Johnston, D.M. and Ronan, K.R. (2013) 'Salient beliefs about earthquake hazards and household preparedness', *Risk Analysis*, 33(9), pp. 1710–1727.
- Begg, C. *et al.* (2017) 'Interactions between citizen responsabilization, flood experience and household resilience: insights from the 2013 flood in Germany', *International Journal of Water Resources Development*, 33(4), pp. 591–608.
- Bergkvist, L. and Rossiter, J.R. (2007) 'The predictive validity of multiple-item versus single-item measures of the same constructs', *Journal of Marketing Research*, 44(2), pp. 175–184.
- Beringer, J. (2000) 'Community fire safety at the urban/rural interface: the bushfire risk', *Fire Safety Journal*, 35(1), pp. 1–23.
- Bhagavathula, A.S. *et al.* (2020) 'Novel Coronavirus (COVID-19) Knowledge and Perceptions: A Survey on Healthcare workers', working paper, Institute of Public Health, College of Medicine and Health Sciences, UAE University, Al Ain, UAE, 16 March.

- Bodas, M. *et al.* (2015) 'Assessment of Emergency Preparedness of Households in Israel for War - Current Status', *Disaster Medicine and Public Health Preparedness*, 9(4), pp. 382–390.
- Bodas, M. *et al.* (2018) 'The Role of Victimization in Shaping Households' Preparedness for Armed Conflicts in Israel', *Disaster Medicine and Public Health Preparedness*, 12(1), pp. 67–75.
- Boholm, A. (1998) 'Comparative studies of risk perception: a review of twenty years of research', *Journal of Risk Research*, 1(2), pp. 135–163.
- Bossong, R. and Hegemann, H. (2016) 'EU internal security governance and national risk assessments: towards a common technocratic model?', *European Politics and Society*, 17(2), pp. 226–241.
- Bostrom, A., Morss, R., Lazo, J.K., Demuth, J. and Lazrus, H. (2018) 'Eyeing the storm: How residents of coastal Florida see hurricane forecasts and warnings', *International Journal of Disaster Risk Reduction*, 30, pp. 105–119.
- Botzen, W.J.W. *et al.* (2019) 'Adoption of Individual Flood Damage Mitigation Measures in New York City: An Extension of Protection Motivation Theory', *Risk Analysis*, 39(10), pp. 2143–2159.
- Bourque, L.B. (2013) 'Household Preparedness and Mitigation', *International Journal of Mass Emergencies and Disasters*, 31(3), pp. 360–372.
- Bourque, L.B. *et al.* (2013) 'An Examination of the Effect of Perceived Risk on Preparedness Behavior', *Environment and Behavior*, 45(5), pp. 615–649.
- Bradford, R.A. *et al.* (2012) 'Risk perception - Issues for flood management in Europe', *Natural Hazards and Earth System Science*, 12(7), pp. 2299–2309.
- Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 3(2), pp. 77–101.
- Braun, V. and Clarke, V. (2021) 'One size fits all? What counts as quality practice in (reflexive) thematic analysis?', *Qualitative Research in Psychology*, 18(3), pp. 328–352.
- Brody, J.C. (1984) 'Differences by sex in support for nuclear power', *Social Forces*, 63(1), pp. 209–228.
- Brown, G.D. *et al.* (2023) 'Weathering the storm: Developing a user-centric weather forecast and warning system for Ireland', *International Journal of Disaster Risk Reduction*, 91(April), p. 103687.
- Brown, G.D., Largey, A. and McMullan, C. (2021a) 'The impact of gender on risk perception: Implications for EU member states' national risk assessment processes', *International Journal of Disaster Risk Reduction*, 63(July), p. 102452.
- Brown, G.D., Largey, A. and McMullan, C. (2021b) 'The influence of expertise on perceived and actual household disaster preparedness', *Progress in Disaster Science*, 9, p. 100150.

- Brown, G.D., Largey, A., McMullan, C. and Daffy, P. (2022) 'Fire safety protection motivation and preparedness in Irish apartments: A Post-Grenfell analysis', *Safety Science*, 148, p. 105630.
- Brown, G. D., McMullan, C., Largey, A., & Leon, D. (2024). An assessment of nurses' perceived and actual household emergency preparedness. *Plos one*, 19(4), e0300536.
- Brown, G. D., Largey, A., McMullan, C., O'Shea, G., & Reilly, N. (2022). Voices from the frontline: a review of EMS first responders' experience of COVID-19 in Ireland. *International Journal of Emergency Services*, 12(1), 103-118.
- Bubeck, P. *et al.* (2020) 'Using Panel Data to Understand the Dynamics of Human Behavior in Response to Flooding', *Risk Analysis*, 40(11), pp. 2340–2359.
- Bubeck, P., Botzen, W.J., Kreibich, H. and Aerts, J.C. (2013) 'Detailed insights into the influence of flood-coping appraisals on mitigation behaviour', *Global Environmental Change*, 23(5), pp. 1327–1338.
- Bubeck, P., Botzen, W.J.W. and Aerts, J.C. (2012) 'A review of risk perceptions and other factors that influence flood mitigation behavior', *Risk Analysis: An International Journal*, 32(9), pp. 1481–1495.
- Bubeck, P., Wouter Botzen, W.J., Laudan, J., Aerts, J.C.J.H. and Thieken, A.H. (2018) 'Insights into flood-coping appraisals of protection motivation theory: Empirical evidence from Germany and France', *Risk Analysis*, 38(6), pp. 1239–1257.
- Budhathoki, N.K., Paton, D., Lassa, J.A. and Zander, K.K. (2020) 'Assessing farmers' preparedness to cope with the impacts of multiple climate change-related hazards in the Terai lowlands of Nepal', *International Journal of Disaster Risk Reduction*, 49, p. 101656.
- Burningham, K., Fielding, J. and Thrush, D. (2008) 'It'll never happen to me: understanding public awareness of local flood risk', *Disasters*, 32(2), pp. 216–238.
- Byrnes, J.P., Miller, D.C. and Schafer, W.D. (1999) 'Gender differences in risk taking: a meta-analysis', *Psychological Bulletin*, 125(3), pp. 367–383.
- Brown, G.D., Largey, A. and McMullan, C., 2021. The impact of gender on risk perception: Implications for EU member states' national risk assessment processes. *International Journal of Disaster Risk Reduction*, 63, p.102452.
- Brown, G.D., Largey, A., McMullan, C. and Daffy, P., 2022. Fire safety protection motivation and preparedness in Irish apartments: a post-Grenfell analysis. *Safety science*, 148, p.105630.
- Brown, G.D., Largey, A. and McMullan, C., 2021. The influence of expertise on perceived and actual household disaster preparedness. *Progress in Disaster Science*, 9, p.100150.
- Brown, G.D., Largey, A., McMullan, C., O'Shea, G. and Reilly, N., 2022. Voices from the frontline: a review of EMS first responders' experience of COVID-19 in Ireland. *International Journal of Emergency Services*, 12(1), pp.103-118.

- Brown, G.D., McMullan, C., Largey, A. and Leon, D., 2024. An assessment of nurses' perceived and actual household emergency preparedness. *Plos one*, 19(4), p.e0300536.
- Brown, G.D., Largey, A., McMullan, C., Reilly, N. and Sahdev, M., 2023. Weathering the storm: Developing a user-centric weather forecast and warning system for Ireland. *International journal of disaster risk reduction*, 91, p.103687.
- Cai, H. *et al.* (2020) 'Psychological Impact and Coping Strategies of Frontline Medical Staff in Hunan Between January and March 2020 During the Outbreak of Coronavirus Disease 2019 (COVID-19) in Hubei, China', *Medical Science Monitor*, 26, pp. 1–16.
- Canadian Red Cross (2022) *Be Ready: Emergency Preparedness and Recovery*, Red Cross. Available at: <https://www.redcross.ca/how-we-help/emergencies-and-disasters-in-canada/be-ready-emergency-preparedness-and-recovery/get-an-emergency-kit> (Accessed: 12 February 2022).
- Canter, D. (1990) *Fires and Human Behaviour*, 2nd Edition. David Fulton Publishers.
- Carameli, K.A. (2010) The relationship between workplace and employee household preparedness: Application of an ecological and stage-based model of behavior change. University of California, Los Angeles: ProQuest Dissertations Publishing.
- Carr, R.H., Montz, B., Semmens, K., Maxfield, K., Connolly, S., Ahnert, P., Shedd, R. and Elliott, J. (2018) 'Major risks, uncertain outcomes: Making ensemble forecasts work for multiple audiences', *Weather and Forecasting*, 33(5), pp. 1359–1373.
- Casteel, M.A. (2016) 'Communicating increased risk: An empirical investigation of the National Weather Service's impact-based warnings', *Weather, Climate, and Society*, 8(3), pp. 219–232.
- Casteel, M.A. (2018) 'An empirical assessment of impact based tornado warnings on shelter in place decisions', *International Journal of Disaster Risk Reduction*, 30, pp. 25–33.
- Central Statistics Office Ireland (2016) *Women and Men in Ireland : Health service personnel by grade category, 2016*. Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-wamii/womenandmeninireland2016/health/> (Accessed: 1 September 2016).
- Chan, E.Y.Y. *et al.* (2019) 'Is urban household emergency preparedness associated with short-term impact reduction after a super typhoon in subtropical city?', *International Journal of Environmental Research and Public Health*, 16(4), pp. 1–16.
- Chan-Yeung, M. (2004) 'Severe acute respiratory syndrome (SARS) and healthcare workers', *International Journal of Occupational and Environmental Health*, 10(4), pp. 421–427.
- Chauvin, B. (2018) 'Individual differences in the judgment of risks: Sociodemographic characteristics, cultural orientation, and level of expertise', In *Psychological Perspectives on Risk and Risk Analysis*, pp. 37–61. Springer.
- Chen, C.Y. *et al.* (2019) 'Household preparedness for emergency events: A cross-sectional survey on residents in four regions of China', *BMJ Open*, 9(11), pp. 1–9.

Cheng, V.C. *et al.* (2013) 'Clinical management and infection control of SARS: lessons learned', *Antiviral Research*, 100(2), pp. 407-419.

Chersich, M.F. *et al.* (2020) 'COVID-19 in Africa: care and protection for frontline healthcare workers', *Globalization and Health*, 16(46), pp. 1-6.

Chung, S. *et al.* (2020) 'Development of the Stress and Anxiety to Viral Epidemics-9 (SAVE-9) scale for assessing work-related stress and anxiety in healthcare workers in response to viral epidemics', working paper, Department of Psychiatry, Asan Medical Center, University of Ulsan College of Medicine, Seoul, South Korea, 10 June.

Citizens Information (2020) 'New measures to combat COVID-19 from midnight on 27 March 2020', available at: <https://whatsnew.citizensinformation.ie/2020/03/27/new-measures-to-combat-covid-19-from-midnight-on-27-march-2020> (accessed 01 November 2021).

Cohen, J. (1988) *Statistical power analysis for the behavioral sciences*, 2nd Edition. Lawrence Erlbaum Associates.

Collado-Boira, E.J. *et al.* (2020) 'The COVID-19 outbreak'—An empirical phenomenological study on perceptions and psychosocial considerations surrounding the immediate incorporation of final-year Spanish nursing and medical students into the health system', *Nurse Education Today*, 92, pp. 1-6.

Commission Staff Working Paper (2010) Risk Assessment and Mapping Guidelines for Disaster Management. Available at: https://ec.europa.eu/echo/files/about/COMM_PDF_SEC_2010_1626_F_staff_working_document_en.pdf.

Commission Staff Working Paper (2017) Overview of natural and man-made disaster risks the European Union may face. Available at: <https://op.europa.eu/en/publication-detail/-/publication/285d038f-b543-11e7-837e-01aa75ed71a1>.

Cone, D.C. and Cummings, B.A. (2006) 'Hospital disaster staffing: if you call, will they come?', *American Journal of Disaster Medicine*, 1(1), pp. 28–36.

Conlon, C. (2023) *Nursing is in crisis – how can it be resolved?* Available at: <https://www.irishexaminer.com/opinion/commentanalysis/arid-41127445.html>.

Connor, S.B. (2014) 'Factors Associated with the Intention of Health Care Personnel to Respond to a Disaster', *Prehospital and Disaster Medicine*, 29(6), pp. 555–560.

Considine, J. and Mitchell, B. (2009) 'Chemical, biological and radiological incidents: Preparedness and perceptions of emergency nurses', *Disasters*, 33(3), pp. 482–497.

Cooper, S. *et al.* (2020) 'Cochrane corner: factors that influence compliance by healthcare workers with infection prevention and control guidelines for COVID-19 and other respiratory infections', *The Pan African Medical Journal*, 35(23), pp. 2–4.

Cope, M.R. *et al.* (2018) 'Geographically distant social networks elevate perceived preparedness for coastal environmental threats', *Population and Environment*, 39(3), pp. 277–296.

Corwin, K.A. *et al.* (2017) 'Household preparedness motivation in lahar hazard zones: assessing the adoption of preparedness behaviors among laypeople and response professionals in communities downstream from Mount Baker and Glacier Peak (USA) volcanoes', *Journal of Applied Volcanology*, 6(1), pp. 1–19.

Council Decision 1313/2013/EU of the European Parliament and of the Council of 17 December 2013 on a Union Civil Protection Mechanism.

Craighead, G. (2009) *High-rise security and fire life safety*, 3rd Edition. Butterworth-Heinemann.

Creswell, J.W. and Plano Clark, V.L. (2011) 'Choosing a mixed methods design', in Creswell, J.W. and Plano Clark, V.L. (eds) *Designing and conducting mixed methods research*. Sage Publications, pp.53-106.

CSO (2016a) Census 2016 Summary Results - Part 1. Available at: <https://www.cso.ie/en/media/csoie/newsevents/documents/census2016summaryresultspart1/Census2016SummaryPart1.pdf> (Accessed: 3 June 2019).

CSO (2016b) Census of Population 2016 - Profile 1 Housing in Ireland. Available at: <https://www.cso.ie/en/csolatestnews/pressreleases/2017pressreleases/presstatementcensus2016resultsprofile1-housinginireland/>.

CSO (2016c) Geographical Profiles of Income in Ireland 2016. Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-gpii/geographicalprofilesincomeinireland2016/incomeinireland/> (Accessed: 3 June 2019).

CSO (2016d) Census of Population 2016 - Profile 3 An Age Profile of Ireland. Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-cp3oy/cp3/agr/>.

CSO (2016e) Census of Population 2016 – Profile 8 Irish Travellers, Ethnicity and Religion. Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-cp8iter/p8iter/p8e/>.

CSO (2018) *Information Society Statistics - Households*. Available at: <https://www.cso.ie/en/releasesandpublications/er/isshh/informationstistics-households2018/> (Accessed: 31 August 2018).

CSO (2019) *Urban and Rural Life in Ireland*. Available at: <https://www.cso.ie/en/releasesandpublications/ep/p-urli/urbanandrurallifeinireland2019/> (Accessed: 20 December 2019).

CSO, 2019. Urban and Rural Life in Ireland. Central Statistics Office, 12 March 2021, <https://www.cso.ie/en/releasesandpublications/ep/p-urli/urbanandrurallifeinireland2019/introduction/#d.en.211130>

Damery, S. *et al.* (2010) 'Healthcare workers' perceptions of the duty to work during an influenza pandemic', *Journal of Medical Ethics*, 36, pp. 12–18.

Daniel, J. (2012) 'Choosing between taking a census and sampling'. In: *Sampling essentials: Practical guidelines for making sampling choices*, pp. 23-65. SAGE Publications.

Darker, C. (2013) 'Risk Perception'. In: Gellman, M.D. and Turner, J.R. (eds.) *Encyclopedia of Behavioral Medicine*. Springer New York, New York, NY, pp. 1689–1691.

DeBastiani, S.D. *et al.* (2015) 'Preparedness Perceptions, Sociodemographic Characteristics, and Level of Household Preparedness for Public Health Emergencies: Behavioral Risk Factor Surveillance System, 2006-2010', *Health security*, 13(5), pp. 317–326.

Delgado, D. *et al.* (2020) 'Personal safety during the covid-19 pandemic: Realities and perspectives of healthcare workers in latin America', *International Journal of Environmental Research and Public Health*, 17(8), pp. 1–8.

Department of Homeland Security (2018) Make A Plan. Available at: <https://www.ready.gov/make-a-plan>.

Department of Housing, Planning and Local Government (2015) Fire Safety Week. Available at: <http://firesafetyweek.ie/aboutus/en>.

Der-Martirosian, C., Balut, M.D. and Dobalian, A. (2022) 'Household Preparedness and Perceptions of Workforce Preparedness During Pandemics : A Health Care Employee Survey at the US Department of Veterans Affairs', *Disaster Medicine and Public Health Preparedness*, 16, pp. 1953–1958.

DeSimone, C.L. (2009) 'Response of Public Health Workers to Various Emergencies', *AAOHN Journal*, 57(1), pp. 17–23.

DeYoung, S. and Peters, M. (2016) 'My community, my preparedness: The role of sense of place, community, and confidence in government in disaster readiness', *International Journal of Mass Emergencies and Disasters*, 34(2), pp. 250–282.

DeYoung, S.E. *et al.* (2019) 'Disaster preparedness and well-being among Cambodian– and Laotian–Americans', *Disaster Prevention and Management: An International Journal* 29(4), pp.425-443.

DeYoung, S.E., Sutton, J.N., Farmer, A.K., Neal, D. and Nichols, K.A., 2019. "Death was not in the agenda for the day": Emotions, behavioral reactions, and perceptions in response to the 2018 Hawaii Wireless Emergency Alert. *International Journal of Disaster Risk Reduction*, 36, p.101078.

Dillenardt, L., Hudson, P. and Thieken, A.H. (2021) 'Urban pluvial flood adaptation: Results of a household survey across four German municipalities', *Journal of Flood Risk Management*, (September 2020), pp. 1–15.

Dimaggio, C. *et al.* (2005) 'The Willingness of U.S. Emergency Medical Technicians to Respond to Terrorist Incidents', *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*, 3(4), pp. 331–337. Available at: <https://www.liebertpub.com/doi/abs/10.1089/bsp.2005.3.331> (Accessed: 21 February 2020).

Dittrich, R. *et al.* (2016) 'The impact of flood action groups on the uptake of flood management measures', *Climatic Change*, 138(3–4), pp. 471–489.

- Dittrich, R., Wreford, A., Butler, A. and Moran, D., 2016. The impact of flood action groups on the uptake of flood management measures. *Climatic Change*, 138(3), pp.471-489.
- Dobalian, A., Balut, M.D. and Der-Martirosian, C. (2020) 'Workforce preparedness for disasters: Perceptions of clinical and non-clinical staff at the U.S. Department of Veterans Affairs', *BMC Public Health*, 20(1501), pp. 1–9.
- Donahue, A.K., Eckel, C.C. and Wilson, R.K. (2014) 'Ready or Not? How Citizens and Public Officials Perceive Risk and Preparedness', *American Review of Public Administration*, 44(4S), pp. 89S –111S.
- Donner, W. and Rodríguez, H. (2008) 'Population composition, migration and inequality: The influence of demographic changes on disaster risk and vulnerability', *Social Forces*, 87(2), pp. 1089–1114.
- Donner, W.R. and Lavariega-Montforti, J. (2018) 'Ethnicity, income, and disaster preparedness in Deep South Texas, United States', *Disasters*, 42(4), pp. 719–733.
- Efthymiou, M., Whiston, S., O'Connell, J.F. and Brown, G.D., 2021. Flight crew evaluation of the flight time limitations regulation. *Case Studies on Transport Policy*, 9(1), pp.280-290.
- Ejeta, L.T. *et al.* (2016) 'Predictors of community preparedness for flood in Dire-Dawa town, Eastern Ethiopia: Applying adapted version of Health Belief Model', *International Journal of Disaster Risk Reduction*, 19(October 2016), pp. 341–354.
- Ejeta, L.T. *et al.* (2018) 'Emotional and cognitive factors influencing flood preparedness in Dire Dawa town, Ethiopia', *Natural Hazards*, 93(2), pp. 715–737.
- Espina, E. and Teng-calleja, M. (2015) 'A Social Cognitive Approach to Disaster Preparedness', *Philippine Journal of Psychology*, 48(2), pp. 161–174. Available at: https://www.pap.org.ph/includes/view/default/uploads/pjp-journals/PJP1502_Final_7Espina_and_Calleja.pdf.
- Extra, 2021. The seven funniest Irish weather moments in 10 years, DMG Ireland, 12 January 2022, <https://extra.ie/2021/01/09/must-see/funniest-irish-weather-moments-10-years>
- Fearnley, C. and Kelman, I. (2021) 'Enhancing Warnings', (December). Available at: <https://nationalpreparednesscommission.uk/2022/01/enhancing-warnings/>.
- Fearnley, C.J., 2011. Standardising the USGS volcano alert level system: acting in the context of risk, uncertainty and complexity. Doctoral dissertation, University College London. <https://discovery.ucl.ac.uk/id/eprint/1301994/>
- FEMA (2007) *Ready Responder: Emergency planning for first responders and their families*, *Ready.gov*. Available at: <https://www.ready.gov/sites/default/files/documents/files/RRToolkit.pdf> (Accessed: 26 July 2017).
- FEMA (2014) Citizen Corps Survey Database. Federal Emergency Management Agency. Available at: <https://www.fema.gov/media-library-data/1416321907704->

7ae359d3c1af32f3c8ef628c59643a03/20141007_Citizen_Corps_Survey_Database_Update_Fall_2014_508.pdf.

FEMA (2015) *National Household Survey (2015)*. Available at: https://www.fema.gov/media-library-data/1467116407881-096f834e638f02fa8499941ce5c155bb/national_household_survey_2015_508_062716_508.pdf.

FEMA (2016) *Preparedness Checklists & Toolkits*. Available at: <https://www.fema.gov/preparedness-checklists-toolkits> (Accessed: 1 October 2016).

FEMA (2017) *Ready Responder: Emergency planning for first responders and their families*. Available at: <https://www.ready.gov/sites/default/files/documents/files/RRToolkit.pdf> (Accessed: 26 July 2017).

FEMA (2020) *Are you ready? An In-depth Guide to Citizen Preparedness, Ready.gov*. Available at: <https://www.ready.gov/collection/are-you-ready>.

Finucane, M.L., Slovic, P., Mertz, C.K., Flynn, J. and Satterfield, T.A. (2000) 'Gender, race, and perceived risk: The 'White Male' Effect', *Health, Risk & Society*, 2(2), pp. 159–172.

Fire Services Act (1981) Number 30 of 1981. Available at: <http://www.irishstatutebook.ie/eli/1981/act/30/section/18/enacted/en/html#sec18>.

Fishbein, M. and Ajzen, I. (2010) *Predicting and Changing Behavior: The Reasoned Action Approach*. Taylor & Francis, New York, NY.

Flynn, J., Slovic, P. and Mertz, C.K. (1994) 'Gender, race, and perception of environmental health risks', *Risk Analysis*, 14(6), pp. 1101–1108.

Fraustino, J.D. and Ma, L., 2015. CDC's use of social media and humor in a risk campaign—"Preparedness 101: Zombie Apocalypse". *Journal of Applied Communication Research*, 43(2), pp.222-241.

French, E.D., Sole, M. Lou and Byers, J.F. (2002) 'A comparison of nurses' needs/concerns and hospital disaster plans following Florida's hurricane Floyd', *Journal of Emergency Nursing*, 28(2), pp. 111–117.

Gan, W.H. *et al.* (2020) 'Preventing intra-hospital infection and transmission of coronavirus disease 2019 in health-care workers', *Safety and Health at Work*, 11(2), pp. 241–243.

Gardoni, P. and Murphy, C. (2014) 'A scale of risk', *Risk Analysis*, 34(7), pp. 1208–1227.

Gebrehiwot, T. and van der Veen, A. (2015) 'Farmers Prone to Drought Risk: Why Some Farmers Undertake Farm-Level Risk-Reduction Measures While Others Not?', *Environmental Management*, 55(3), pp. 588–602.

- Gershon, R.R.M. *et al.* (2010) 'Factors associated with the ability and willingness of essential workers to report To duty during a pandemic', *Journal of Occupational and Environmental Medicine*, 52(10), pp. 995–1003.
- Gigerenzer, G., Hertwig, R., Van Den Broek, E., Fasolo, B. and Katsikopoulos, K.V., 2005. "A 30% chance of rain tomorrow": How does the public understand probabilistic weather forecasts?. *Risk Analysis: An International Journal*, 25(3), pp.623-629.
- Girgin, S., Necci, A. and Krausmann, E. (2019) 'Dealing with cascading multi-hazard risks in national risk assessment: the case of Natech accidents', *International Journal of Disaster Risk Reduction*, 35, 101072.
- Glaubergerman, G. and Qureshi, K. (2018) 'Exploratory Qualitative Study of Fire Preparedness Among High-rise Building Residents', *PLoS. Currents*, 1(10).
- Glaubergerman, G. and Qureshi, K. (2021) 'Community/Public Health Nurses' Awareness of Residential High-Rise Fire Safety issues', *SAGE Open Nursing*, 7, pp. 1–9.
- Goodhue, C.J. *et al.* (2012) 'Willingness to Respond in a Disaster: A Pediatric Nurse Practitioner National Survey', *Journal of Pediatric Health Care*, 26(4), pp. e7–e20.
- Gough, A., Hunter, R.F., Ajao, O., Jurek, A., McKeown, G., Hong, J., Barrett, E., Ferguson, M., McElwee, G., McCarthy, M. and Kee, F., 2017. Tweet for behavior change: using social media for the dissemination of public health messages. *JMIR Public Health and Surveillance*, 3(1), p.e6313.
- Grimes, D.E. and Mendias, E.P. (2010) 'Nurses' intentions to respond to bioterrorism and other infectious disease emergencies', *Nursing Outlook*, 58(1), pp. 10–16.
- Grothmann, T. and Reusswig, F. (2006) 'People at risk of flooding: Why some residents take precautionary action while others do not', *Natural Hazards*, 38(1–2), pp. 101–120.
- Gudi, S.K. and Tiwari, K.K. (2020) 'Preparedness and lessons learned from the novel coronavirus disease', *The International Journal of Occupational and Environmental Medicine*, 11(2), pp. 108-112.
- Gumasing, M.J.J. *et al.* (2022) 'Determination of factors affecting the response efficacy of Filipinos under Typhoon Conson 2021 (Jolina): An extended protection motivation theory approach', *International Journal of Disaster Risk Reduction*, 70(October 2021), p. 102759.
- Gustafsod, P.E. (1998) 'Gender Differences in risk perception: Theoretical and methodological perspectives', *Risk Analysis*, 18(6), pp. 805–811.
- Han, Z. *et al.* (2017) 'The effects of trust in government on earthquake survivors' risk perception and preparedness in China', *Natural Hazards*, 86(1), pp. 437–452.
- Handmer, J. and Proudley, B., 2007. Communicating uncertainty via probabilities: The case of weather forecasts. *Environmental Hazards*, 7(2), pp.79-87.

- Hasnain, M. *et al.* (2020) 'A narrative review on the role and safety challenges of frontline medical staff and emerging technologies during COVID-19 pandemic', working paper, School of IT, Monash University, Malaysia, 14 May.
- Hedlund, J. (2000) 'Risky business: Safety regulations, risk compensation, and individual behavior', *Injury Prevention*, 6, pp. 82–89.
- Heidenreich, A., Masson, T. and Bamberg, S. (2020) 'Let's talk about flood risk – Evaluating a series of workshops on private flood protection', *International Journal of Disaster Risk Reduction*, 50(August), p. 101880.
- Henly-Shepard, S. *et al.* (2015) 'Quantifying household social resilience: a place-based approach in a rapidly transforming community', *Natural Hazards*, 75(1), pp. 343–363.
- Hillman, M. and Adams, J. (2001) 'The risk compensation theory and bicycle helmets', *Injury Prevention*, 7, pp. 89–91.
- Hoffmann, R. and Muttarak, R. (2017) 'Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand', *World Development*, 69(August 2017), pp. 32–51.
- Housing (Standards for Rented Houses) Regulations (2017) S.I. No. 17/2017. Available at: <http://www.irishstatutebook.ie/eli/2017/si/17/made/en/print>.
- HSE (2016) *Our People/Our Workforce - Public Health Service - 2016*. Available at: <https://paycommission.gov.ie/wp-content/uploads/Our-People-Our-Workforce-December-2016-.pdf>.
- Hu, D. *et al.* (2020) 'Frontline nurses' burnout, anxiety, depression, and fear statuses and their associated factors during the COVID-19 outbreak in Wuhan, China: A large-scale cross-sectional study', *EClinicalMedicine*, 24, pp. 1-10.
- Hu, S.Y., Yu, M., Que, T., Fan, G. and Xing, H.G., (2021) 'Individual willingness to prepare for disasters in a geological hazard risk area: an empirical study based on the protection motivation theory', *Natural Hazards* [Preprint], 24, pp.1-25.
- Huang, M., Wang, H., Wang, G., Liu, Z. and Hu, S. (2020) 'Factors associated with mental health outcomes among health care workers exposed to coronavirus disease 2019', *JAMA Network Open*, 3(3), pp. 1-12.
- Hudson, P., Hagedoorn, L. and Bubeck, P. (2020) 'Potential Linkages Between Social Capital, Flood Risk Perceptions, and Self-Efficacy', *International Journal of Disaster Risk Science*, 11(3), pp. 251–262.
- Hulse, L.M., Galea, E.R., Thompson, O.F. and Wales, D. (2020) 'Perception and recollection of fire hazards in dwelling fires', *Safety Science*, 122, 104518.
- Hung, L.S. (2019) 'Comparing spousal agreement on perceived responsibility for household natural hazard preparedness to actual behavior', *PLoS ONE*, 14(8), pp. 1–19.
- Hutchison, K. (2017) *Modifiable Factors Impeding Nurses' Willingness to Report in a Disaster*. University of Arkansas. Available at: <https://scholarworks.uark.edu/nursuht> (Accessed: 21 February 2020).

Huynh, G. *et al.* (2020) 'Knowledge and attitude toward COVID-19 among healthcare workers at District 2 Hospital, Ho Chi Minh City', *Asian Pacific Journal of Tropical Medicine*, 13(6), pp. 260-265.

IFRC and UK Met Office. 2020. The Future of Forecasts: Impact-based Forecasting for Early Action. Accessed 19th April 2022. <https://www.forecast-based-financing.org/wp-content/uploads/2020/09/Impact-based-forecasting-guide-2020.pdf>

Independent (2018a) *Shoppers clear supermarket shelves ahead of Storm Emma*. Available at: <https://www.independent.ie/weather/shoppers-clear-supermarket-shelves-ahead-of-storm-emma-36645679.html> (Accessed: 20 March 2018).

Independent (2018b) *Status Red: Just hours until nationwide lockdown as Taoiseach warns people not to underestimate Storm Emma*. Available at: <https://www.independent.ie/irish-news/storm-emma/status-red-just-hours-until-nationwide-lockdown-as-taoiseach-warns-people-not-to-underestimate-storm-emma-36656471.html> (Accessed: 20 March 2018).

Independent (2022) *Damning UHL inspection report finds 116-hour wait times and patients at risk of harm*. Available at: <https://www.independent.ie/irish-news/health/damning-uhl-inspection-report-finds-116-hour-wait-times-and-patients-at-risk-of-harm-41763855.html> (Accessed: 28 June 2022).

Ipsos (2017) *Social Networking - Nov 17*.

Irish Times (2018) *Empty shelves point to fragility in our food supply*. Available at: <https://www.irishtimes.com/news/consumer/empty-shelves-point-to-fragility-in-our-food-supply-1.3426844> (Accessed: 20 March 2018).

ISO 31000:2018. Risk Management—Principles and Guidelines. Available at: <https://www.iso.org/iso-31000-risk-management.html>.

ISO 31010:2019. Risk Management - Risk assessment techniques. Available at: <https://www.iso.org/standard/72140.html>.

Ives, J. *et al.* (2009) 'Healthcare workers' attitudes to working during pandemic influenza: A qualitative study', *BMC Public Health*, 9(56), pp. 1–13.

Jacobson, H.E. *et al.* (2010) 'Self-assessed emergency readiness and training needs of nurses in rural Texas', *Public Health Nursing*, 27(1), pp. 41–48.

Jang, L.J. *et al.* (2016) 'Cross-cultural comparisons between the earthquake preparedness models of Taiwan and New Zealand', *Disasters*, 40(2), pp. 327–345.

Jansen, J. and Van Schaik, P. (2017) 'Comparing three models to explain precautionary online behavioural intentions', *Information & Computer Security*, 25(2), pp. 165–180.

Jansen, P.C.P., Snijders, C.C.P. and Willemsen, M.C. (2021) 'Determinants of Domestic Risk Prevention Behavior: The Importance of Separating Effects Within-Persons and Between-Persons', *Risk Analysis*, 41(6), pp. 929–943.

- Jassempour, K. *et al.* (2014) 'The impact of educational intervention for providing disaster survival kit: Applying precaution adoption process model', *International Journal of Disaster Risk Reduction*, 10(December 2014), pp. 374–380.
- Jin, Y.H. *et al.* (2020) 'Perceived infection transmission routes, infection control practices, psychosocial changes, and management of COVID-19 infected healthcare workers in a tertiary acute care hospital in Wuhan: a cross-sectional survey', *Military Medical Research*, 7(1), pp. 1-13.
- Joffe, H. *et al.* (2016) 'How to increase earthquake and home fire preparedness: the fix-it intervention', *Natural Hazards*, 84(3), pp. 1943–1965.
- Joslyn, S. and Savelli, S., 2010. Communicating forecast uncertainty: Public perception of weather forecast uncertainty. *Meteorological Applications*, 17(2), pp.180-195.
- Kaltenberger, R., Schaffhauser, A. and Staudinger, M., 2020. "What the weather will do"—results of a survey on impact-oriented and impact-based warnings in European NMHSs. *Advances in Science and Research*, 17, pp.29-38.
- Kapucu, N. (2008) 'Culture of preparedness: Household disaster preparedness', *Disaster Prevention and Management: An International Journal*, 17(4), pp. 526–535.
- Kellens, W., Terpstra, T. and De Maeyer, P. (2013) 'Perception and communication of flood risks: a systematic review of empirical research', *Risk Analysis: An International Journal*, 33(1), pp. 24–49.
- Kellens, W., Zaalberg, R., Neutens, T., Vanneuville, W. and De Maeyer, P. (2011) 'An analysis of the public perception of flood risk on the Belgian coast', *Risk Analysis*, 31(7), pp. 1055–1068.
- Kelly, B. and Ronan, K.R. (2018) 'Preparedness for natural hazards: Testing an expanded education- and engagement-enhanced social cognitive model', *Natural Hazards*, 91(1), pp. 19–35.
- Kelman, I., & Glantz, M. H. 2014. Early Warning Systems Defined. In: Singh, A., Zommers, Z. (eds) *Reducing Disaster: Early Warning Systems For Climate Change*, 89–108 pp.
- Kelman, I., Ahmed, B., Esraz-Ul-Zannat, M., Saroar, M.M., Fordham, M. and Shamsudduha, M., 2018. Warning systems as social processes for Bangladesh cyclones. *Disaster Prevention and Management: An International Journal*, 27, 370–379.
- Kerstholt, J., Duijnhoven, H. and Paton, D. (2017) 'Flooding in The Netherlands: How people's interpretation of personal, social and institutional resources influence flooding preparedness', *International Journal of Disaster Risk Reduction*, 24(September 2017), pp. 52–57.
- Key, T. *et al.* (2020) 'Personal protective equipment during the COVID-19 crisis: a snapshot and recommendations from the frontline of a university teaching hospital', *Bone & Joint Open*, 1(5), pp. 131-136.

- Kievik, M. and Gutteling, J.M. (2011) 'Yes, we can: Motivate Dutch citizens to engage in self-protective behavior with regard to flood risks', *Natural Hazards*, 59(3), pp. 1475–1490.
- Kinateder, M.T., Kuligowski, E.D., Reneke, P.A. and Peacock, R.D. (2014) 'A Review of Risk Perception in Building Fire Evacuation', *NIST Technical Note 1840*.
- Kinateder, M.T., Kuligowski, E.D., Reneke, P.A. and Peacock, R.D. (2015) 'Risk perception in fire evacuation behavior revisited: definitions, related concepts, and empirical evidence', *Fire Science Reviews*, 4(1), 1–26.
- Kirschenbaum, A. (2002) 'Disaster preparedness: A conceptual and empirical re-evaluation', *International Journal of Mass Emergencies and Disasters*, 20(1), pp. 5–28.
- Kirschenbaum, A. (2004) 'Generic sources of disaster communities: A social network approach', *International Journal of Sociology and Social Policy*, 24(10–11), pp. 94–129.
- Kirschenbaum, A. (2005) 'Preparing For The Inevitable: Environmental Risk Perceptions and Disaster Preparedness', *International Journal of Mass Emergencies and Disasters*, 23(2), pp. 97–127.
- Kirschenbaum, A. (2006) 'Families and Disaster Behavior: A Reassessment of Family Preparedness Alan', *International Journal of Mass Emergencies and Disasters*, 24(1), pp. 111–143.
- Kirschenbaum, A.A., Rapaport, C. and Canetti, D. (2017) 'The impact of information sources on earthquake preparedness', *International Journal of Disaster Risk Reduction*, 21, pp. 99–109.
- Knuth, D., Kehl, D., Hulse, L., Spangenberg, L., Brähler, E. and Schmidt, S. (2015) 'Risk perception and emergency experience: comparing a representative German sample with German emergency survivors', *Journal of Risk Research*, 18(5), pp. 581–601.
- Knuth, D., Schulz, S., Kietzmann, D., Stumpf, K. and Schmidt, S. (2017) 'Better safe than sorry-emergency knowledge and preparedness in the German population', *Fire Safety Journal*, 93, pp. 98–101.
- Kobes, M., Helsloot, I., De Vries, B. and Post, J.G. (2010) 'Building safety and human behaviour in fire: A literature review', *Fire Safety Journal*, 45(1), pp. 1–11.
- Koh, D. et al. (2005) 'Risk perception and impact of severe acute respiratory syndrome (SARS) on work and personal lives of healthcare workers in Singapore: What can we learn?', *Medical Care*, 43(7), pp. 676–682.
- Kohn, S. et al. (2012) 'Personal disaster preparedness: An integrative review of the literature', *Disaster Medicine and Public Health Preparedness*, 6(3), pp. 217–231.
- Kox, T., Gerhold, L. and Ulbrich, U., 2015. Perception and use of uncertainty in severe weather warnings by emergency services in Germany. *Atmospheric Research*, 158, pp.292-301.

- Kox, T., Kempf, H., Lüder, C., Hagedorn, R. and Gerhold, L., 2018. Towards user-orientated weather warnings. *International Journal of Disaster Risk Reduction*, 30, pp.74-80.
- Krippendorff, K. (2018) *Content Analysis: An Introduction to Its Methodology*. 4th edn. London: SAGE Publications.
- Kruger, J. *et al.* (2018) 'Attitudes, Motivators, and Barriers to Emergency Preparedness Using the 2016 Styles Survey', *Health Promotion Practice*, Vol. XX(No. (X)), pp. 1–9.
- Kung, Y.W. and Chen, S.H. (2012) 'Perception of earthquake risk in Taiwan: Effects of gender and past earthquake experience', *Risk Analysis*, 32(9), pp. 1535–1546.
- Kurata, Y.B. *et al.* (2022) 'Factors affecting perceived effectiveness of Typhoon Vamco (Ulysses) flood disaster response among Filipinos in Luzon, Philippines: An integration of protection motivation theory and extended theory of planned behavior', *International Journal of Disaster Risk Reduction*, 67(October 2021), p. 102670.
- Kyne, D. *et al.* (2020) 'Empirical evaluation of disaster preparedness for hurricanes in the Rio Grande Valley', *Progress in Disaster Science*, 5(January 2020), p. 100061.
- Labrague, L.J. *et al.* (2018) 'Disaster preparedness among nurses: a systematic review of literature', *International Nursing Review*, 65(1), pp. 41–53.
- Landahl, M. and Cox, C. (2009) 'Beyond the Plan: Individual Responder and Family Preparedness in the Resilient Organization', *Homeland Security Affairs*, 5(3), pp. 1–22.
- Lechowska, E. (2018) 'What determines flood risk perception? A review of factors of flood risk perception and relations between its basic elements', *Natural Hazards*, 94(3), pp. 1341–1366.
- LeClerc, J. and Joslyn, S., 2015. The cry wolf effect and weather-related decision making. *Risk Analysis*, 35(3), pp.385-395.
- Levac, J., Toal-Sullivan, D. and O'Sullivan, T.L. (2012) 'Household emergency preparedness: A literature review', *Journal of Community Health*, 37(3), pp. 725–733.
- Levym, D.T. and Miller, T. (2000) 'Review: Risk Compensation Literature — The Theory and Evidence', *Journal of Crash Prevention and Injury Control*, 2(1), pp. 75–86.
- Liddell, T.M. and Kruschke, J.K. (2018) 'Analyzing ordinal data with metric models : What could possibly go wrong ?', *Journal of Experimental Social Psychology*, 79(November 2018), pp. 328–348.
- Lin, L. (2018) 'Integrating a national risk assessment into a disaster risk management system: Process and practice', *International Journal of Disaster Risk Reduction*, 27, pp. 625–631.
- Lincoln, Y.S. and Guba, E.G. (1985) *Naturalistic inquiry*. Sage, USA.
- Lindell, K.M. and Hwang, S.N. (2008) 'Households' Perceived Personal Risk and Responses in a Multi-hazard Environment', *Risk Analysis*, 28(2), pp. 539–556.

- Lindell, M. K. (1994) 'Perceived characteristics of environmental hazards.pdf', *Internal Journal of Mass Emergencies and Disasters*, pp. 303–326.
- Lindell, M.K. and Perry, R.W. (2000) 'Household adjustment to earthquake hazard: A review of research', *Environment and Behavior*, 32(4), pp. 461–501.
- Lindell, M.K. and Whitney, D.J. (2000) 'Correlates of household seismic hazard adjustment adoption', *Risk Analysis*, 20(1), pp. 13–25.
- Longo, B.M. (2022) 'Earthquake Preparedness and Knowledge of Recommended Self-Protective Actions: A Survey of Nursing Students', *Disaster Medicine and Public Health Preparedness*, 16(2), pp. 495–499.
- Losee, J.E. and Joslyn, S., 2018. The need to trust: How features of the forecasted weather influence forecast trust. *International Journal of Disaster Risk Reduction*, 30, pp.95-104.
- Loster, T., 2012. From the Last Mile to the First: Risk Awareness is the Key. In: Edenhofer O, Wallacher J, Lotze-Campen H, Reder M, Knopf B, Müller J (eds) *Climate Change, Justice and Sustainability*, 239–246.
- Lujala, P., Lein, H. and Rød, J.K. (2015) 'Climate change, natural hazards, and risk perception: the role of proximity and personal experience', *Local Environment*, 20(4), pp. 489–509.
- Lusher, J. *et al.* (2020) 'COVID-19: psychological support for healthcare workers during and after the pandemic'. Available at: <https://rcni.com/nursing-management/opinion/comment/covid-19-psychological-support-healthcare-workers-during-and-after-pandemic-160991> (Accessed: 23 May 2020).
- Mabuku, M.P. *et al.* (2018) 'Rural households' flood preparedness and social determinants in Mwandi district of Zambia and Eastern Zambezi Region of Namibia', *International Journal of Disaster Risk Reduction*, 28(June 2018), pp. 284–297.
- Maddux, J.E., 1993. Social cognitive models of health and exercise behavior: An introduction and review of conceptual issues. *Journal of Applied Sport Psychology*, 5(2), pp.116-140.
- Maddux, J.E. and Rogers, R.W. (1983) 'Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change', *Journal of Experimental Social Psychology*, 19(5), pp. 469–479.
- Makama, J.G., Joshua, I.A. and Makama, E.J. (2016) 'Family emergency plan and preparedness among medical practitioners in Zaria, Nigeria', *Journal of Emergency Management*, 14(6), pp. 423–430.
- Martin, I.M., Bender, H. and Raish, C. (2007) 'What motivates individuals to protect themselves from risks: the case of wildland fires', *Risk Analysis: An International Journal*, 27(4), pp. 887–900.
- Martin, S.D. (2011) 'Nurses' ability and willingness to work during pandemic flu', *Journal of Nursing Management*, 19(1), pp. 98–108.

- Masterson, L. *et al.* (2009) 'Willingness to Respond: Of Emergency Department Personnel and Their Predicted Participation in Mass Casualty Terrorist Events', *Journal of Emergency Medicine*, 36(1), pp. 43–49.
- Maunder, R. (2004) 'The experience of the 2003 SARS outbreak as a traumatic stress among frontline healthcare workers in Toronto: Lessons learned', *Philosophical Transactions of the Royal Society B: Biological Sciences*, 359(1447), pp. 1117–1125.
- Mayhorn, C.B. and McLaughlin, A.C., 2014. Warning the world of extreme events: A global perspective on risk communication for natural and technological disaster. *Safety Science*, 61, pp.43-50.
- McCaffrey, S. (2008) 'Understanding public perspectives of wildfire risk'. In: *Wildfire Risk: Human Perceptions and Management Implications*. Resources for the Future, Washington, DC, pp. 11–22.
- McCaffrey, S.M., Stidham, M., Toman, E. and Shindler, B. (2011) 'Outreach programs, peer pressure, and common sense: what motivates homeowners to mitigate wildfire risk?', *Environmental Management*, 48(3), pp. 475–488.
- McCaughey, J.W. *et al.* (2017) 'Trust and distrust of tsunami vertical evacuation buildings: Extending protection motivation theory to examine choices under social influence', *International Journal of Disaster Risk Reduction*, 24(June), pp. 462–473.
- McGee, T.K., McFarlane, B.L. and Varghese, J. (2009) 'An examination of the influence of hazard experience on wildfire risk perceptions and adoption of mitigation measures', *Society and Natural Resources*, 22(4), pp. 308–323.
- McLennan, J., Elliott, G., Omodei, M. and Whittaker, J. (2013) 'Householders' safety-related decisions, plans, actions and outcomes during the 7th February 2009 Victorian (Australia) wildfires', *Fire Safety Journal*, 61, pp. 175–184.
- McLennan, J., Paton, D. and Beatson, R. (2015) 'Psychological differences between south-eastern Australian householders ' who intend to leave if threatened by a wildfire and those who intend to stay and defend', *International Journal of Disaster Risk Reduction*, 11(March 2015), pp. 35–46.
- McMullan, C., Largey, A., Brown, G.D. and O'Shea, G., 2020. 'LISTEN: Capturing learning from the frontline response to COVID-19'.
<https://doras.dcu.ie/25156/1/DCU%20LISTEN%20Research%20Report.pdf>
- McMullan, C., Largey, A., Brown, G., Reilly, N. and Sahdev, M., 2021. 'Shaping the future of weather & climate services in Ireland: a public perspective'.
<https://doras.dcu.ie/28312/1/Shaping%20the%20Future%20of%20Weather%20%26%20Climate%20Services%20In%20Ireland%20A%20Public%20Perspective.pdf>
- McMullan, C. (2010) 'Emergency Management in the Republic of Ireland: A rising tide has lifted all boats'. Comparison Emergency Management Book Project, FEMA.
https://www.researchgate.net/publication/380105108_Emergency_Management_in_the_Republic_of_Ireland_A_rising_tide_has_lifted_all_boats
- McMullan, C., Reilly, N., Largey, A., and Brown, G. (2024) 'Scanning for Impact Integrating Effective Risk Horizon Scanning & Emergent Risk Forecasting into

Ireland's National Risk Assessment'. <https://assets.gov.ie/289060/6d2296be-afc4-4fb6-8d04-f3ca1ab8dea1.pdf>

McMullan, C., Brown, G.D., Tully, E. and Craven, T., 2018, February. Methodology, process & outcomes: delivering the national risk assessment 2017. In *EMII Research Symposium: Risk Management in Ireland*. Available at: http://doras.dcu.ie/22263/1/EMII_Research_Symposium_Feb_2018.pdf (Accessed: 8 March 2018).

McMullan, C. and Brown, G.D., 2015. Current Practice In Postgraduate Emergency Management Education. *Emergency Management*, 2(2), p.45.

McMullan, C., Brown, G.D. and Largey, A. (2015) 'Risk Preparedness: An Individual and Household Perspective', *Major Emergency Management National Conference*, Athlone, Ireland.

McMullan, C., Brown, G.D. and O'Sullivan, D. (2016) 'Preparing to respond: Irish nurses' perceptions of preparedness for an influenza pandemic', *International Emergency Nursing*, 26(May 2016), pp. 3–7.

McMullan, C., Largey A., and Brown G.D., 2020. Weather & climate-related risk perception and household preparedness, Accessed 12th February 2023 <http://doras.dcu.ie/26063/>

McNeill, C. *et al.* (2020) 'Characterization of nurses' duty to care and willingness to report', *Nursing Ethics*, 27(2), pp. 348–359.

McNeill, I.M. *et al.* (2013) 'Expecting the unexpected: Predicting physiological and psychological wildfire preparedness from perceived risk, responsibility, and obstacles', *Risk Analysis*, 33(10), pp. 1829–1843.

MEM 2006. A framework for major emergency management, Accessed 5th June 2024 <https://www.gov.ie/en/collection/ca182-a-framework-for-major-emergency-management/>

Melnikov, S., Itzhaki, M. and Kagan, I. (2014) 'Israeli Nurses' intention to report for work in an emergency or disaster', *Journal of Nursing Scholarship*, 46(2), pp. 134–142.

Mercer, M.P. *et al.* (2014) 'Ready or not: does household preparedness prevent absenteeism among emergency department staff during a disaster?', *Am J Disaster Med*, 9(3), pp. 221–232.

Met Éireann (2019) *An Analysis of Storm Emma and the cold spell which struck Ireland between the 28th of February and the 4th of March 2018*, Met Éireann. Available at: <https://www.met.ie/cms/assets/uploads/2019/02/EmmaReport2019.pdf> (Accessed: 27 January 2021).

Met Éireann (2021) *Met Éireann Warning System Explained*, 22 December 2021. Available at: <https://www.met.ie/met-eireann-warning-system-explained> (Accessed: 21 February 2023).

Met Éireann 2017. Met Éireann Strategy, Accessed 19th April 2022 https://www.met.ie/cms/assets/uploads/2017/08/Met_Eireann_Strategy_2017-2027.pdf

Met Éireann 2021a. Ensemble Prediction Systems, 22 December 2021, Accessed 19th April 2022 <https://www.met.ie/upgrade-to-met-eireanns-weather-forecast-system-april-may-2020>

Met Éireann, 2021b. Met Éireann Warning System Explained, 22 December 2021, Accessed 19th April 2022 <https://www.met.ie/met-eireann-warning-system-explained>

Met Éireann, 2023. Red & Orange wind warnings ahead of Storm Barra, Accessed 13th Feb 2023 <https://www.met.ie/red-orange-wind-warnings-ahead-of-storm-barra>

Met Éireann. (2023) <https://www.met.ie/climate/major-weather-events>

Meyer, R. and Kunreuther, H. 2017. The ostrich paradox: Why we underprepare for disasters. University of Pennsylvania Press, 132 pp.

Miceli, R., Sotgiu, I. and Settanni, M. (2008) 'Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy', *Journal of Environmental Psychology*, 28(2), pp. 164–173.

Mileti, D. (1999) *Disasters by design: A reassessment of natural hazards in the United States*. USA: Joseph Henry Press.

Mileti, D., 1995. Factors related to flood warning response. In US-Italy Research Workshop on the Hydrometeorology, Impacts, and Management of Extreme Floods Perugia, Italy. 17 pp, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.322.4179&rep=rep1&type=pdf>

Mileti, D.S. and Darlington, J.D., 1997. The role of searching in shaping reactions to earthquake risk information. *Social Problems*, 44(1), pp.89-103.

Mileti, D.S., and Sorensen, J. H. 1990. Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. Department of Energy's, 162 pp, <https://www.osti.gov/servlets/purl/6137387>

Milne, S., Sheeran, P. and Orbell, S., 2000. Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology*, 30(1), pp.106-143.

Misra, A. (2020) 'Doctors and healthcare workers at frontline of COVID 19 epidemic: Admiration, a pat on the back, and need for extreme caution', *Diabetes & Metabolic Syndrome*, 14(3), pp. 255-256.

Moher, D. *et al.* (2009) 'Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement', *PLoS Medicine*, 6(7), pp. 1–6.

Mondal, M.S.H., Murayama, T. and Nishikizawa, S. (2021) 'Examining the determinants of flood risk mitigation measures at the household level in Bangladesh', *International Journal of Disaster Risk Reduction*, 64(March), p. 102492.

Morgan, D.L. (1988) *Focus groups as qualitative research*. London: Sage.

Morss, R.E., Cuite, C.L., Demuth, J.L., Hallman, W.K. and Shwom, R.L., 2018. Is storm surge scary? The influence of hazard, impact, and fear-based messages and

individual differences on responses to hurricane risks in the USA. *International Journal of Disaster Risk Reduction*, 30, pp.44-58.

Morss, R.E., Demuth, J.L. and Lazo, J.K., 2008. Communicating uncertainty in weather forecasts: A survey of the US public. *Weather and forecasting*, 23(5), pp.974-991.

Morss, R.E., Mulder, K.J., Lazo, J.K. and Demuth, J.L., 2016. How do people perceive, understand, and anticipate responding to flash flood risks and warnings? Results from a public survey in Boulder, Colorado, USA. *Journal of hydrology*, 541, pp.649-664.

Moyer-Gusé, E., Mahood, C. and Brookes, S., 2011. Entertainment-education in the context of humor: Effects on safer sex intentions and risk perceptions. *Health Communication*, 26(8), pp.765-774.

Mulilis, J.-P. and Duval, T.S. (1997) 'The PrE model of coping and tornado preparedness: Moderating effects of responsibility', *Journal of Applied Social Psychology*, 27(19), pp. 1750–1766.

Mulilis, J.-P. and Lippa, R. (1990) 'Behavioral change in earthquake preparedness due to negative threat appeals: A test of protection motivation theory', *Journal of Applied Social Psychology*, 20(8), pp. 619–638.

Mulilis, J.P., Duval, T.S. and Rombach, D. (2001) 'Personal responsibility for tornado preparedness: Commitment or choice?', *Journal of Applied Social Psychology*, 31(8), pp. 1659–1688.

Murphy, E. (2017) Statement from Minister Murphy on the recent fire in London. Available at: <https://www.housing.gov.ie/community/fire-and-emergency-management/statement-minister-murphy-recent-fire-london>.

Muttarak, R. and Pothisiri, W. (2013) 'The role of education on disaster preparedness: Case study of 2012 Indian Ocean earthquakes on Thailand's Andaman coast', *Ecology and Society*, 18(4), pp. 1–16.

Nadav-Greenberg, L. and Joslyn, S.L., 2009. Uncertainty forecasts improve decision making among nonexperts. *Journal of Cognitive Engineering and Decision Making*, 3(3), pp.209-227.

NDFEM (2013) National Directorate for Fire and Emergency Management, Keeping Communities Safe - A Framework for Fire Safety in Ireland.

NDFEM (2018) Fire Safety in Ireland - Report of The Fire Safety Task Force. Department of Housing, National Directorate for Fire and Emergency Management, Planning and Local Government.

NDFEM (2019) *Review Report on Severe Weather Events 2017 - 2018.*, National Directorate for Fire and Emergency Management. Available at: https://www.gov.ie/en/publication/0c2e4-review-report-on-severe-weather-events-2017-2018/?referrer=http://www.housing.gov.ie/sites/default/files/publications/files/severe_weather_review_report_-_final.pdf (Accessed: 27 January 2021).

NECG (2018a) *Report of the National Emergency Coordination Group on Severe Weather*. Available at: <https://www.housing.gov.ie/local-government/fire-and->

emergency-management/severe-weather/report-national-emergency-coordination.
Accessed 10 April 2018 (Accessed: 10 April 2018).

NECG (2018b) *Statement from the National Emergency Coordination Group (NECG) 12.00 hrs Sat 3 March*. Available at: <https://www.housing.gov.ie/local-government/fire-and-emergency-management/severe-weather/statement-necg-1200-hrs-sat-3-march>. (Accessed: 10 April 2018).

Neumayer, E. and Plümper, T. (2007) 'The gendered nature of natural disasters: The impact of catastrophic events on the gender gap in life expectancy, 1981–2002', *Annals of the Association of American Geographers*, 97(3), pp. 551–566.

Nguyen, L.H. *et al.* (2006) 'Exploring the causal relationship between exposure to the 1994 Northridge earthquake and pre- and post- earthquake preparedness activities', *Earthquake Spectra*, 22(3), pp. 569–587.

Norman, P., Boer, H. and Seydel, E.R. (2005) 'Protection Motivation Theory', in P. Norman and M. Conner (eds) *Predicting Health Behaviour: Research and Practice with Social Cognition Models*. 2nd edn. Berkshire, England: Open University Press, pp. 81–126.

Norris, F.H., Stevens, S.P., Pfefferbaum, B., Wyche, K.F., and Pfefferbaum, R.L. (2008) 'Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness', *American Journal of Community Psychology*, 41(1-2), pp. 127-150.

NRA 2023: National Risk Assessment 2023, Department of Defence, Ireland, <https://www.gov.ie/en/press-release/3da9e-tanaiste-publishes-results-of-national-risk-assessment-2023/>

NRA 2020: National Risk Assessment 2020, Department of Defence, Ireland, <https://assets.gov.ie/128544/e3cf811b-8fc9-4fc6-ab4e-a70bd1fd423c.pdf>

NRA Belgium (2018) NRA Activity Report. Available at: <https://crisiscentrum.be/nl/inhoud/risico-analyse>.

NRA Denmark (2018) National Risk Profile for Denmark. Available at: <https://brs.dk/viden/publikationer/Documents/National%20Risk%20Profile%20for%20Denmark.pdf>.

NRA Finland (2018) National Risk Assessment. Available at: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/161351/9_2019_National%20risk%20assessment.pdf.

NRA Germany (2011) Method of Risk Analysis for Civil Protection. Available at: https://www.bbk.bund.de/SharedDocs/Downloads/BBK/EN/booklets_leaflets/Method_of_%20Risk_Analysis.pdf.

NRA Ireland (2017) National Risk Assessment 2017. Available at: <https://www.emergencyplanning.ie/en/news/national-risk-assessment-ireland-2017>.

NRA Ireland (2020) National Risk Assessment 2020. Available at: <https://assets.gov.ie/128544/e3cf811b-8fc9-4fc6-ab4e-a70bd1fd423c.pdf>.

NRA Lithuania (2015) National Risk Assessment. Available at: <https://risk-net.org/node/60>.

NRA Netherlands (2019) National Risk Assessment. Available at: <https://english.nctv.nl/binaries/nctv-en/documents/publications/2019/09/18/dutch-national-risk-assessment/Dutch+National+Risk+Assessment++2019.pdf>.

NRA Sweden (2012) National Risk Assessment. Available at: <https://www.msb.se/en/publications2>.

O'Brien, R.M. (2007) 'A caution regarding rules of thumb for variance inflation factors.', *Quality & quantity*, 41(5), pp. 673–690.

O'Sullivan, T.L. *et al.* (2009) 'If Schools Are Closed, Who Will Watch Our Kids? Family Caregiving and Other Sources of Role Conflict among Nurses during Large-scale Outbreaks', *Prehospital and Disaster Medicine*, 24(4), pp. 321–325.

Odidi, S., Tantanee, S., Nusit K., and Buranajarukorn, P. 2020. Factors Influencing the Uptake of Flood Mitigation Measured in Budalangi, Kenya. *Geographia Technica*, 15, pp.80–90.

OEP (2018) *Storm Emma Household Preparedness Guidance*. Available at: <https://www.gov.ie/en/campaigns/624e4-emergency-planning/> (Accessed: 30 March 2018).

OEP (2020) *Home safety advice – Be Winter Ready*, Department of Defence, Office of Emergency Planning. Available at: <https://www.gov.ie/en/publication/5c73d1-advice-in-the-home-be-winter-ready/> (Accessed: 20 December 2020).

Office of Emergency Planning (2013) *Being Prepared*. Available at: <https://www.emergencyplanning.ie/en/being-prepared> (Accessed: 1 September 2016).

Office of Emergency Planning (2016) *Being Prepared*. Available at: <https://www.emergencyplanning.ie/en/being-prepared> (Accessed: 1 September 2016).

Ogunbode, C.A. *et al.* (2019) 'The resilience paradox: flooding experience, coping and climate change mitigation intentions', *Climate Policy*, 19(6), pp. 703–715.

Olofsson, A. and Rashid, S. (2011) 'The white (male) effect and risk perception: Can equality make a difference?', *Risk Analysis*, 31(6), pp. 1016–1032.

Oral, M. *et al.* (2015) 'Earthquake experience and preparedness in Turkey', *Disaster Prevention and Management: An International Journal*, 24(1), pp. 21–37.

Oriangi, G. *et al.* (2019) 'Household resilience to climate change hazards in Uganda', *International Journal of Climate Change Strategies and Management*, 12(1), pp. 59–73.

Paek, H. *et al.* (2010) 'Theory-Based Approaches to Understanding Public Emergency Preparedness : Implications for Effective Health and Risk Communication', *Journal of health communication*, 15(4), pp. 428–444.

- Pappa, S. *et al.* (2020) 'Prevalence of depression, anxiety, and insomnia among healthcare workers during the COVID-19 pandemic: A systematic review and meta-analysis', *Brain, Behavior, and Immunity*, 88, pp. 901–907.
- Parker, C.F., Persson, T. and Widmalm, S. (2019) 'The effectiveness of national and EU-level civil protection systems: evidence from 17 member states', *Journal of European Public Policy*, 26(9), pp. 1312–1334.
- Patel, R. *et al.* (2017) 'Health Care Student Knowledge and Willingness to Work in Infectious Disease Outbreaks', *Disaster Medicine and Public Health Preparedness*, 11(6), pp. 694–700.
- Paton, D. (2003) 'Disaster preparedness: a social-cognitive perspective', *Disaster Prevention and Management: An International Journal*, 12(3), pp. 210–216.
- Paton, D. (2007) 'Preparing for natural hazards: The role of community trust', *Disaster Prevention and Management: An International Journal*, 16(3), pp. 370–379.
- Paton, D. *et al.* (2006) 'Preparing for bushfires: Understanding intentions', *Disaster Prevention and Management: An International Journal*, 15(4), pp. 566–575.
- Paton, D. *et al.* (2010) 'Predicting community earthquake preparedness: A cross-cultural comparison of Japan and New Zealand', *Natural Hazards*, 54(3), pp. 765–781.
- Paton, D., Smith, L. and Johnston, D. (2005) 'When good intentions turn bad: promoting natural hazard preparedness', *Australian Journal of Emergency Management*, 20(1), pp. 25.
- Patton, M.Q., 2002: Qualitative Research and Evaluation Methods, Thousand Oaks, CA: Sage, 688 pp.
- Peacock, W.G., Brody, S.D. and Highfield, W. (2005) 'Hurricane risk perceptions among Florida's single family homeowners', *Landscape and Urban Planning*, 73(2-3), pp. 120–135.
- Perreault Jr., W.D. (1975) 'Controlling Order-Effect Bias', *The Public Opinion Quarterly*, 39(4), pp. 544–551.
- Pettifer, R.E.W., 2015. The development of the commercial weather services market in Europe: 1970–2012. *Meteorological Applications*, 22(3), pp.419-424.
- Plapp, T. (2001) 'Perception and Evaluation of Natural Risks: Interim Report on First Results of a Survey in Six Districts in Germany', *Risk Research and Insurance Management Working Paper*, pp. 1–10.
- Plapp, T. and Werner, U. (2006) 'Understanding risk perception from natural hazards: examples from Germany', In Ammann, Walter J., Stefanie Dannenmann, and Laurent Vulliet (eds) *RISK21-coping with risks due to natural hazards in the 21st century*, pp. 111–118. CRC Press.
- Poljanšek, K. *et al.* (2019) Recommendations for National Risk Assessment for Disaster Risk Management in EU. Available at:

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC114650/jrc114650_nrarecommendations_updatedfinal_online1.pdf.

Pothiawala, S. (2020) 'Psychological Impact of the COVID-19 on Health Care Workers in the Emergency Department', *Advanced Journal of Emergency Medicine*, 4(2), pp. e58-e58.

Potter, S., Harrison, S. and Kreft, P., 2021. The benefits and challenges of implementing impact-based severe weather warning systems: Perspectives of weather, flood, and emergency management personnel. *Weather, Climate, and Society*, 13(2), pp.303-314.

Poussin, J.K., Botzen, W.J.W. and Aerts, J.C.J.H. (2014) 'Factors of influence on flood damage mitigation behaviour by households', *Environmental Science and Policy*, 40(June 2014), pp. 69–77.

Prati, G., Pietrantonio, L. and Zani, B. (2011) 'A Social-Cognitive Model of Pandemic Influenza H1N1 Risk Perception and Recommended Behaviors in Italy', *Risk Analysis*, 31(4), pp. 645–656.

PRISMA (2015) *PRISMA Flow Diagram*. Available at: <http://www.prisma-statement.org/PRISMAStatement/FlowDiagram> (Accessed: 1 November 2019).

Proulx, G. (1995) 'Evacuation time and movement in apartment buildings', *Fire Safety Journal*, 24(3), pp. 229–246.

Proulx, G. (1999) 'Occupant response during a residential high-rise fire', *Fire and Materials*, 23(6), pp. 317–323.

Qualtrics (2023) *Sample size calculator*. Available at: <https://www.qualtrics.com/blog/calculating-sample-size/>.

Quarantelli, E.L. (2008) 'Conventional beliefs and counterintuitive realities', *An International Quarterly of the Social Sciences*, 75(3), pp. 873–904.

Qureshi, K. *et al.* (2005) 'Health care workers' ability and willingness to report to duty during catastrophic disasters', *Journal of Urban Health*, 82(3), pp. 378–388.

Ranjbar, M. *et al.* (2018) 'The predictors of earthquake preparedness in Tehran households Maryam', *Electronic Physician*, 10(3), pp. 6478–6486.

Rebmann, T. *et al.* (2013) 'Personal Disaster and Pandemic Preparedness of U.S. Human Resource Professionals', *Journal of Biosafety & Health Education*, 1(1), pp. 1–7.

Red Cross (2018) Make a Plan. Available at: <https://www.redcross.org/get-help/how-to-prepare-for-emergencies/make-a-plan.html>.

Reynaud, A., Aubert, C. and Nguyen, M.H. (2013) 'Living with floods: Protective behaviours and risk perception of Vietnamese households', *The Geneva Papers on Risk and Insurance-Issues and Practice*, 38(3), pp. 547–579.

- Ripberger, J.T., Silva, C.L., Jenkins-Smith, H.C., Carlson, D.E., James, M. and Herron, K.G., 2015. False alarms and missed events: The impact and origins of perceived inaccuracy in tornado warning systems. *Risk Analysis*, 35(1), pp.44-56.
- Rogers, D. and Tsirkunov, V., 2011: Implementing hazard early warning systems. GFDRR WCIDS Report 11-03, 47 pp, https://www.preventionweb.net/files/24259_implementingearlywarningsystems1108.pdf
- Rogers, R.W. (1975) 'A protection motivation theory of fear appeals and attitude change', *The Journal of Psychology*, 91(1), pp. 93–114.
- Rogers, R.W. (1983) 'Cognitive and physiological processes in fear-based attitude change: A revised theory of protection motivation', In *Social Psychophysiology: A Sourcebook*, pp. 153–176.
- Rogers, R.W. and Prentice Dunn, S. (1997) 'Protection motivation theory'. In Gochman, D. (Ed.) *Handbook of Health Behaviour Research: Vol 1. Determinants of Health Behaviour: Personal and Social*, pp. 113–132.
- Ronchi, E. and Nilsson, D. (2013) 'Fire evacuation in high-rise buildings: a review of human behaviour and modelling research', *Fire Science Reviews*, 2(7).
- Rosenstock, I.M., Strecher, V.J. and Becker, M.H. (1988) 'Social learning theory and the health belief model', *Health Education Quarterly*, 15(2), pp. 175–183.
- Rözer, V. *et al.* (2016) 'Coping with pluvial floods by private households', *Water (Switzerland)*, 8(7).
- Saleh Safi, A., James Smith Jr, W. and Liu, Z. (2012) 'Rural Nevada and climate change: vulnerability, beliefs, and risk perception', *Risk Analysis*, 32(6), pp. 1041–1059.
- Santarone, K. *et al.* (2020) 'Preserving mental health and resilience in frontline healthcare workers during COVID-19', *American Journal of Emergency Medicine*, 38(7), pp. 1530–1531.
- Sasangohar, F. *et al.* (2020) 'Provider burnout and fatigue during the COVID-19 pandemic: lessons learned from a high-volume intensive care unit', *Anesthesia and Analgesia*, 131(1), pp. 106–111.
- Satterfield, T.A., Mertz, C.K. and Slovic, P. (2004) 'Discrimination, vulnerability, and justice in the face of risk', *Risk Analysis*, 24(1), pp. 115–129.
- Schiller, R. (2018) *Nurses forced to stay on mattresses at Dublin hospital as a result of Storm Emma havoc*, *Independent*. Available at: <https://www.independent.ie/weather/nurses-forced-to-stay-on-mattresses-at-dublin-hospital-as-a-result-of-storm-emma-havoc/36660383.html> (Accessed: 1 September 2023).
- Schlef, K.E. *et al.* (2018) 'Relating perceptions of flood risk and coping ability to mitigation behavior in West Africa: Case study of Burkina Faso', *Environmental Science and Policy*, 89(November 2017), pp. 254–265.

Scovell, M. *et al.* (2021) 'Rethinking Risk Perception and its Importance for Explaining Natural Hazard Preparedness Behavior', *Risk Analysis*, 0(0).

Scovell, M., McShane, C. and Swinbourne, A., 2020. Experience and the perceived efficacy of cyclone preparedness behaviour. *International Journal of Disaster Resilience in The Built Environment*, 12, 70–183. h

Seebauer, S. and Babicky, P. (2020) 'The Sources of Belief in Personal Capability: Antecedents of Self-Efficacy in Private Adaptation to Flood Risk', *Risk Analysis*, 40(10), pp. 1967–1982.

SEM 2017. Strategic Emergency Management (SEM) National Structures and Framework, Accessed 5th June 2024 <https://www.gov.ie/en/publication/7ff6f-strategic-emergency-management-sem-national-structures-and-framework/>

Semaan, A. *et al.* (2020) 'Voices from the frontline: findings from a thematic analysis of a rapid online global survey of maternal and newborn health professionals facing the COVID-19 pandemic', working paper, Center for Research on Population and Health, Faculty of Health Sciences, American University of Beirut, Beirut, Lebanon, 11 May.

Shah, A.S.V. *et al.* (2020) 'Risk of hospital admission with coronavirus disease 2019 in healthcare workers and their households: Nationwide linkage cohort study', *The BMJ*, 371.

Shapira, S. *et al.* (2016) 'Knowledge, perceptions, attitudes and willingness to report to work in an earthquake: A pilot study comparing Canadian versus Israeli hospital nursing staff', *International Emergency Nursing*, 25(March 2016), pp. 7–12.

Siegrist, M. and Gutscher, H. (2006) 'Flooding risks: A comparison of lay people's perceptions and expert's assessments in Switzerland', *Risk Analysis*, 26(4), pp. 971–979.

Siegrist, M. and Gutscher, H. (2008) 'Natural hazards and motivation for mitigation behavior: People cannot predict the affect evoked by a severe flood', *Risk Analysis*, 28(3), pp. 771–778.

Siegrist, M. *et al.* (2007) 'Laypeople's and experts' perception of nanotechnology hazards', *Risk Analysis*, 27(1), pp. 59–69.

Siegrist, M., Gutscher, H. and Earle, T.C. (2005) 'Perception of risk: the influence of general trust, and general confidence', *Journal of Risk Research*, 8(2), pp. 145–156.

Silver, A., 2015. Watch or warning? Perceptions, preferences, and usage of forecast information by members of the Canadian public. *Meteorological Applications*, 22(2), pp.248-255.

Sim, M.R. (2020) 'The COVID-19 pandemic: major risks to healthcare and other workers on the front line', *Occupational and Environmental Medicine*, 77(5), pp. 281-282.

Simmons, K.M. and Sutter, D., 2009. False alarms, tornado warnings, and tornado casualties. *Weather, Climate, and Society*, 1(1), pp.38-53.

- Slepski, L.A. (2007) 'Emergency Preparedness and Professional Competency Among Health Care Providers During Hurricanes Katrina and Rita: Pilot Study Results', *Disaster Management and Response*, 5(4), pp. 99–110.
- Slovic, P., Peters, E., Finucane, M. L., and MacGregor, D. G. (2005) 'Affect, risk, and decision making'. *Health Psychology*, 24(4, Suppl), S35–S40.
- Slovic, P. (1999) 'Trust, emotion, sex, politics and science: Surveying the risk-assessment battlefield', *Risk Analysis*, 19(4), pp. 390–412.
- Slovic, P. (2016) 'Understanding perceived risk: 1978–2015', *Environment: Science and Policy for Sustainable Development*, 58(1), pp. 25–29.
- Slovic, P., Fischhoff, B. and Lichtenstein, S. (1980) 'Facts and fears: Understanding perceived risk', in R.C. Schwing and W.A. Albers (eds) *Societal risk assessment*. USA: Springer US, pp. 181–216.
- Smith, C. and Hewison, A. (2012) 'Are nurses prepared to respond to a bioterrorist attack: a narrative synthesis', *Journal of Advanced Nursing*, 68(12), pp. 2597–2609.
- Smith, E. (2007) 'Emergency health care workers' willingness to work during major emergencies and disasters', *Australian Journal of Emergency Management*, 22(2), pp. 21–24.
- Smith, E. (2008) 'Willingness to work during a terrorist attack: A case-study of first responders during the 9/11 World Trade Centre terrorist attacks', *Australasian Journal of Paramedicine*, 6(1), pp. 1–11.
- Smith, E. *et al.* (2008) 'Paramedics' perceptions of risk and willingness to work during disasters.', *Australian Journal of Emergency Management*, 23(2), pp. 14–20.
- Souadka, A. *et al.* (2020) 'COVID-19 and Healthcare worker's families: behind the scenes of frontline response', *EclinicalMedicine*, 23, p. 100373.
- Spittal, M.J. *et al.* (2006) 'The earthquake readiness scale: The development of a valid and reliable unifactorial measure', *Natural Hazards*, 39(1), pp. 15–29.
- SRA (2018) *Society for Risk Analysis Glossary*, Society for Risk Analysis. Available at: <https://www.sra.org/wp-content/uploads/2020/04/SRA-Glossary-FINAL.pdf> (Accessed: 27 January 2021).
- Starr, C. (1969) 'Social benefit versus technological risk: what is our society willing to pay for safety?', *Science*, 165(3899), pp. 1232–1238.
- Stergachis, A. *et al.* (2011) 'Health Care Workers' Ability and Willingness to Report to Work During Public Health Emergencies', *Disaster Medicine and Public Health Preparedness*, 5(4), pp. 300–308.
- Stumpf, K., Knuth, D., Kietzmann, D. and Schmidt, S. (2017) 'Adoption of fire prevention measures – Predictors in a representative German sample', *Safety Science*, 94, pp. 94–102.
- Sullivan-Wiley, K.A. and Gianotti, A.G.S. (2017) 'Risk perception in a multi-hazard environment', *World Development*, 97, pp. 138–152.

- Sutton, J. and Woods, C. (2016) 'Tsunami warning message interpretation and sense making: Focus group insights', *Weather, Climate, and Society*, 8(4), pp. 389–398.
- Sutton, J. *et al.* (2018) 'Designing effective tsunami messages: Examining the role of short messages and fear in warning response', *Weather, Climate, and Society*, 10(1), pp. 75–87.
- Suwantarat, N. and Apisarnthanarak, A. (2015) 'Risks to healthcare workers with emerging diseases: lessons from MERS-CoV, Ebola, SARS, and avian flu', *Current Opinion in Infectious Diseases*, 28(4), pp. 349–361.
- Tabe-Ojong, M.P., Boakye, J.A. and Muliro, M. (2020) 'Mitigating the impacts of floods using adaptive and resilient coping strategies: The role of the emergency Livelihood Empowerment Against Poverty program (LEAP) in Ghana', *Journal of Environmental Management*, 270(December 2019), p. 110809.
- Taherdoost, H. (2016) 'Validity and Reliability of the Research Instrument ; How to Test the Validation of a Questionnaire / Survey in a Research Hamed Taherdoost To cite this version : HAL Id : hal-02546799 Validity and Reliability of the Research Instrument ; How to Test the', *International Journal of Academic Research in Management*, 5(3), pp. 28–36.
- Tam, C.W. *et al.* (2004) 'Severe acute respiratory syndrome (SARS) in Hong Kong in 2003: stress and psychological impact among frontline healthcare workers', *Psychological Medicine*, 34(7), p. 1197–1204.
- Tang, J.S. and Feng, J.Y., 2018. Residents' disaster preparedness after the Meinong Taiwan earthquake: A test of protection motivation theory. *International Journal of Environmental Research and Public Health*, 15(7), p.1434.
- Tasantab, J.C., Gajendran, T. and Maund, K. (2022) 'Expanding protection motivation theory : The role of coping experience in flood risk adaptation intentions in informal settlements', *International Journal of Disaster Risk Reduction*, 76(March), p. 103020.
- Tavakol, M. and Dennick, R. (2011) 'Making sense of Cronbach's alpha', *International Journal of Medical Education*, 2, pp. 53–55.
- Taylor, A.L., Kause, A., Summers, B. and Harrowsmith, M., 2019. Preparing for Doris: Exploring public responses to impact-based weather warnings in the United Kingdom. *Weather, Climate, and Society*, 11(4), pp.713–729.
- Taylor, A.L., Kox, T. and Johnston, D., 2018. Communicating high impact weather: improving warnings and decision making processes. *International Journal of Disaster Risk Reduction*, 30, pp.1–4.
- Taylor, H.A., Rutkow, L. and Barnett, D.J. (2018) 'Local preparedness for infectious disease outbreaks: A qualitative exploration of willingness and ability to respond', *Health Security*, 16(5), pp. 311–319. A
- Tej, J. *et al.* (2014) 'Crisis Awareness of the Municipal District Residents: Implication for Crisis Management At the Local Government Level', *Quality Innovation Prosperity*, 18(2), pp. 1–14.

- Terpstra, T. (2011) 'Emotions, Trust, and Perceived Risk: Affective and Cognitive Routes to Flood Preparedness Behavior', *Risk Analysis*, 31(10), pp. 1658–1675.
- Terpstra, T. and Lindell, M.K. (2013) 'Citizens' perceptions of flood hazard adjustments: an application of the protective action decision model', *Environment and Behavior*, 45(8), pp. 993–1018.
- Thompson, O.F., Galea, E.R. and Hulse, L.M. (2018) 'A review of the literature on human behaviour in dwelling fires', *Safety Science*, 109, pp. 303–312.
- Thorpe, A., 2016: The Weather Enterprise: A Global Public-Private Partnership. World Meteorological Organization, Accessed 19th April 2022
<https://public.wmo.int/en/resources/bulletin/unnatural-disasters-communicating-linkages-between-extreme-events-and-climate>
- Tippett, V.C. *et al.* (2010) 'Anticipated Behaviors of Emergency Prehospital Medical Care Providers during an Influenza Pandemic', *Prehospital and Disaster Medicine*, 21(1), pp. 20–25.
- Tómasson, B. and Karlsson, B. (2020) 'The role of households in Nordic national risk assessments', *International Journal of Disaster Risk Reduction*, 45, 101495.
- Tomio, J. *et al.* (2014) 'Household and Community Disaster Preparedness in Japanese Provincial City: A Population-Based Household Survey', *Advances in Anthropology*, 4(2), pp. 68–77.
- Trainor, J.E. and Barsky, L.E. (2011) Reporting for duty? A synthesis of research on role conflict, strain, and abandonment among emergency responders during disasters and catastrophes. Disaster Research Center - University of Delaware. Available at: <http://cdp.dhs.gov>. (Accessed: 21 February 2020).
- Trimintzios, P. and Gavrilă, R. (2013) National-level Risk Assessments: An Analysis Report. Available at: <https://www.enisa.europa.eu/publications/nlra-analysis-report>.
- Twerefou, D.K., Adu-Danso, E., Abbey, E. and Dovie, B.D., 2019. Choice of household adaptation strategies to flood risk management in Accra, Ghana. *City and Environment Interactions*, 3, p.100023.
- Uccellini, L. W. and Hovee, J. E. T., 2019. Evolving the National Weather Service to Build a Weather-Ready Nation: Connecting Observations, Forecasts, and Warnings to Decision-Makers through Impact-Based Decision Support Services. *Bulletin of the American Meteorological Society*, 100 (10), pp. 1923–1942.
- Uhm, D. *et al.* (2019) 'Factors Affecting the Disaster Response Competency of Emergency Medical Technicians in South Korea', *Asian Nursing Research*, 13(4), pp. 264–269.
- UNISDR, 2006: Global survey of early warning systems: An assessment of capacities, gaps and opportunities toward building a comprehensive global early warning system for all natural hazards. United Nations, 56 pp.
https://www.preventionweb.net/files/3612_GlobalSurveyofEarlyWarningSystems.pdf

- Vaismoradi, M., Turunen, H. and Bondas, T. (2013) 'Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study', *Nursing & Health Sciences*, 15(3), pp. 398–405.
- Vihalemm, T., Kiisel, M. and Harro-Loit, H., 2012. Citizens' response patterns to warning messages. *Journal of Contingencies and Crisis Management*, 20(1), pp.13-25.
- Vlek, C. (2013) 'How solid is the Dutch (and the British) national risk assessment? Overview and decision-theoretic evaluation', *Risk Analysis*, 33(6), pp. 948–971.
- Wachinger, G., Renn, O., Begg, C. and Kuhlicke, C. (2013) 'The risk perception paradox—implications for governance and communication of natural hazards', *Risk Analysis*, 33(6), pp. 1049–1065.
- Walters, J.E., Mason, L.R., Ellis, K. and Winchester, B., 2020. Staying safe in a tornado: A qualitative inquiry into public knowledge, access, and response to tornado warnings. *Weather and Forecasting*, 35(1), pp.67-81.
- Walton, M. *et al.* (2020) 'Mental health care for medical staff and affiliated healthcare workers during the COVID-19 pandemic', *European Heart Journal: Acute Cardiovascular Care*, 9(3), pp. 241–247.
- Wei, H.H., Sim, T. and Han, Z. (2019) 'Confidence in authorities, neighborhood cohesion and natural hazards preparedness in Taiwan', *International Journal of Disaster Risk Reduction*, 40(November 2019), p. 101265.
- Wei, H.L. and Lindell, M.K. (2017) 'Washington households' expected responses to lahar threat from Mt. Rainier', *International Journal of Disaster Risk Reduction*, 22(June 2017), pp. 77–94.
- Weinstein, N.D. (1989) 'Effects of personal experience on self-protective behavior', *Psychological Bulletin*, 105(1), pp. 31–51.
- Westcott, R., Ronan, K., Bambrick, H. and Taylor, M. (2017) 'Expanding protection motivation theory: investigating an application to animal owners and emergency responders in bushfire emergencies', *BMC Psychology*, 5(13).
- Weyrich, P., Scolobig, A., Bresch, D.N. and Patt, A., 2018. Effects of impact-based warnings and behavioral recommendations for extreme weather events. *Weather, Climate, and Society*, 10(4), pp.781-796.
- Weyrich, P., Scolobig, A., *et al.* (2020) 'Responses to severe weather warnings and affective decision-making', *Natural Hazards and Earth System Sciences*, 20(10), pp. 2811–2821.
- Whelan, D. (2018) *National Directorate for Fire and Emergency Management Major Emergency Management Conference, Athlone*. Available at: <http://mem.ie/wp-content/uploads/2018/12/Derek-Whelan-Storm-Emma-Kildare-County-Council.pdf>. (Accessed: 8 December 2018).
- Whitfield, S.C., Rosa, E.A., Dan, A. and Dietz, T. (2009) 'The future of nuclear power: Value orientations and risk perception', *Risk Analysis*, 29(3), pp. 425–437.

WHO (2020) 'Statement on the second meeting of the International Health Regulations (2005) Emergency Committee regarding the outbreak of novel coronavirus (2019-nCoV)'. Available at: [https://www.who.int/news/item/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-\(2005\)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-\(2019-ncov\)](https://www.who.int/news/item/30-01-2020-statement-on-the-second-meeting-of-the-international-health-regulations-(2005)-emergency-committee-regarding-the-outbreak-of-novel-coronavirus-(2019-ncov)) (Accessed 25 June 2020).

Wilcox, L., Heagele, T. and McNeill, C. (2022) 'Household emergency preparedness: A multidisciplinary concept analysis.', *Nursing Forum*, 57(2), pp. 305–310.

Williams, C.A., Miller, P.W., Black, A.W. and Knox, J.A., 2017. Throwing Caution to the Wind: National Weather Service Wind Products as Perceived by a Weather-Salient Sample. *Journal of Operational Meteorology*, 5(9). pp.103-120.

Williams, L., Arguillas, M.J.B. and Arguillas, F. (2020) 'Major storms, rising tides, and wet feet: Adapting to flood risk in the Philippines', *International Journal of Disaster Risk Reduction*, 50(December 2019), p. 101810.

Williams, R. (2006) 'Generalized ordered logit/partial proportional odds models for ordinal dependent variables', *Stata Journal*, 6(1), pp. 58–82.

Wirtz, P.W., Rohrbeck, C.A. and Burns, K.M. (2019) 'Anxiety effects on disaster precautionary behaviors: A multi-path cognitive model', *Journal of Health Psychology*, 24(10), pp. 1401–1411.

WMO, 2015a. Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services. World Meteorological Organization, 308 pp, https://library.wmo.int/doc_num.php?explnum_id=3314

WMO, 2015b. Guidelines on multi-hazard impact based forecast and warning scenarios. World Meteorological Organization, World Meteorological Organization, 23 pp, https://library.wmo.int/doc_num.php?explnum_id=7901

WMO, 2018. Multi-hazard early warning systems: A checklist. World Meteorological Organization Doc., 20 pp, https://library.wmo.int/doc_num.php?explnum_id=4463

Wood, M.M. *et al.* (2012) 'Communicating Actionable Risk for Terrorism and Other Hazards', *Risk Analysis*, 32(4), pp. 601–615.

Wood, M.M., Mileti, D.S., Bean, H., Liu, B.F., Sutton, J. and Madden, S., 2018. Milling and public warnings. *Environment and Behavior*, 50(5), pp.535-566.

Wu, H.C. *et al.* (2017) 'Preparing for the new normal: Students and earthquake hazard adjustments in Oklahoma', *International Journal of Disaster Risk Reduction*, 25(October 2017), pp. 312–323.

Xu, D. *et al.* (2018) 'Influences of Risk Perception and Sense of Place on Landslide Disaster Preparedness in Southwestern China', *International Journal of Disaster Risk Science*, 9(2), pp. 167–180.

Yassi, A. *et al.* (2005) 'Research gaps in protecting healthcare workers from SARS and other respiratory pathogens: an interdisciplinary, multi-stakeholder, evidence-based approach', *Journal of Occupational and Environmental Medicine*, 47(1), p. 41-50.

Yong, A.G. and Lemyre, L. (2019) 'Getting Canadians prepared for natural disasters: a multi-method analysis of risk perception, behaviors, and the social environment', *Natural Hazards*, 98(1), pp. 319–341.

Young, D. and McKeown, A.L. (2018, March 21st) 'Firefighters tackling major blaze at Dublin hotel and apartment block building', *The Independent*. Available at: <https://www.independent.ie/breaking-news/irish-news/firefighters-tackling-major-blaze-at-dublin-hotel-and-apartment-block-building-36731002.html>.

Zaalberg, R., Midden, C., Meijnders, A. and McCalley, T., 2009. Prevention, adaptation, and threat denial: Flooding experiences in the Netherlands. *Risk Analysis: An International Journal*, 29(12), pp.1759-1778.

Zhu, Z. *et al.* (2020) 'COVID-19 in Wuhan: Sociodemographic characteristics and hospital support measures associated with the immediate psychological impact on healthcare workers', *EclinicalMedicine*, 24, pp. 1-11.

Zinbarg, R., Craske, M. and Barlow, D. (2006) *Mastery of your anxiety and worry (MAW): Therapist guide*. USA: Oxford University Press.

10. Appendices

10.1 Appendix Chapter 1

Ethical Approvals

**Dublin City University
RESEARCH ETHICS COMMITTEE**

DCU

NOTIFICATION FORM FOR LOW-RISK PROJECTS

Application No. (office use only)

DCUREC/2015/0017

Section A: Applicant Details

PROJECT TITLE:	Risk Perception & Emergency Preparedness
APPLICANT NAME:	David Leon
SCHOOL/UNIT:	DCU BUSINESS SCHOOL
APPLICANT EMAIL:	david.leon3@mail.dcu.ie
<i>If a student applicant, please provide the following additional information:</i>	
Programme of Study:	MSc Emergency Management 2
Supervisor Name:	Mary Loonam
Supervisor Email:	mary.loonam@dcu.ie
Date:	10 th October 2015

Section B: Questions

1. Notification Review is reserved for low-risk social studies that fall under the following classifications. Please indicate your project type below:

Please mark as appropriate:	
Yes	Anonymous Survey (the topic will not elicit significant difficulties for participants)
	Observation (without audio or visual recording) of a public setting
	Questioning participants regarding their opinions on products or services
	Questioning students about standard educational practices
	Study will monitor the impact of participants' daily activities
	Questioning public figures/professionals in their professional capacity regarding their professional activities
	Analysis of existing anonymised data which has been provided to the researcher by a third party
	Collection of biological samples which are anonymised and do not require invasive techniques (e.g. hair, nails).
	Other <i>Please explain:</i>

2. Please provide a justification for why your study is considered to be low-risk.

This research focuses on emergency preparedness at an individual and household level. Using risks drawn from the Irish National Risk Register (2012). The questionnaire explores risk perception and protection motivation. The research focuses on respondents' attitudes and actions and does not collect personal data (as defined by 'dataprotection.ie').

This study collects anonymised data directly from the respondent. To prevent the identification of the respondent to whom it relates, the data is collected in an irreversible format. This means it is not possible to identify any respondent either by further processing of the data or by cross-referencing it with other information.

The target population for this study are adults living in Ireland - not children or persons labelled vulnerable or at risk. Special attention will be given to collecting responses from State Registered Nurses in Ireland.

Reference: A National Risk Assessment for Ireland (2012). Office of Emergency, Department of Defence.

3. Please describe how your participants will be recruited.

The sample for this study will be drawn from the Irish population. The survey will be distributed and completed online using Survey Monkey software. Non-probability (Sarantakos 2005) sampling techniques will be employed. Non-probability sampling will result in the sample being drawn from persons who come in contact with the survey distributed via online platforms such as LinkedIn, Twitter and Facebook. They in turn will be asked to cascade the questionnaire out to their circle of colleagues and friends. Furthermore, a link to the questionnaire will be shared on a Nurses and Midwives in Ireland private Facebook group, which has approximately 15,000 members.

Reference: Sarantakos, S. 2005. Social Research. 2nd ed. England: Palgrave Macmillan.

4. Informing your participants – Plain Language Statement

A Plain Language Statement (PLS) should be used in all cases. This is written information in plain language that you will be providing to participants, outlining the nature of their involvement in the project and inviting their participation. The PLS should specifically describe what will be expected of participants, the risks and inconveniences for them, and other information relevant to their involvement. Please note that the language used must reflect the participant age group and corresponding comprehension level – if your participants have different comprehension levels (e.g. both adults and children) then separate forms should be prepared for each group. The PLS can be embedded in an email to which an online survey is attached, or handed/posted to individuals in advance of their consent being sought. **A copy of the PLS should be attached to this application.** See link to sample templates on the website:
http://www4.dcu.ie/research/research_ethics/rec_forms.shtml

Please confirm whether the following issues have been addressed in your plain language statement for participants:

	YES or NO
Introductory Statement (PI and researcher names, school, title of the research)	Yes
What is this research about?	Yes
Why is this research being conducted?	Yes
What will happen if the person decides to participate in the research study?	Yes
How will their privacy be protected?	Yes
How will the data be used and subsequently disposed of?	Yes
What are the legal limitations to data confidentiality?	No
What are the benefits of taking part in the research study (if any)?	Yes
What are the risks of taking part in the research study?	Yes
Confirmation that participants can change their mind at any stage and withdraw from the study	Yes
How will participants find out what happens with the project?	Yes
Contact details for further information (including REC contact details)	Yes

If any of these issues are marked NO, please justify their exclusion:

"What are the legal limitations to data confidentiality?": 'No', has been selected in this instance as the legal limitations of data confidentiality do not apply to this study. No explanation is required within the PLS as the questionnaire is irreversibly anonymised at the point when data is collected. We do not collect identifiers which allow us to single a respondent out from the general Irish population, therefore, the anonymised data is not defined as "personal data" and no legal limitation regarding data confidentiality exists.

5. Capturing consent – Informed Consent Form

In most cases where interviews or focus groups are taking place, an Informed Consent Form is required. This is an important document requiring participants to indicate their consent to participate in the study, and give their signature. If your participants are minors (under 18), it is best practice to provide them with an assent form, while their parents/guardians will be given the Informed Consent Form. In cases where an anonymous questionnaire is being used, it is enough to include a tick box in the questionnaire (underneath the information section for participant), where the participant can indicate their consent. See link to sample templates on the website:
http://www4.dcu.ie/research/research_ethics/rec_forms.shtml. A copy of the Informed Consent Form should be attached to this application.

Note – IF AN INFORMED CONSENT FORM IS NOT BEING USED, THE REASON FOR THIS MUST BE JUSTIFIED HERE:

Before commencing the questionnaire, participants will be provided with a plain language statement explaining the purpose of the study and offered an opportunity to contact the researcher with any questions.

To consent, participants will click a button on the online questionnaire indicating they have read the plain language statement and consented to take part in the study. It is made clear to participants that once their

responses are submitted, they cannot withdraw from the study, given the anonymous nature of the online questionnaire.

Approved By:

Programme Director:


Dr Caroline McMullan

DCU Business School Research Office:


Ms Margaret Galuszynska



Ollscoil Chathair Bhaile Átha Cliath
Dublin City University



Mr Gavin Brown

DCU Business School

27 October 2017

REC Reference: DCUREC/2017/171

Proposal Title: Risk Perception & Emergency Preparedness

Applicant(s): Mr Gavin Brown, Dr Caroline McMullan

Dear Gavin,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this project.

Materials used to recruit participants should state that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,

A handwritten signature in blue ink that reads 'Dónal O'Gorman'.

Dr Dónal O'Gorman
Chairperson
DCU Research Ethics Committee



Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
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Gavin Brown <gavin.brown@dcu.ie>

Fwd: DCUREC/2017/171 Amendment #1

2 messages

rec dcu <rec@dcu.ie>

1 March 2021 at 12:37

To: Gavin Brown <gavin.brown@dcu.ie>

Hi Gavin,

Just located the amendment approval email which you can find below. This was sent to Caroline at the time.

If you need anything else, please let me know.

Kind regards

Adam Platt (on behalf of REC)

Riarthóir Coiste Eitice um Thaighde | DCU Research Ethics Committee Administrator

Tacaíocht Taighde & Núálaíochta | Ollscoil Chathair Bhaile Átha Cliath

Research and Innovation Support | Dublin City University

Email: rec@dcu.ie

Tel: +353 (0)1 700 5612

Web: www.dcu.ie/research

----- Forwarded message -----

From: **rec dcu** <rec@dcu.ie>

Date: Thu, 29 Mar 2018 at 14:51

Subject: Re: Urgent

To: Caroline McMullan <caroline.mcmullan@dcu.ie>

Dear Caroline,

Thank you for confirming that the original project is still ongoing. This amendment has been approved by the Chair of REC.

Regards,
Katya**Research Ethics Committee**

Dublin City University

Tel: 01 700 8000

On 28 March 2018 at 15:32, Caroline McMullan <caroline.mcmullan@dcu.ie> wrote:

Dear Katya

Yes, the project is ongoing. It is still in the very early stages.

Regards

Caroline

On 28 March 2018 at 15:31, rec dcu <rec@dcu.ie> wrote:

Dear Caroline,

In relation to the amendment request for DCUREC2017_171, can you please confirm that this falls within the timeline of the existing project? Is the original project still ongoing?

Thank you and all the best,

Katya

On 27 March 2018 at 09:40, Caroline McMullan <caroline.mcmullan@dcu.ie> wrote:

Dear Katya

Gavin Brown and I have been asked by the government to do a review of how people coped during the recent Storm Emma.

This will be an extension of the study for which we gained ethical approval - DCUREC2017_171.

A short, follow-up, anonymous questionnaire needs to go out immediately if the findings are to have validity.

May we forward a copy of the Low-Risk form and ask that it be considered outside of your normal meeting schedule?

Regards

Caroline

--

Dr Caroline McMullan

Associate Dean for Teaching & Learning

Associate Professor of Management (Risk, Business Continuity & Emergency Management)

Programme Director MSc Emergency Management

Programme Director MSc Business Administration - DCU@PNU

DCU Business School

Prof Caroline McMullan
Dublin City University Business School

29th April 2019

REC Reference: DCUREC/2019/069

Proposal Title: Risk Perception & Emergency Household Preparedness

Applicant(s): Prof Caroline McMullan and Mr Gavin Brown

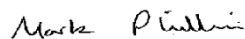
Dear Caroline and Gavin,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this project.

Materials used to recruit participants should state that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,



Dr Mark Philbin
Interim Chairperson
DCU Research Ethics Committee



Taighde & Nuálaíocht Tacaíocht
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REC Reference: DCUREC/2021/003

Proposal Title: FÓGRA: DELIVERING EFFECTIVE, EVIDENCE-BASED
WEATHER & CLIMATE SERVICES FOR IRELAND

Applicant(s): Prof. Caroline McMullan, Dr. Ann Largey, Dr. Gavin Brown,
Niamh Reilly, and Muskan Sahdev

Dear Colleagues,

This research proposal qualifies under our Notification Procedure, as a low risk social research project. Therefore, the DCU Research Ethics Committee approves this project.

Materials used to recruit participants should state that ethical approval for this project has been obtained from the Dublin City University Research Ethics Committee.

Should substantial modifications to the research protocol be required at a later stage, a further amendment submission should be made to the REC.

Yours sincerely,



Dr Geraldine Scanlon
Chairperson
DCU Research Ethics Committee



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Paper 1 & 2 Survey Questions

How likely do you think the following emergencies are to affect you or your home?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g. water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Extremely Unlikely, Very Unlikely, Unlikely, Likely, Very Likely

Should they occur, what level of impact do you think you or your home would experience from the following?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g. water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Very Low Impact, Low Impact, Moderate Impact, High Impact, Very High Impact

Have you ever experienced any of the following emergencies?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g. water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Yes, No

Would you consider yourself prepared to deal with an emergency?

Options: Yes, No, Somewhat, Unsure

If not, why?

Options: I don't know what to do, I haven't had time, I don't want to think about it, Expense factor, I don't think it will make a difference, I think the emergency services will help me, Other (please specify)

For each of the following emergencies, which statement best represents your view?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g. water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Nothing I do to prepare will help should this emergency occur, I do not need to prepare for this emergency, I am not prepared to deal with this emergency but I do see a benefit in preparing, I am prepared for this emergency

Do you have a household emergency plan for...

Options: All situations, Specific types of situations

Please note the context of the specific plan(s) (e.g. a house fire, a flood, etc)

If yes, have you discussed such plans with other members of your household?

Options: Yes, No

Which of the following do you have in your home?

Items: A smoke detector, A fire extinguisher, A fire blanket, A carbon monoxide (CO) detector, Generator, Gas Grill (With spare gas), Tank of fuel (Small can etc), Bicycle, General tool set, Axe and/or chain saw, Other (please specify)

Which emergency supplies do you keep in your home?

Items: First aid kit, Supply of packaged food, Supply of bottled water, Medications, Batteries, Torch, A phone list of emergency contacts, Important documents (passport(s), financial documents, etc), Cash, Battery powered radio, Other (please specify)

Regarding the emergency supplies noted in the question above.

- Do you keep these supplies solely for the purpose of an emergency?
- Are these emergency supplies kept in one location within your household?
- Are these supplies regularly checked to ensure proper working order/ that they are kept in date?

Scale: Yes, No

Do you have...

- Enough bottled water for
- Enough food for
- Enough medication for

Scale: 0 Days, 1-2 Days, 3-5 Days, 6-7 Days, 8+ Days

Is there a vehicle at your household?

Options: Yes, No

If so, do you have supplies set aside in this vehicle to be used only in the case of an emergency?

Options: Yes, No

If yes, could you please tell us what supplies these are?

Which statement best describes your average refueling pattern for your vehicle?

Options: I quarter fill my tank, I half fill my tank, I three-quarters fill my tank, I fully fill my tank, No pattern, I don't know, Other (please specify)

When do you refuel your vehicle?

Options: When tank is close to empty (warning light is on), When tank is close to empty (but refuel before warning light is on), I drive until I have only a quarter of a tank, I drive until I have only a half a tank, No pattern, I don't know, Other (please specify)

If you had to evacuate your home, what assistance do you think you or a member of your household might require?

Options: A place to go (access to evacuation center), Information on the evacuation route, Transport, Help evacuating disabled/elderly family member, Help evacuating my pet(s), None, Other (please specify)

In the event of a major emergency in your region, what level of assistance would you require from each of the following?

Options: Household members, People in my neighbourhood, Non-profit organisations such as Order of Malta, Civil Defence, St. Vincent de Paul, Emergency services, Other local government, National government

Scale: None, Very Little, Little, Some, Considerable, Substantial

Do you have household insurance?

Options: Yes, No, Don't know

Does this insurance cover a flood?

Options: Yes, No, Don't Know

How important is it that national government invest in: Options: Protecting private property, Protecting historical and cultural landmarks, Preventing development in hazardous areas, Protecting and reducing damage to utilities, Strengthening emergency services, Protecting critical facilities (e.g. hospitals, fire stations, transport networks)

Scale: Not important, Not very important, Neither important nor unimportant, Somewhat important, Very important

Which of the following do you support: Options: The disclosure of natural hazard risks during real estate transactions, A local inventory of at-risk buildings and infrastructure, Improving the emergency preparedness of local schools, Steps to safeguard the local economy following a major emergency, Policies to prohibit development in areas subject to natural hazards, Use of local tax money to reduce risks and losses from natural hazards, Protecting historical and cultural structures

Scale: Strongly oppose, Somewhat oppose, Neither oppose or support, Somewhat support, Strongly support

I am...

Options: Female, Male

My age is...

Options: Under 25, 25-34, 35-44, 45-54, 55-64, 65 or older

I live in...

Options: A city, The suburbs or outskirts of a city, A town, A village, A rural area, Other (please specify)

What is the closest town/city to where you live?

In what county do you live?

Do you rent or own your home?

Options: Own, Rent

For how long have you lived in your current home (approximately)?

Years: _____

In which type of housing do you live?

Options: Apartment, House, Other (please specify)

How many adults live in your household?

How many children (younger than 18) live in your household?

Which of the following best describes your current situation?

Options: Working full time, Working part time, Unemployed (Seeking work), Unemployed (Not seeking work), In education (Student), Permanently sick or disabled, Retired, Doing housework, looking after children (Homemaker), Other (please specify)

What is/was your job?

What is the highest qualification you have completed?

Options: None, Junior certificate, Leaving certificate, FETAC level 4 or 5, Apprenticeship, Advanced or higher certificate including FETAC level 6, Bachelors degree or higher diploma, Master degree or post-graduate diploma, PhD, D.Phil or equivalent, Other (please specify)

What is your approximate annual household income (this question is not compulsory)?

Options: Less than €18000, €18001 - €30000, €30001 - €50000, €50001 - €70000, €70001 - €100000, Over €100000

Paper 3 Survey Questions

Please select the organisation in which you primarily work/volunteer as a pre-hospital first responder.

Options: National Ambulance Service, Fire Service, Defence Forces, Private Ambulance Service, Irish Community Rapid Response Doctor, Irish Coast Guard, Civil Defence, Mountain Rescue Ireland, Order of Malta, Irish Red Cross, St Johns Ambulance, RNLI, Community First Responder Group, Other (Please specify), I am not a Pre-hospital Practitioner

In relation to the organisation you selected in the previous question; at what level do you practice?

Options: Critical Care Doctor, Doctor, Nurse, Advanced Paramedic, Paramedic, Emergency Medical Technician, Cardiac First Responder, Emergency First Responder, First Aid Responder, Other (Please specify)

In relation to the organisation, what is your current rank?

Options: General Operational level, Supervisor level, Officer/Managerial Level, Other (Please specify)

Have you or are you currently working with the front-line medical services as part of the national response to COVID-19? (If no please provide some context e.g. sick leave)

Options: Yes, No (Please specify)

For how long have you worked as a pre-hospital practitioner? (years)

Apart from yourself, how many adults live in your household?

Options: None, Please Specify (Number)

How many pre-school children live in your household?

Options: None, Please Specify (Number)

How many primary school children live in your household?

Options: None, Please Specify (Number)

How many secondary school children live in your household?

Options: None, Please Specify (Number)

How many pets are in your household?

Options: None, Please Specify (Number)

Are you a registered carer?

Options: Yes, No

What level of impact has COVID-19 had on...

Options: You or your home, The Country

Scale: Very Low Impact, Low Impact, Moderate Impact, High Impact, Very High Impact

How much did you worry about COVID-19 when cases were reported in...: China, Italy, Ireland

Scale: Not at all, A little, A moderate amount, A lot, A great deal

How did your level of worry change during the response to COVID-19 in Ireland?

Options: Worry decreased, Worry stayed the same, Worry increased

What caused your level of worry to decrease?

What caused your level of worry to increase?

Do you feel you were professionally prepared for COVID-19?

Scale: Not at all Prepared (0%), Completely Prepared (100%)

Do you feel your home/family were prepared for COVID-19?

Scale: Not at all Prepared (0%), Completely Prepared (100%)

Do you feel the country was prepared for COVID-19?

Scale: Not at all Prepared (0%), Completely Prepared (100%)

Have you sought information on how to prepare for COVID-19?

Options: Yes, No

Options: Personally, Professionally

In general, where are you getting your COVID-19 pandemic-related information from? (Please tick all that apply)

Options: Organisational email(s), Organisational mobile communication, Social Media, Television, Radio, World Health Organisation, Health Protection Surveillance Centre (HPSC), Research Papers, Other (Please specify)

Has your work during COVID-19 impacted the way you interact with your family or household members? Please explain.

Options: Yes (Please specify), No (Please specify)

Had you experienced an Influenza Outbreak prior to COVID-19? If yes please provide some details.

Options: Yes (Please specify), No

Have you contracted COVID-19?

Options: Yes, No

Has a member of your household contracted COVID-19?

Options: Yes, No

Has a friend/family member (who does not live in your home) contracted COVID-19?

Options: Yes, No

Has a friend/family member died from COVID-19?

Options: Yes, No

Regarding the COVID-19 Pandemic: for each of the following statements, which option best represents your view?

Options: I feel adequately trained by my organisation to respond, I feel my role in my agency's response is valued, My organisation has provided me with adequate Personal Protective Equipment, My organisation is looking after my basic needs (e.g. Rest & Shelter), I am prepared to work extended hours/days as required, I am not willing to work on the COVID-19 response, My family/carer commitments are impacting my response to this pandemic, My childcare commitments are impacting my response to this pandemic, My household pet commitments are impacting my response to this pandemic, Public transport issues are impacting my response to this pandemic

Scale: Strongly disagree, Disagree, Somewhat disagree, Neither disagree or agree, Somewhat agree, Agree, Strongly agree, N/A

When was the last time you received training in the techniques for Donning & Doffing of Personal Protective Equipment (PPE)?

Options: During the COVID-19 response, within the past 6 months, within the past year, between 2 to 5 years ago, 6 years ago or greater

Staff Welfare: How would you rate the quality of the following provided to you during the COVID-19 response?

Options: Uniform Storage, Uniforms, PPE, Uniform Washing/Drying facilities, Shower facilities, Washing facilities, Changing facilities, Dining facilities

Scale: Extremely Poor, Moderately Poor, Slightly Poor, Neither good nor poor, Slightly good, Moderately good, Extremely good, N/A

Please indicate your level of satisfaction with respect to your organisation's provision of:

Options: PPE, Handwashing facilities, Uniform washing facilities, Social distancing measures, Staff hygiene facilities, Clinical guidelines, Clinical directives, Cleaning guidance for Ambulances/Vehicles, Health & Well-being Advice

Scale: Extremely displeased, Moderately displeased, Slightly displeased, Neither pleased nor displeased, Slightly pleased, Moderately pleased, Extremely pleased, N/A

Do you feel you have personal commitments which impact on your availability to respond during COVID-19? Please supply details.

Options: Yes (Please specify), No (Please specify)

Do you feel a sense of duty to your colleagues and organisation to make yourself available to work during the COVID-19 response? Please supply details.

Options: Yes (Please specify), No (Please specify)

Do you feel you are providing appropriate care/treatment to your patients when responding to their emergencies during the COVID-19 response? Please supply details.

Options: Yes (Please specify), No (Please specify)

Have you experienced any ethical dilemmas when responding to patients' needs during the response phase of COVID-19? Please supply details with no patient identifiers.

Options: Yes (Please specify), No

Do you believe that your occupation places you at higher risk of contracting COVID-19?

Options: Definitely yes, Probably yes, Might or might not, Probably not, Definitely not

If you wish to explain your response please use the following box:

What do you see as a particular issue(s) of concern during this pandemic response?

What do you see as a particular strength(s) during the current pandemic response?:

In relation to COVID-19 please answer the following block of statements.

Options: My organisation has acted in the best interests of high-risk staff (Age, Pre-existing health conditions), My organisation has acted in the best interest of all staff at all times, I have received appropriate levels of training to enable me to work safely, My organisation has provided appropriate PPE to enable me do my work safely, My organisation has been supportive of my personal commitments, I have concerns that I will get infected at work, I have concerns that I will bring home the infection, My family have concerns about me going to work, My family have concerns that I will get infected at work, My family have concerns that I will bring home the infection, My employer has been supportive when I required time off work due to suspected or known infection

Scale: Strongly Disagree, Disagree, Somewhat Disagree, Neither Disagree or Agree, Somewhat Agree, Agree, Strongly Agree

If you could change one thing about the pandemic response what would you change and why? _____

Below you will find a list of individuals & organisations with lead roles in managing this crisis. What is your confidence level regarding their actions during the response phase of the current pandemic COVID-19?

Options: Taoiseach, Minister for Health, Chief Medical Officer, Public Health Decision Makers, Health Service Executive, General Practitioners, Your Organisation, Your Base

Scale: 0% = No confidence, 100% = Full confidence

Given your experience of this pandemic COVID-19 would you feel confident working at your current role in a future pandemic?

Options: Yes, No, Other (please specify)

If a vaccine becomes available during the response phase of COVID-19 how soon would you avail of it? Please give a reason

Options: Immediately (Please specify), Wait a short while (1-2 months) (Please specify), Wait a medium length of time (3-6 months) (Please specify), Wait a long time (7 months or more) (Please specify), Never (Please specify)

Have you considered leaving your profession during the response phase of this pandemic? (Please specify why)

Options: Yes (Please specify), Maybe (Please specify), No

Reminder: we do not examine individual responses and your responses are anonymous. These questions are important in helping us understand the profile of the survey participants.

Do you identify as

Options: Female, Male

My age is (years) _____

Do you rent or own your home?

Options: Own, Rent, Live with relatives, Other (please specify)

For how many years have you lived in your current home (approximately)?

In which type of housing do you live?

Options: House, Apartment, Other (please specify)

I live in...

Options: A city, The suburbs or outskirts of a city, A town, A village, A rural area, Other (please specify)

What is your approximate annual household income?

Options: Less than 30000, 30000 - 70000, Over 70000

In which region of Ireland do you work? (please select all that apply)

Options: North West, North East, West, Mid West, Midland, East, South East, South

How far do you commute to work?

Options: <5km, 5 - 10km, 10 - 20km, 20 - 30km, 30 - 40km, > 40km

How do you commute to work?

Options: Walk, Cycle, Motorbike, Car / Car pool, Public Transport, Other (please specify)

Would you consider yourself actively involved in the community (prior to the COVID-19 response)?

Scale: Not Active (0%), Very Active (100%)

Community support: during this crisis have you experienced any acts of community support/kindness? (please specify e.g. support from a neighbour)

Options: No (Please specify), Yes (Please specify)

Are you a member of any local community group? (select all that apply)

Options: No, Yes Residents' Committee, Yes Local Neighbourhood Watch, Yes Religious Community, Yes Voluntary Group, Yes Other(s) please list (please specify)

Paper 4 Survey Questions

On what floor is your apartment situated?

Options: Basement ... 20th floor

Approximately how many floors are in your apartment block?:

Do you think an Apartment Fire will affect you?

Scale: Extremely Unlikely, Very Unlikely, Unlikely, Likely, Very Likely

Should it occur what level of impact would you experience from an Apartment Fire?

Scale: Very Low Impact, Low Impact, Moderate Impact, High Impact, Very High Impact

Have you ever experienced a Fire?

Scale: No, Indirectly someone close to me has experienced this emergency, Yes

Options: Household Fire, Workplace Fire, Other (Please note type of fire)

How much do you worry about an Apartment Fire?

Scale: Not at all, A little, A moderate amount, A lot, A great deal

Preparedness Scale - Apartment Fire

Scale: Not at all Prepared (0%) ... Completely Prepared (100%)

How prepared for an Apartment Fire do you think you are?

Scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

When the fire alarm is activated how do you generally feel?

Options: Low Negative Affect (e.g., Calm; Relaxed), High Negative Affect (e.g., Nervous; Fearful)

Scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Have you taken any action to protect your apartment against fire?

Options: Yes, No

Why have you not taken action to protect your apartment against fire? (Tick all that apply)

Options: I don't know what to do, I haven't had time, I don't want to think about it, It was too expensive, I don't think it will make a difference, Others will help me e.g., the emergency services, community members, etc., I will cope as I am, I was okay during a previous fire therefore I will be okay in future, Physically Unable due to disability, Other (please specify)

Which statement best represents your view regarding an apartment fire?

Options: Nothing I do to prepare will help should this emergency occur, I do not need to prepare for this emergency, I am not prepared to deal with a fire but I do see a benefit in preparing, I am prepared for this emergency

Do you have a household emergency plan for...

Scale: Yes, No

Options: All situations, Fire, Evacuation, Other (please specify)

Does your apartment have a fire evacuation plan (or set of evacuation instructions) similar to that pictured above?

Scale: Yes (inside the apartment), Yes (apartment complex hallway), No, Don't Know

When the alarm is activated which of the following applies to how you react?

Options: Stay in place - I do not leave until instructed, Carry on and complete current task, Look to neighbours for guidance, Gather personal belongings e.g., coat valuables before leaving, Leave the building immediately, Ignore the alarm, Check on neighbours, Other (please specify)

Why do you not leave the building immediately?

Options: Unsure what to do or where to go, Fire alarm is continually going off so I believe that it is probably a false alarm, I wait for instruction from other people, I wait for

instruction from emergency services, Management Policy is to stay in apartment, Other (please specify)

If you discovered a fire in an apartment which of the statements below best describes the action you would take?

Options: Using fire blanket or extinguisher, Seek advice from neighbours, Leave the building immediately raising the alarm while exiting, Leave the building immediately, Disregard the fire unless it gets out of control, Other (please specify)

Do you have the following in your home?

Scale: Yes, No though I should get this, No

Options: Smoke detector, Fire extinguisher, Carbon monoxide detector, Fire blanket, First aid kit, Torch, Extra batteries, Emergency contact information (paper format), A protective container for documents, Emergency evacuation smoke mask, Other (please specify)

How often do you test your smoke detector?

Options: Once a week, Twice a month, Once a month, Once every six months, Once a year, Never, Don't know

If your normal escape route and exit were obstructed or compromised during a fire would you?

Options: Try to use the exit route anyway, Use an alternative exit route, Stay where you are, Wait for advice

Did you receive any fire safety training/instruction when you moved into Apartment?

Scale: Yes, No

Have you ever taken part in a fire alarm evacuation drill?

Scale: Yes, No

Options: At work/college, At my apartment block

Who is responsible for fire safety in your apartment block? (Tick all that apply)

Options: Yourself, All Residents, Landlord, Apartment Complex Management Company, Fire Service, Other (please specify)

Do you identify as:

Options: Female, Male

My age is (Years)

Scale: 17, 24, 31, 38, 45, 52, 59, 65, 72, 79, 86, 93, 100

Do you rent or own your apartment?

Options: Own, Rent, Live with relatives, Other (please specify)

In which county do you live?

Options: Antrim ... Wicklow (Dropdown list with counties)

Do you have household insurance?

Options: Yes, No, Don't Know

For how many YEARS have you lived in your current apartment (approximately)?

Scale: 0, 8, 17, 25, 33, 42, 50, 58, 67, 75, 83, 92, 100

How many...

Scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15

Options: Children (younger than 18) live in your apartment, Adults live in your apartment

I am (tick all that apply)

Options: A member of the Emergency Services, A member of the Voluntary Emergency Services, A member of the Defence Forces, A member of the Health Services, An Emergency/Crisis/Business Continuity Professional, None of the above

Which of the following best describes your current situation?

Options: Working full time, Working part time, In education (Student), Looking after home/family, Retired, Not in education employment or training

Have you completed a Bachelors degree higher diploma or higher?

Options: Yes, No

What is your ethnic or cultural background?

Options: White, Black / African / Caribbean, Asian, Arab / Middle East, Other ethnic groups including mixed/multiple ethnic groups (please specify)

What is your approximate annual household income?

Options: Less than €30000, €30000 - €70000, Over €70000

Paper 5 Survey Questions

Were you in Ireland during Storm Emma (Feb/March 2018)?

Options: Yes, No

Was your area impacted by Storm Emma?

Options: Yes, No

Were you or your home negatively impacted by Storm Emma?

Options: Yes, No

Where were you during Snow Storm Emma?

Options: Antrim ... Wicklow (County Dropdown), A rural area (Community Setting), Yes, No (Do you usually live in that location)

How much did you worry about Storm Emma (before it arrived)?

Scale: Not at all, A little, A moderate amount, A lot, A great deal

How did your level of worry change during Storm Emma?

Options: Worry decreased, Worry stayed the same, Worry increased

What caused your level of worry to decrease?

What caused your level of worry to increase?

On reflection do you feel you were prepared for Storm Emma? Not at all Prepared (0%) ... Completely Prepared (100%)

Scale: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

As a result of the weather warnings did you seek any further information on how to prepare?

Options: Yes, No

When Storm Emma arrived I had...

Scale: 0 Days, 1-2 Days, 3-5 Days, 6-7 Days, 8+ Days

Options: Enough bottled water, Enough food, Enough medication

During Storm Emma did you have?

Scale: Yes, No

Options: An alternative means of heating, Shovel, Bag of salt (Clearing Paths), First aid kit, Large drinking water container, Battery-powered or hand-crank radio, Torch, Extra batteries, Candles & Matches/Lighter, Emergency contact information (paper format), Emergency Cash, An emergency kit should I need to evacuate

Did you...

Scale: Yes, No

Options: Make any plans for the possible loss of water supply, Make any plans for the possible loss of power supply, Purchase additional food supplies in preparation for Storm Emma

What other actions did you take to prepare for Storm Emma?

On reflection what else should you have done to prepare for Storm Emma?

During Snow Storm Emma...

Scale: Yes (in person), Yes (over the phone), No

Options: Did you assist any neighbours?, Did you assist any family members?, Did any of your neighbours assist you?, Did any of your family members assist you?

Please tell us more about how you gave assistance

Options: I helped with their shopping, I helped clear snow around their home, I spent some time talking with them, Other (please specify)

Please tell us about the assistance you received

Options: I was given help with shopping, I was given help clearing snow, Someone checked did I need assistance, I called for assistance from the emergency services, Other assistance (please specify)

Did this assistance help you cope with Storm Emma?

Scale: Extremely useful, Very useful, Moderately useful, Slightly useful, Not at all useful

Did you witness any of the following: (Tick all that apply)

Options: Roads, Paths, Neither

Options: Community organisations clearing snow from..., The Residents' Committee clearing snow from..., Individuals coming together to clear the snow from...

During Storm Emma did you witness any other positive examples of community support (Example: farmers transporting locals to work)?

Since Storm Emma have you done anything to protect you or your home against severe weather?

Options: Yes, No

Please provide details of anything you have done to protect you or your home against severe weather?

Options: _____

How satisfied were you with the national response to Storm Emma?

Options: Extremely satisfied, Mostly satisfied, Somewhat satisfied, Neither satisfied nor dissatisfied, Somewhat dissatisfied, Mostly dissatisfied, Extremely dissatisfied

In response to which of the Met Éireann weather warnings would you take action to prepare for severe weather?

Options: STATUS YELLOW, STATUS ORANGE, STATUS RED, Don't Know

How satisfied are you with the current Met Éireann weather warning system?

Options: Extremely satisfied, Mostly satisfied, Somewhat satisfied, Neither satisfied nor dissatisfied, Somewhat dissatisfied, Mostly dissatisfied, Extremely dissatisfied

Do you believe the weather warnings are... (Tick all that apply)

Options: Issued too frequently?, Difficult to understand?, Other (please specify)

Are you a member of any community/local groups?

Options: Yes, No

Do you play an active role in helping your local area protect the environment and/or facilities?

Options: Yes, Sometimes, No

How often have members of your community come together to solve problems?

Options: Very Frequently, Frequently, Sometimes, Rarely, Never

How active would you consider yourself in the community?

Scale: No (0%) ... Very Active (100%)

On Average how many hours per week do you spend volunteering in a community group? _____

Of which community groups are you a member?

Options: Residents' Committee, Local Neighbourhood Watch, Religious Community, Voluntary Group, Other (please specify)

Please tell us if there is anything which prevents you from being more active in your community? _____

Do you identify as:

Options: Female, Male

Age

Scale: 17, 24, 31, 38, 45, 52, 59, 65, 72, 79, 86, 93, 100

I live in...

Options: A city, The suburbs or outskirts of a city, A town, A village, A rural area, Other (please specify)

Do you rent or own your home?

Options: Own, Rent, Live with relatives, Other (please specify)

For how many YEARS have you lived in your current home (approximately)?

In which type of housing do you live?

Options: House, Apartment, Other (please specify)

How many children (younger than 18) live in your household?

How many adults live in your household?

I am (tick all that apply)

Options: A farmer, A member of the Emergency Services, A member of the Voluntary Emergency Services, An Emergency/Crisis/Business Continuity Manager, A member of the Defence Forces, A Nurse, A Medical Doctor, None of the above

Which of the following best describes your current situation?

Options: Working full time, Working part time, In education (Student), Looking after home/family, Retired, Not in education employment or training

What is your ethnic or cultural background?

Options: White, Black / African / Caribbean, Asian, Arab / Middle East, Other ethnic groups including mixed/multiple ethnic groups (please specify)

What is your approximate annual household income?

Options: Less than 30000, 30000 - 70000, Over 70000

Paper 6 Survey Questions

Do you work as a nurse/midwife in Ireland or have you ever worked as a nurse/midwife in Ireland?

Options: Yes, No

How likely do you think the following emergencies are to affect you or your home?

Risks: Flooding, Drought, Severe snow, Storm, High temperatures, Low temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g., water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Extremely Unlikely, Very Unlikely, Unlikely, Likely, Very Likely

Should they occur what level of impact do you think you or your home would experience from the following?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperature, Low Temperature, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g., water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Very Low Impact, Low Impact, Moderate Impact, High Impact, Very High Impact

Have you ever experienced any of the following emergencies?

Risks: Flooding, Drought, Severe Snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g., water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Yes, No

Would you consider yourself prepared to deal with an emergency?

Options: Yes, No, Somewhat, Unsure

Have you taken any action to protect yourself or your home in case of an emergency?

Options: Yes, No

If not, why?

Options: I don't know what to do, I haven't had time, I don't want to think about it, Expense factor, I don't think it will make a difference, I think the emergency services will help me, Other (please specify)

For each of the following emergencies which statement best represents your view?

Risks: Flooding, Drought, Severe snow, Storm, High Temperatures, Low Temperatures, Fire, Disruption to Energy Supply, Nuclear (Abroad), Radiation (Domestic), Loss of Critical Infrastructure (e.g., water), Infectious Disease (affecting humans), Infectious Disease (affecting livestock), Water Borne Disease Outbreak, Food Borne Disease Outbreak, Terrorism, Cyber Incident

Scale: Nothing I do to prepare will help should this emergency occur, I do not need to prepare for this emergency, I am not prepared to deal with this emergency but I do see a benefit in preparing, I am prepared for this emergency

Do you have a household emergency plan for...

Options: Yes, No

Options: All situations, Specific types of situations (please note below the context of the specific plan(s) e.g., a house fire, a flood, etc)

If yes, have you discussed such plans with other members of your household?

Options: Yes, No, Not Relevant

Which of the following do you have in your home?

Options: A smoke detector, A fire extinguisher, A fire blanket, A carbon monoxide (CO) detector, Generator, Gas Grill (With spare gas), Tank of fuel (Small can etc), Bicycle, General tool set, Axe and/or chain saw, Other (please specify)

Which of the following emergency supplies do you keep in your home?

Options: First aid kit, Supply of packaged food, Supply of bottled water, Medications,

Batteries, Torch, A phone list of emergency contacts, Important documents (passport(s), financial documents, etc), Cash, Battery powered radio, Other (please specify)

Regarding the emergency supplies noted in the question above.

Options: Yes, No

Options: Do you keep these supplies solely for the purpose of an emergency?, Are these emergency supplies kept in one location within your household?, Are these supplies regularly checked to ensure proper working order/ that they are kept in date?

Do you have...

Options: 0 Days, 1-2 days, 3-5 Days, 6-7 Days, 8+ Days

Options: Enough bottled water, Enough food, Enough medication

Is there a vehicle at your household?

Options: Yes, No

Do you have supplies set aside in this vehicle to be used only in the case of an emergency?

Options: Yes, No

If yes, could you please tell us what supplies you have set aside in this vehicle?

Which statement best describes your average refueling pattern for your vehicle?

Options: I quarter fill my tank, I half fill my tank, I three-quarters fill my tank, I fully fill my tank, No pattern, I Don't know, Other (please specify)

When do you refuel your vehicle?

Options: When the tank is close to empty (warning light is on), When tank is close to empty (but refuel before warning light is on), I drive until I have only a quarter of a tank, I drive until I have only a half a tank, No pattern, I Don't know, Other (please specify)

If you had to evacuate your home what assistance do you think you or a member of your household might require?

Options: A place to go (access to evacuation center), Information on the evacuation route, Transport, Help evacuating disabled/elderly family member, Help evacuating my pet(s), None, Other (please specify)

In the event of a major emergency in your region what level of assistance would you require from each of the following?

Options: Household members, People in my neighbourhood, Non-profit organisations such as Order of Malta, Civil Defence, St. Vincent de Paul, Emergency services, Other local government, National government

Scale: None, Very Little, Little, Some, Considerable, Substantial

Do you have household insurance?

Options: Yes, No, Don't know

Does this insurance cover a flood?

Options: Yes, No, Don't know

How important is it that national government invest in...

Options: Protecting private property, Protecting historical and cultural landmarks, Preventing development in hazardous areas, Protecting and reducing damage to utilities, Strengthening emergency services, Protecting critical facilities (e.g., hospitals, fire stations, transport networks)

Scale: Not important, Not very important, Neither important nor unimportant, Somewhat important, Very important

Which of the following do you support?

Options: The disclosure of natural hazard risks during real estate transactions, A local inventory of at-risk buildings and infrastructure, Improving the emergency preparedness of local schools, Steps to safeguard the local economy following a major emergency, Policies to prohibit development in areas subject to natural hazards, Use of local tax money to reduce risk and losses from natural hazards, Protecting historical and cultural structures

Scale: Strongly oppose, Somewhat oppose, Neither oppose or support, Somewhat support, Strongly support

I am...

Options: Female, Male

My age is...

Options: Under 25, 25-34, 35-44, 45-54, 55-64, 65 or older

I live in...

Options: A city, The suburbs or outskirts of a city, A town, A village, A rural area

What is the closest town/city to where you live?

In what county do you live?

Options: Antrim ... Wicklow (Dropdown list with counties)

Do you rent or own your home?

Options: Own, Rent

For how long have you lived in your current home (approximately)? (Years Only; e.g., 7 years) _____

In which type of housing do you live?

Options: Apartment, House, Other (please specify)

How many adults live in your household?

How many children (younger than 18) live in your household?

What is your current marital status?

Options: Single, Married, In a registered same-sex civil partnership, Separated, Divorced, Widowed

Which of the following best describes your current situation?

Options: Working full time, Working part time, Unemployed (Seeking work), Unemployed (Not seeking work), In education (Student), Permanently sick or disabled, Retired, Doing housework, looking after children (Homemaker), Other (please specify)

What is the highest qualification you have completed?

Options: None, Junior Certificate, Leaving Certificate, FETAC level 4 or 5, Apprenticeship, Advanced or higher certificate including FETAC level 6, Bachelors degree or higher diploma, Master degree or post-graduate diploma, PhD, D. Phil or equivalent, Other (please specify)

What is/was your job/qualification?

Options: Registered General Nurse, Registered Midwife, Registered Psychiatric Nurse, Registered Intellectual Disability Nurse, Registered Paediatric Nurse, Other (please specify)

How many years of experience do you have as a practicing registered nurse? (Years Only; e.g., 12 years) _____

What is your approximate annual household income (this question is not compulsory)?

Options: Less than 18000, 18001-30000, 30001-50000, 50001-70000, 70001-100000, Over 100000

Paper 6 - Focus Group Questions

Weather Forecasting: Accuracy / Uncertainty

How important are accurate weather forecasts to you in general?

- How often would you check the forecast to find out that information?
- How many days in advance do you want to get accurate weather forecasts?
- Does anybody else feel like that?

How many days ahead do you think the weather can be forecast accurately?

- How accurate do you think weather forecasts are?

When it comes to scheduling your daily or weekly activities would you plan these activities to take advantage of forecasted good weather, or to avoid bad weather conditions?

Weather Forecasts:

From which service do you get your weather forecast?

- (If more than one service) Which one do you prefer?
- Why is that?

Are there any particular reasons why you use this service?

- Why do you like the particular service you use?
- Is there anything you don't like about a particular service?

How do you access this weather forecast (using what device)?

Is anybody aware of the Met Éireann app?

- If yes, do you use the Met Éireann app?
- If yes, please share your feedback on it (user experience, accessibility).

Weather Warnings:

Are you familiar with the weather warnings system used in Ireland?

- How many different warning categories are there?
- Do you know their colours?
- What is the lowest/highest category?

Warnings

What would you do if there is a **yellow** snow/ice warning issued for your area?

What would you do if there is an **orange** snow/ice warning issued for your area?

What would you do if there is a **red** snow/ice warning issued for your area?

- Do the warnings influence your behaviour in any other way?

Do you think the weather warning system works?

- Do you feel you are given enough time to prepare when a severe weather warning is issued?
- How do you feel when the severe weather that was predicted doesn't happen?

How do you become aware of a weather warning being issued for your area?

How could awareness of the weather warning system be improved?

- Why do you think that would help?
- Does anybody else agree with that suggestion?

Weather Service Needs:

What do you see as the key roles or services delivered by Met Éireann at present?

Prompts:

- Do you think it succeeds in these roles?

What changes would you like to see to the services they provide?

How could their services be improved?

- Why do you think that would make a difference?
- Would you be prepared to pay to see that change?

Would you be willing to pay for weather and climate information in the future? Either the current services or those you have suggested?

10.2 Appendix Chapter 2 - Paper 1

Supplementary Table 1: Goodman & Kruskal's Gamma - Associations with Gender (Female)

	Likelihood		Impact		Risk Rating	
	Gamma	Sig	Gamma	Sig	Gamma	Sig
Flooding	0.1297	***	-0.0230	**	0.0508	*
Drought	0.1395	*	0.0504	***	0.0597	*
Snow	0.0552		0.1059	**	0.0714	*
Storm	0.0657	***	0.0504	***	0.1240	***
High Temperatures	-0.0424		0.0655		0.0015	
Low Temperatures	0.0885	**	0.1042	***	0.0424	**
Fire	0.1512	***	-0.1029	**	0.0271	
Disruption to Energy Supply	0.1737	***	0.1558	***	0.1959	***
Nuclear Incident Abroad	0.1645	***	0.0856		0.1398	***
Radiation (Domestic)	0.2638	***	0.1528	***	0.1487	***
Loss of Critical Infrastructure (e.g. Water)	0.0766	**	0.1816	***	0.1320	***
Infectious Disease Affecting Humans	0.1861	***	0.0864	**	0.1593	***
Infectious Disease Affecting Animals	0.1100	***	0.1360	***	0.1326	***
Waterborne Disease Outbreak	0.1901	***	0.1360	***	0.1742	***
Foodborne Disease Outbreak	0.2057	***	0.1003	**	0.1674	***
Terrorism	0.2492	***	0.1875	***	0.2361	***
Cyber Incident	0.1528	***	0.1563	***	0.1539	***

*p<0.1, **p<0.05, ***p<0.01

Supplementary Table 2: Polychoric correlations for likelihood & impact measures

Likelihood	Flood	Drought	Snow	Storm	High Temp	Low Temp	Fire	Disruption to Energy Supply	Nuclear Incident Abroad	Radiation Domestic	Loss of Critical Infrastructure	Infectious Disease Humans	Infectious Disease Animals	Waterborne Disease	Foodborne Disease	Terrorism
Flooding	1.000															
Drought	0.372	1.000														
Snow	0.276	0.405	1.000													
Storm	0.260	0.293	0.616	1.000												
High Temperatures	0.167	0.369	0.394	0.387	1.000											
Low Temperatures	0.210	0.246	0.538	0.550	0.470	1.000										
Fire	0.180	0.154	0.203	0.269	0.171	0.201	1.000									
Disruption to Energy Supply	0.179	0.252	0.347	0.440	0.246	0.336	0.508	1.000								
Nuclear Incident Abroad	0.196	0.295	0.283	0.253	0.207	0.209	0.325	0.305	1.000							
Radiation (Domestic)	0.183	0.297	0.263	0.242	0.219	0.222	0.328	0.317	0.741	1.000						
Loss of Critical Infrastructure (e.g. Water)	0.249	0.282	0.332	0.358	0.207	0.266	0.391	0.541	0.436	0.449	1.000					
Infectious Disease Affecting Humans	0.263	0.272	0.305	0.333	0.224	0.279	0.379	0.392	0.528	0.496	0.570	1.000				
Infectious Disease Affecting Animals	0.250	0.283	0.324	0.338	0.248	0.317	0.278	0.333	0.484	0.453	0.382	0.644	1.000			
Waterborne Disease Outbreak	0.229	0.300	0.277	0.321	0.206	0.241	0.363	0.388	0.531	0.538	0.542	0.685	0.644	1.000		
Foodborne Disease Outbreak	0.238	0.284	0.290	0.351	0.237	0.270	0.404	0.407	0.525	0.516	0.520	0.689	0.642	0.860	1.000	
Terrorism	0.229	0.223	0.278	0.297	0.171	0.237	0.265	0.259	0.515	0.508	0.305	0.524	0.570	0.568	0.580	1.000
Cyber Incident	0.216	0.194	0.246	0.328	0.174	0.276	0.293	0.321	0.452	0.419	0.376	0.526	0.510	0.530	0.560	0.623

Impact	Flood	Drought	Snow	Storm	High Temp	Low Temp	Fire	Disruption to Energy Supply	Nuclear Incident Abroad	Radiation Domestic	Loss of Critical Infrastructure	Infectious Disease Humans	Infectious Disease Animals	Waterborne Disease	Foodborne Disease	Terrorism
Flooding	1															
Drought	0.546	1.000														
Snow	0.374	0.536	1.000													
Storm	0.346	0.410	0.672	1.000												
High Temperatures	0.272	0.525	0.504	0.486	1.000											
Low Temperatures	0.218	0.320	0.547	0.569	0.653	1.000										
Fire	0.399	0.309	0.305	0.357	0.232	0.226	1.000									
Disruption to Energy Supply	0.186	0.265	0.392	0.386	0.374	0.412	0.320	1.000								
Nuclear Incident Abroad	0.239	0.332	0.279	0.245	0.214	0.186	0.393	0.279	1.000							
Radiation (Domestic)	0.293	0.375	0.307	0.279	0.289	0.240	0.406	0.344	0.831	1.000						
Loss of Critical Infrastructure (e.g. Water)	0.268	0.369	0.378	0.329	0.298	0.323	0.406	0.606	0.478	0.574	1.000					
Infectious Disease Affecting Humans	0.277	0.390	0.349	0.335	0.330	0.304	0.430	0.419	0.590	0.663	0.650	1.000				
Infectious Disease Affecting Animals	0.208	0.360	0.297	0.281	0.331	0.257	0.146	0.285	0.440	0.489	0.446	0.593	1.000			
Waterborne Disease Outbreak	0.278	0.391	0.343	0.336	0.303	0.305	0.417	0.406	0.548	0.625	0.649	0.799	0.587	1.000		
Foodborne Disease Outbreak	0.280	0.385	0.336	0.330	0.325	0.301	0.382	0.384	0.535	0.611	0.593	0.814	0.619	0.900	1.000	
Terrorism	0.287	0.346	0.306	0.293	0.285	0.234	0.351	0.243	0.595	0.596	0.413	0.621	0.521	0.609	0.628	1.000
Cyber Incident	0.168	0.271	0.266	0.265	0.300	0.288	0.248	0.307	0.427	0.453	0.423	0.510	0.471	0.513	0.548	0.650

Supplementary Table 3: Loss of Critical Infrastructure – Risk Rating

OLS Regression			
Dependent Variable: Loss of Critical Infrastructure – Risk Rating			
Explanatory variables	Coef.	Std. Err.	P
Female	1.023***	0.282	<0.001
Has a Child	-0.306	0.289	0.29
Years at address	0.008	0.015	0.609
Owns home	0.579	0.369	0.117
Lives in a village	0.665*	0.370	0.072
Lives in a town	-0.491	0.387	0.205
Lives in a suburb/outskirt of a city	0.081	0.494	0.87
Lives in a city	-0.295	0.416	0.479
Age 35-54	0.868***	0.318	0.006
Age 55 & Over	0.451	0.509	0.376
Income 30,000-70,000	-0.577	0.376	0.125
Income Over 70,000	-0.793*	0.424	0.062
Higher Educated	1.019***	0.322	0.002
Household Preparedness Score	-0.463**	0.188	0.014
Risk Exposure	0.313***	0.046	<0.001
Non-protective responses	-0.286***	0.038	<0.001
R ² : 0.11			
F: 11.44***			
N: 1,459			

*p<0.1, **p<0.05, ***p<0.01

Supplementary Table 4: Loss of Critical Infrastructure – Likelihood

Ordered Probit Regression			
Dependent Variable: Loss of Critical Infrastructure – Likelihood			
Explanatory variables	Coef.	Std. Err.	P
Female	0.102*	0.059	0.085
Has a Child	-0.083	0.060	0.168
Years at address	0.000	0.003	0.888
Owns home	0.168**	0.077	0.03
Lives in a village	0.066	0.077	0.396
Lives in a town	-0.103	0.081	0.202
Lives in a suburb/outskirt of a city	-0.111	0.103	0.285
Lives in a city	-0.073	0.087	0.402
Age 35-54	0.198***	0.067	0.003
Age 55 & Over	0.117	0.106	0.27
Income 30,000-70,000	-0.126	0.079	0.109
Income Over 70,000	-0.120	0.089	0.177
Higher Educated	0.180***	0.067	0.008
Household Preparedness Score	-0.031	0.039	0.435
Risk Exposure	0.069***	0.010	<0.001
Non-protective responses	-0.042***	0.008	<0.001
χ^2 (Chi-squared) (df = 16): 134.34			
N: 1,459			
/cut1	-1.184	0.133	
/cut2	-0.273	0.129	
/cut3	0.845	0.130	
/cut4	2.118	0.137	

*p<0.1, **p<0.05, ***p<0.01

Supplementary Table 5: Loss of Critical Infrastructure – Impact

Ordered Probit Regression			
Dependent Variable: Loss of Critical Infrastructure – Impact			
Explanatory variables	Coef.	Std. Err.	P
Female	0.216***	0.060	<0.001
Has a Child	-0.020	0.061	0.745
Years at address	0.002	0.003	0.587
Owens home	0.029	0.078	0.715
Lives in a village	0.156**	0.079	0.048
Lives in a town	-0.029	0.082	0.724
Lives in a suburb/outskirt of a city	0.155	0.105	0.14
Lives in a city	-0.052	0.088	0.552
Age 35-54	0.067	0.067	0.32
Age 55 & Over	0.005	0.108	0.962
Income 30,000-70,000	-0.053	0.080	0.509
Income Over 70,000	-0.172*	0.090	0.056
Higher Educated	0.141**	0.068	0.039
Household Preparedness Score	-0.098**	0.040	0.014
Risk Exposure	0.027***	0.010	0.006
Non-protective responses	-0.056***	0.008	<0.001
χ^2 (Chi-squared) (df = 16): 105.17			
N: 1,459			
/cut1	-1.680	0.139	
/cut2	-1.045	0.133	
/cut3	-0.250	0.131	
/cut4	0.823	0.131	

*p<0.1, **p<0.05, ***p<0.01

Supplementary Table 6. Regression Analysis: Gender Coefficients

		Gender Coefficients β		
		Likelihood (Ordered Probit)	Impact (Ordered Probit)	Risk Rating (OLS)
Natural Risks	Flooding	0.166***	-0.088	0.164
	Drought	0.157**	0.017	0.563***
	Snow	0.081	0.138**	0.618**
	Storm	0.213***	0.122**	0.919***
	High temperatures	-0.004	0.035	0.141
	Low Temperatures	0.129**	0.123**	0.636**
Technological Risks	Fire	0.152**	-0.115*	0.158
	Disruption to Energy Supply	0.219***	0.187***	1.256***
	Nuclear (Abroad)	0.152**	0.077	0.841***
	Radiation (Domestic)	0.261***	0.108*	1.226***
	Cyber Incident	0.146**	0.200***	1.029***
Civil Risks	Loss of Critical Infrastructure	0.102*	0.216***	1.023***
	Infectious Disease (humans)	0.232***	0.030	1.008***
	Infectious Disease (livestock)	0.118**	0.154***	1.095***
	Water Borne Disease Outbreak	0.249***	0.145**	1.344***
	Food Borne Disease Outbreak	0.239***	0.076	1.029***
	Terrorism	0.322***	0.207***	1.856***

Note: *p<0.1, **p<0.05, ***p<0.01. Regression analysis gender coefficients while controlling for Table 1 variables. Coefficients are reported as unstandardized beta coefficient.

10.3 Appendix Chapter 3 – Paper 2

Table A1: SLR structured stepwise search - overview

	“Emergency preparedness” OR “Disaster preparedness” OR “crisis preparedness”	“Perceived preparedness” OR “Actual preparedness” OR “checklist preparedness”	“household preparedness” OR “individual preparedness”	"regression"	Research articles... Exclude Book/ Chapters, Conference abstracts	English & Access check	Outputs combined	Duplicates removed - via Mendeley	Completion of the eligibility check
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
Academic Search/Business Source Complete	28848	66	22	15	12	12	.	.	.
Google Scholar	17200	808	283	270	134	122	.	.	.
Emerald Management Xtra	2261	1012	256	38	35	31	.	.	.
SAGE journals online	2642	21	5	5	5	5	.	.	.
ScienceDirect	9227	74	21	12	10	10	.	.	.
Scopus	7122	26	4	2	2	2	.	.	.
SpringerLink	5248	155	83	54	2	2	.	.	.
Taylor & Francis Online	4332	21	1	1	1	1	.	.	.
Web of Science	6153	25	3	2	2	2	.	.	.
Wiley Online Library	5508	34	7	6	5	5	.	.	.
Total	88541	2242	685	405	208	192	192	158	69

Table A2: SLR outputs

Reference	Country Context	Hazard Context	Preparedness Variable		Analysis - Preparedness	Constructs & Variables - Predicting Preparedness	
						<u>Key:</u> NS = Non-Significant variable SIG = Significant variable +ev = Significant positive variable	-ev = Significant negative variable N/A = Variable not in a model A, B, C, D , denote results from multiple models
Ablah, <i>et al.</i> ¹	USA	Disasters	Preparedness (deemed to be “prepared”) Relevance rating: 2	Actual	Logistic Regression	Medical factors (List), +ev & NS (Race - List), NS Female, -ev Age (List), +ev Rural, NS Education (List), NS	Children, NS Income above \$50,000, +ev Unable to afford a doctor in past year, NS Unemployed, +ev Subjective Preparedness (List), +ev
Abunyewah <i>et al.</i> ²	Republic of Ghana	Flooding	Intentions to prepare Relevance rating: 2	Intention	Structural Equation Modelling	Information sufficiency, +ev Message clarity, +ev Source credibility, +ev	
Adame and Miller ³	USA	Flooding	Perceived preparedness Relevance rating: 2	Perceived	Linear Regression	Response-efficacy, -ev Self-efficacy, +ev Certainty, +ev	Immediacy, +ev Salience (perceived threat), NS Susceptibility, NS
Annis <i>et al.</i> ⁴	USA	Disasters	72-hour disaster kit Relevance rating: 2	Actual	Logistic Regression	Significant: Gender, Marital Status, Education Level, Income, Duty Status, Chronic Health Condition, Will, Disaster Kit for Two Weeks, Safe Shelter, Secondary Shelter, Emergency Plan, Communication Plan, Evacuation Plan, Affected by Prior Disaster, Taken a Preparatory Class, Live in Disaster Area, Non-significant: Minor Child in Household, Deployed Member	
Appleby-Arnold <i>et al.</i> ⁵	island of Malta	Disasters	Feeling personally prepared Relevance rating: 2	Perceived	Correlations & Coding Framework	Qualitative findings: "participants linked preparedness, or lack thereof, specifically to local attitudes" "Others explained a lack of preparedness by linking to perceived cultural traits"	
Basolo <i>et al.</i> ⁶	USA	Hurricane / Earthquakes	Perceived level of preparedness Family plan Supplies Mitigation Shut off utilities	Perceived & Actual	Logistic Regressions	<i>DV = Perceived Level of Preparedness for Earthquakes (=A), for Hurricanes (=B)</i> Confidence in government, +ev (A & B) Information sources, +ev (A & B) Fatal, -ev (B) Non-significant: Experience, Dread, Happen, Gender, Marital status, Annual household income, Age, Race , Child, Education, Tenure.	

			Relevance rating: 3			<i>Preparedness Actions for Earthquakes</i> <i>DV = Family Plan</i> - Information sources +ev, remainder NS <i>DV =Supplies</i> - All NS <i>DV =Mitigation</i> - All NS <i>DV = Shut off Utilities</i> - Information sources & Tenure +ev, remainder NS <i>Preparedness Actions for Hurricanes</i> <i>DV = Family Plan</i> - Confidence in government & Dread & Marital status +ev, remainder NS <i>DV =Supplies</i> - Child & Tenure +ev, remainder NS <i>DV = Shut off Utilities</i> - Gender & Age, remainder NS	
Basolo <i>et al.</i> ⁷	USA	Hurricane	Perceived level of preparedness. Intent to evacuate. House preparedness (sandbags on-site). Household preparedness (family plan). Household preparedness (all recommended items). Relevance rating: 3	Intention / Perceived & Actual	Ordered Logistic Regression & Logistic Regression	<i>Model C, DV's= Level of perceived preparedness (A), household preparedness (family plan) (B), household preparedness (all recommended items on hand) (C)</i> White, NS (All) Gender, NS (All) Marital status, NS (A & B), +ev (C) Child, NS (All) Age, +ev (A), NS (B & C) Immigrant, -ev (A), NS (B & C)	Education, NS (All) Annual HH income, NS (All) Tenure, +ev (A & C), NS (B) Information (some), NS (All) Information (a lot), NS (A & C), +ev (B) Hurricane experience, NS (A & C), +ev (B) Perceived readiness of local government, +ev (A & B), NS (C) Perceived risk, +ev (A), NS (B & C)
Baytiyeh and Naja ⁸	Lebanon	Earthquake	Disaster preparedness Relevance rating: 2	Actual	Multiple Regression	Hazard and vulnerability awareness +ev Fatalistic beliefs -ev Denial beliefs -ev	
Becker <i>et al.</i> ⁹	New Zealand	Earthquake	Preparedness activities Relevance rating: 2	NA	Core Categories Identified	• Raising awareness and knowledge • Thinking and talking (hazards and preparedness) • Understanding consequences • Developing skills • Formation of beliefs (hazard beliefs - risk perception, preparedness beliefs and personal beliefs) •	• Emotions and feelings (e.g. Worry/Fearful) • Societal factors (e.g. Community participation) • Uncertainty • Acceptance of loss • Formation of intentions to prepare • Resource issues • Preparedness (Actual) • Sustained preparedness
Becker <i>et al.</i> ¹⁰	New Zealand	Earthquake	Household preparedness	NA	Thematic Analysis	<i>Types of experience:</i> • Direct disaster experience • Indirect disaster experience	<i>Effects of experience:</i> • Thinking and talking • Awareness and knowledge

			Relevance rating: 2			• Vicarious experience • Life experience	• Understanding consequences • Formation of beliefs • Developing preparedness, including skills • Emotions and feelings
Becker <i>et al.</i> ¹¹	New Zealand	Earthquake	Household preparedness	NA	Thematic Analysis	<i>Hazard Beliefs:</i> • What Do People Believe Natural Hazards to Be? • Hazard Beliefs that Encourage Preparedness • Hazard Beliefs that Discourage Preparedness <i>Preparedness Beliefs:</i> • What Do People Perceive Preparedness to Be?	• Preparedness Beliefs that Encourage Preparedness • Preparedness Beliefs that Discourage Preparedness <i>Personal Beliefs:</i> • Personal Beliefs that Encourage Preparedness Several • Personal Beliefs that Discourage Preparedness
			Relevance rating: 2				
Bodas <i>et al.</i> ¹²	Israel	War	Preparedness index (Preparedness Behaviour)	Actual	Multivariate Linear Regression	Place of birth, +ev Place of residence, +ev Gender, NS Search for information, +ev	Sense of preparedness, +ev Severity of impact on family's routine, -ev
			Relevance rating: 2				
Bodas <i>et al.</i> ¹³	Israel	War	Preparedness index (Behaviour)	Actual	Linear Regression	Gender, +ev Age, +ev	Sense of preparedness, +ev Ignoring instructions, -ev
			Relevance rating: 2				
Bourque <i>et al.</i> ¹⁴	USA	Terrorism	Preparedness	Actual	Path Analysis	<i>Direct paths:</i> Perceived risk, NS Knowledge, +ev	Response efficacy, +ev Milling behavior, +ev
			Relevance rating: 2				
Bradford <i>et al.</i> ¹⁵	Belgium Finland Germany Ireland Italy Scotland	Flooding	Preparedness	Perceived	T-Test	Hazard Awareness, NS Knowledge of evacuation routes, SIG Evacuated properties in previous flood, SIG Flood Experience, SIG Gender (Male), SIG	
			Relevance rating: 2				
Chen <i>et al.</i> ¹⁶	China	Disasters (earthquakes, typhoons, infectious diseases)	Household preparedness	Actual	Logistic Regression	Gender, SIG Age, NS Education, SIG Residency (Urban), NS Regions SIG Monthly household income, NS Prior exposure, SIG	Participation in emergency training* last year, SIG Emergency knowledge score, SIG Risk awareness score, NS Attitudes towards emergency preparedness, SIG Self- reliance, SIG Fate submissiveness, SIG
			Relevance rating: 2				

Cope <i>et al.</i> ¹⁷	USA	Natural Hazard “Environmental threat (coastal)”	Perceived preparedness	Perceived	Logistic Regression	(<i>Model 1</i>) Local resources (social capital), NS Extra-local resources (social capital), SIG Regional resources (social capital), SIG Community associations (social capital), NS General trust (social capital), NS Number of adults know by name (social capital), NS Length of residence (proportion) (social capital), NS Homeownership (social capital), SIG At risk, SIG	Work in the oil industry, SIG Work in fishing industry, NS Employed, SIG Income, NS Education, SIG Race, NS Age, SIG Household size, NS Number of kids, NS Married, NS Male, NS
Corwin <i>et al.</i> ¹⁸	USA	Volcanic	Composite score for preparedness (CP) Planning Score Supplies Score Action Score Relevance rating: 2	Actual	T-Tests	• “The average action indicator score is significantly greater for response professionals” • “Overall, response professionals have an above average preparedness score while laypeople exhibit slightly below average preparedness” • “A statistically significant difference in preparedness exists for five of the 20 preparedness measures listed”	
DeBastiani <i>et al.</i> ¹⁹	USA	Public Health Emergencies	Preparedness items Perceived household preparedness Relevance rating: 3	Perceived & Actual	Logistic Regression Analysis	(<i>Number of Preparedness Items</i>) Sex, SIG Race, SIG Age, SIG Education, SIG	(<i>Perceived Preparedness</i>) Sex, SIG Race, SIG Age, SIG Education, SIG
DeYoung <i>et al.</i> ²⁰	USA	Disaster (hurricanes, tornados, severe thunderstorms, and ice storms)	Disaster preparedness Relevance rating: 2	Actual	Multiple Regression	Psychological sense of community, +ev Sense of place, -ev	Preparedness self-efficacy, +ev Risk perception, +ev Confidence in government, NS
DeYoung <i>et al.</i> ²¹	USA	Disaster	Preparedness Relevance rating: 2	Actual	Regression	Risk perception, +ev Financial coping, +ev Trust in local government to respond to a disaster, +ev	Confidence for engaging in preparedness, +ev
Donahue <i>et al.</i> ²²	USA	Disaster	Preparedness (Self- Assessment) Relevance rating: 2	Perceived	Ordered Logit Regression	Male, NS Age, NS Education, NS White, +ev Married, NS Average loss, NS Risk tolerance, +ev Self-reliance, +ev	Future orientation, NS Compliance, +ev Homeowner, +ev Disaster experience, +ev Likelihood, NS Consequence, +ev Informed, +ev

Donner and Lavariega-Montforti ²³	USA	Disasters (flooding, hail, high winds, and hurricanes)	Preparedness Relevance rating: 2	Actual	OLS Regression	Ethnicity, NS Income, +ev Disaster experience, +ev	Education, NS Gender, NS Age, +ev
Ejeta <i>et al.</i> ²⁴	Ethiopia	Flooding	Household preparedness Relevance rating: 2	Actual	Structural Equation Model	(Table 5) Community participation, NS Perceived threat, -ev Collective efficacy, NS	Perceived susceptibility, NS Perceived severity, NS Cues to action, -ev Perceived benefits (-) barriers, -ev
Ejeta <i>et al.</i> ²⁵	Ethiopia	Flooding	Preparedness intentions Relevance rating: 2	Intention	Structural Equation Model	Negative outcome expectancy, +ev Perceived likelihood, +ev Anxiety, +ev Trust, +ev	Negative feelings, NS Positive outcome expectancy, +ev Perceived consequence, -ev Past experience, +ev
Espina and Teng-Calleja ²⁶	Philippines	Flooding - typhoon and heavy monsoon	Disaster preparedness behaviors Relevance rating: 2	Actual	Regression	Risk Perception, +ev Severity of Disaster Experience, +ev Community Disaster Preparedness, +ev	
Han <i>et al.</i> ²⁷	China	Earthquakes	Preparedness Relevance rating: 2	Perceived	Ordinal Logit Regression	Preparedness Probability, +ev Perceived consequence, +ev Family trust, NS General trust, NS	Specific trust, NS Government trust -ev , Impact, +ev Support, +ev
Henly-Shepard <i>et al.</i> ²⁸	Hawaii (USA)	Natural Hazard	Perceived household preparedness, Coping capacity (e.g. (stocked food/water supplies/emergency rations) Adaptive capacity (e.g. knowledge in traditional medicine, fishing) Relevance rating: 3	Perceived & Actual	Regression	"The majority of explanatory variables regressed against all three outcomes, self-reported preparedness, coping and adaptive capacity indices, were not found to be statistically significant. The findings from each regression specification are listed in Appendix 5 in ESM." Non-significant results are not reported. <i>Summary for perceived preparedness, multiple model specifications</i> 5-10 years residence, -ev Know of safe places to evacuate to, +ev Have experienced or heard stories of disasters, +ev <i>Summary for Household Coping Capacity, multiple model specifications</i> Feel the community is prepared, +ev 1-5 years residence, -ev Participation in a Community Group, +ev <i>Summary for Household Adaptive Capacity</i> Female, -ev I can and will support myself/my family, +ev I can and will support myself/my family and anyone in need of assistance, +ev I can and will support myself/my family and community at large, +ev 1-5 years residence, +ev Participation in a Community Group, +ev	

Hoffmann and Muttarak ²⁹	Philippines and Thailand	"Natural Disaster"	Disaster preparedness	Actual	Logit And Ordered Logit Model	4 Models - Baseline: Philippines A = binary; Philippines B = Scale; Thailand C = binary; Thailand D = Scale Years of education, SIG (All) Disaster experience, SIG (All) Age 30–39, SIG (C), NS (A, B, D) Age 40+ NS (All) Health status, SIG (B), NS (A, C, D) Married/Cohabiting, NS (All) Currently working, NS (All) Female, N/A (A, B), NS (C, D) Mother has secondary education, NS (A, B), N/A (C, D) Father has secondary education, NS (A), SIG (B), N/A (C, D) Started working at age <12, SIG (A), NS (B), N/A (C, D)	Household size, SIG (A, B), NS (C, D) % children (aged <5) in hh, SIG (A, B), NS (C, D) % older people (aged >65) in hh, NS (All) % with secondary education in hh, NS (All) Years of residence, SIG (A), NS (B, C, D) Own house, N/A (A, B), NS (C, D) Own land, N/A (A, B), NS (C, D) House located near coast, N/A (A, B), SIG (C, D) House located near river, NS (All) House located near mountain, SIG (A), NS (B, C, D) Area, SIG (All)
Hung ³⁰	USA	Hurricane	Preparedness item/behaviour: Emergency Contact Insurance Evacuation Zone	Actual	Logistic Regression	Emergency Contact (A), Insurance (B), Evacuation Zone (C) Hurricane risk perception, NS (ALL) Hurricane experience, NS (ALL) Length of marriage, +ev (A, B), NS (C)	Household size, NS (ALL) Presence of very young children, NS (ALL) Own/rent home, SIG (B), N/A (A, C) Mobile home, SIG (B), N/A (A, C) Agreement, SIG (ALL)
Jang et al. ³¹	New Zealand & Taiwan	Earthquake	Intention (preparedness)	Intention	Structural Equation Model	SEM: Taiwan (A), New Zealand (B) (Paths to Intention only) Negative Outcome Expectancy, -ev (A & B), Positive Outcome Expectancy, +ev (A & B), Critical awareness (CRITAWA), +ev (A), N/A (B) Community participation, +ev (A & B), Collective efficacy, +ev (A & B), Trust, NS (A), +ev (B)	
Jassempour et al. ³²	Iran	"Natural Disaster"	Disaster Survival Kit (Decision Stages, unaware of having a kit)	Actual	Ordered Logit Regression	(Note: Predictors of changes in stages for providing disaster survival kit) Perceived susceptibility, NS	Perceived severity, NS Perceived benefits, +ev Perceived barriers, -ev Self-efficacy, NS
Joffe et al. ³³	USA & Turkey	Earthquakes & Household Fires	Overall preparedness, Earthquake preparedness, & Fire preparedness)	Actual	Multivariate & Univariate Analysis	Table 8 significant predictors of preparedness - multivariate Intervention (A), Control (B) DV: Predictors overall preparedness	DV: Predictors of earthquake preparedness Anxiety (earthquake), +ev (A & B) Trust, -ev (A & B)

			Relevance rating: 2			Self-efficacy, +ev (A & B) Collective efficacy, -ev (A & B) Anxiety (earthquake), +ev (A & B) Trust, +ev (A), -ev (B)	DV: Predictors of fire preparedness Self-efficacy, -ev (A), +ev (B)
Kelly and Ronan ³⁴	Australia	Natural Hazards	Preparedness & Intention Relevance rating: 2	Intention & Actual	Hierarchical Multiple Regression	DV Actual Prep Sex, -ev Age, NS Paid workforce, NS Aust/NZ, +ev Participation (Community), NS Children hazard education, NS Confidence (Government), NS Collective efficacy, NS Empowerment, NS Trust, NS	Distrust, NS Negative outcome expectancy, -ev Positive outcome expectancy, NS Responsibility for others, NS Personal responsibility, +ev "The model was run using intention to prepare as the dependent variable, but was not significant."
Kerstholt <i>et al.</i> ³⁵	Netherlands	Flooding	Preparations & Intentions Relevance rating: 2	Intention & Actual	Regressions	DV: Preparations (A), Intentions (B) Affect, -ev (A), +ev (B) Probability, +ev (A & B) Consequences, +ev (A), NS (B)	Response efficacy, NS (A), +ev (B) Participation, +ev (A & B) Community efficacy, NS (A & B) Trust, NS (A), +ev (B) Empowerment, NS (A & B)
Kirschenbaum ³⁶	Israel	Multi-Hazard Location	Preparedness: provisions/supplies, skills, planning, and protection. Relevance rating: 2	Actual	Regression	Regression - Supply (A), Skills (B), Plans (C), Protect (D) Family Based Networks, +ev (A), NS (B), NS (C), +ev (D) Micro-Neighborhood Network, +ev (A), NS (B), +ev (C), NS (D) Macro-Community Networks, +ev (A), +ev (B), NS (C), NS (D)	
Kirschenbaum ³⁷	Israel	Multi-Hazards: Natural, Accident, Industry, Technology, National, & Self-Family	Preparedness: provisions/supplies, skills, planning, and protection. Relevance rating: 2	Actual	Regression	Regression - Supply (A), Skills (B), Plans (C), Protect (D) Self-Family (e.g. Chem Weapons), +ev (A), NS (B, C & D) National (e.g. War), +ev (A), NS (B, C & D) Natural (e.g. Earthquakes), +ev (B), NS (A, C & D) Accident (e.g. Road and Work), +ev (A & B), NS (C & D) Industry (e.g. Industrial Accidents), NS (All) Technology (e.g. Power Outage), +ev (B), NS (A, C & D)	
Kirschenbaum ³⁸	Israel	Multi-Hazard Location	Preparedness: provisions/supplies, skills, planning, and protection. Relevance rating: 2	Actual	Regression	Regression - Supply (A), Skills (B), Plans (C), Protect (D) Couples/Single Household, NS (A, B, C, D) Visits (Family Networks), +ev (A), +ev (B), NS (C), NS (D) Telephone Family & Relatives, NS (A, B, C, D) Seek Family Advise, NS (A, B, C, D) Proximity to Relatives, +ev (A), NS (B), NS (C), -ev (D) State of Family Relations, NS (A), NS (B), -ev (C), NS (D) Gender, NS (A), +ev (B), NS (C), +ev (D) Children, NS (A, B, C, D)	

Kirschenbaum <i>et al.</i> ³⁹	Israel	Earthquake	Actual preparedness & Perceived preparedness Relevance rating: 3	Perceived & Actual	Linear Regression Hierarchical Linear Regression	<i>Hierarchical linear regression (Model 3 with Moderators) predicting actual preparedness (A) and perceived preparedness (B)</i> Age, NS (A), -ev (B) Gender, NS (A), +ev (B) Education, +ev (A & B)	Living in risk zone, NS (A), +ev (B) Religion, -ev (A), NS (B) Past experience, +ev (A), NS (B) Trust in information source, NS (A & B) Past experience*trust, NS (A & B)
Knuth <i>et al.</i> ⁴⁰	Germany	Fire and Medical Emergency	fire protection (Fire Extinguisher, Fire Blanket & Smoke Detectors) and Medical Emergency (First Aid Kit) Relevance rating: 2	Intention & Actual	Logistic Regression	<i>DV = Fire Extinguisher - Availability (A), Consideration (B)</i> Knowledge, NS (A), SIG (B) Perceived knowledge (accident) behaviour NS (A & B) Perceived knowledge preparedness, SIG (A), NS (B)	Experience, NS (A), SIG (B) Risk Perception, NS (A & B) Gender, NS (A & B) Age, NS (A & B) Educational Level, NS (A & B) Marital Status, NS (A), SIG (B) Migration Status, NS (A & B) People in Household, SIG (A & B) Children in Household, SIG (A & B) Homeownership, SIG (A & B) Civil Defence/ Medical Sector, NS (A & B)
Kruger <i>et al.</i> ⁴¹	USA	Disasters	Perceived Preparedness Relevance rating: 2	Perceived	Multivariate Logistic Regressions	<i>DV = Perceived Preparedness, "Among Those Prepared."</i> <i>Attitudes</i> Knowing what to do during an emergency, NS Having the right emergency supplies, SIG Being able to react to an unplanned event, NS Discussing plans in case of emergencies, SIG Preventing harm to myself and my family, NS Acting before an emergency occurs, SIG <i>Motivators</i> Increased likelihood of a local disaster, SIG Information about possible local disasters, NS Personal experience with a disaster, NS Nothing, I am already very prepared, SIG If I received a discount to buy basic supplies, SIG Information about consequences (losses), SIG <i>Barriers</i> Planning for the unknown is confusing, SIG I can't afford to buy supplies, SIG I don't think it is important where I live, SIG I don't know where to begin or what to do, SIG Talking to my family about it is hard, NS	

Kyne <i>et al.</i> ⁴²	USA	Hurricane	Subjective & objective preparedness Relevance rating: 3	Perceived & Actual		See paper - 5.1. Subjective vs. objective preparedness	
Landahl and Cox ⁴³	USA	Multi-Hazard Location	Preparedness Relevance rating: 2	Actual	Summary Statistics	See papers summary statistics	
Mabuku <i>et al.</i> ⁴⁴	Namibia Zambia	Flooding	Preparedness scale Relevance rating: 2	Actual	Tobit Model	Risk Perception (likelihood), NS Risk perception (feeling of worry), NS Critical awareness (think about flood, NS Critical awareness (talk about flood, NS Marital status, NS Country, -ev	Sense of community, +ev Self-efficacy, -ev Responsibility efficacy, +ev Outcome expectancy, +ev Size of land, +ev Land ownership, NS Access to land, +ev Female household members, NS
McNeill <i>et al.</i> ⁴⁵	Australia	Wildfire	Preparedness: Defence Preparation; Evacuation Preparation; House Resilience; Planning Relevance rating: 2	Actual	Regressions	<i>DV = Defence Preparation (A), Evacuation Preparation (B), House Resilience (C), Planning (D)</i> Gender, +ev (A), +ev (B), NS (C), +ev (D) Age, +ev (All) Area, +ev (A,B,C), NS (D) Risk likelihood, NS (All) Risk severity, +ev (All) Protection responsibility, NS (A), +ev (B), NS (C), +ev (D) Warning reliability, NS (A), NS (B), -ev (C), NS (D) Lose water (no vs. yes), -ev (All) Lose electricity (no vs. yes), NS (A), -ev (B), -ev (C), NS (D) Lose mobile phone (no vs. yes), NS (A), -ev (B), -ev (C), NS (D) Lose water (NA vs. yes), +ev (A), NS (B), NS (C), NS (D) Lose electricity (NA vs. yes) NS (All) Lose mobile phone (NA vs. Yes) NS (All)	
Muttarak and Pothisiri ⁴⁶	Thailand	Earthquake & Tsunami	Disaster preparedness Relevance rating: 2	Actual	Ordered Logit	<i>Model 3</i> Education (tertiary), SIG Head of household, NS Years of residence, NS Women, NS Age (40 - 49 years), SIG Married, SIG Occupation, NS Affected by tsunami in 2004, NS Participated in evacuation drills and disaster education, NS Number of sources of information, SIG Education (two or more persons), SIG	Household income, NS Number of persons, NS Number of children aged ≤5, NS No. of members aged ≥ 60, SIG Number of members with a disability, SIG House location, NS <i>Village characteristics:</i> Percentage of men with at least secondary education, NS Percentage of women with at least secondary education, SIG Percentage of members aged 65 years and

						over, NS Percentage of women, SIG
Nguyen <i>et al.</i> ⁴⁷	USA	Earthquake	Pre- and Post-Earthquake Preparedness Activities (Post - DV); Perceived Preparedness Relevance rating: 3	Perceived & Actual	Multinomial Logistic Regression	<i>DV post-earthquake preparedness activities:</i> <i>Some (1–5) vs. no preparation (A)</i> <i>Many (6 or more) vs. no preparation (B)</i> Physical injury, +ev (A & B) Emotional injury, +ev (A & B) Financial injury, NS (A), +ev (B) Marital status, +ev (A & B) Immigrant status, NS (A), +ev (B) 8-item scale of survival preparedness, +ev (A & B) 4-item scale of hazard mitigation, NS (A & B) Perceived pre-quake preparedness, NS (A & B) MMI (Modified Mercalli intensity), +ev (A & B) Financial injury*hazard mitigation, +ev (A & B) Survival preparedness*hazard mitigation, -ev (A & B) Survival preparedness * preparedness feelings, -ev (A & B)
Oral <i>et al.</i> ⁴⁸	Turkey	Earthquake	Earthquake preparation (Earthquake readiness scale) Relevance rating: 2	Actual	Multiple Linear Regression	Gender, NS Age, NS Marital status, NS Education level, NS Occupation, NS Who the person lives with, NS Earthquake Experience, SIG Homeownership, SIG
Oriangi <i>et al.</i> ⁴⁹	Uganda	Climate Change	Perceived capacity to prepare Relevance rating: 2	Perceived	Linear Regressions	<i>(Model 4)</i> Gender, NS Age, NS Household size, -ev Household head, NS Education, NS Expenditure, +ev Income = 1, NS Income = 2, +ev Income = 3, NS Exp*income = 1, -ev Exp*income = 2, NS Exp*income = 3, NS Nets_Friends (network), NS Nets_Relatives, +ev Nets_NGO, NS Government, NS
Paton ⁵⁰	New Zealand & Australia	Bushfire, Volcanic, Earthquake	Preparedness intention Relevance rating: 2	Intention	Multiple Regression Analyses Revealed	<i>Preparedness intentions: Bushfire (A), Volcanic (B), Earthquake (C)</i> Critical awareness, +ev (All) Outcome expectancy, +ev (All) Action coping, +ev (All) Trust, NS (A), +ev (B & C)

Paton <i>et al.</i> ⁵¹	Australia	Bushfire	Intention to Prepare & Bushfire Preparedness Relevance rating: 2	Intention & Actual	Regressions	DV: <i>Intention to Prepare</i> Action Coping, +ev Outcome Expectancy +ev	Critical Awareness +ev Sense of Community +ev
Paton <i>et al.</i> ⁵²	New Zealand & Japan	Earthquakes	Intention to Prepare Relevance rating: 2	Intention	Structural Equation Modelling	<i>Intention to Prepare: Napier (A), Kyoto (B) (Only Paths to Intention are reported)</i> Negative Outcome Expectancy, -ev (A & B), Positive Outcome Expectancy, +ev (A & B), Community participation, +ev (A & B), Collective efficacy, +ev (A & B), Trust, +ev (A & B),	
Prati <i>et al.</i> ⁵³	Italy	Pandemic Influenza	Recommended Behaviours Relevance rating: 2	Actual	Structural Equation Modelling	Affective Response (Feelings of worry about pandemic), +ev (for Recommended Behaviours) --- Level of preparedness of institutions, NS (Affective Response) Family members and friends' levels of worry, +ev (Affective Response) Likelihood of infection, +ev (Affective Response) Perceived severity, +ev (Affective Response)	
Ranjbar <i>et al.</i> ⁵⁴	Iran	Earthquake	Actual preparedness behavior Intention to prepare Perceived preparedness Relevance rating: 3	Intention / Perceived & Actual	Multivariate Regression	DV: <i>Actual preparedness behavior (A), Intention to prepare (B), Perceived preparedness (C)</i> Trust, +ev (All) Past experience NS (A & C), N/A (B) Gender, +ev (A), N/A (B & C) Ownership, NS (A), N/A (B & C) Job situation, N/A (A & B), NS (C) Family members, +ev (A), N/A (B), -ev (C) Age, NS (A), +ev (B), N/A (C) Residence region N/A (A & C), +ev (B) Monthly income, +ev (A), N/A (B & C)	
Rebmann <i>et al.</i> ⁵⁵	USA	"Natural disasters" and Pandemics	Disaster Preparedness. Pandemic Preparedness. Perception of personal preparedness. Relevance rating: 3	Perceived & Actual	Linear Regression	DV: <i>Disaster Preparedness (A), Pandemic Preparedness (B)</i> Perception of personal preparedness - Natural Disaster, +ev (A & B) Perception of personal preparedness - Pandemic, +ev (A & B) Years working in HR, +ev (A), N/A (B) No children in household, +ev (A & B) Employer encouragement to have plan, +ev (A), N/A (B) Disaster preparedness training in last two years, +ev (A & B) Gender (male), N/A (A), +ev (B)	
Stumpf <i>et al.</i> ⁵⁶	Germany	Fire (Residential)	Presence of smoke detector; Presence of fire extinguisher; Presence of fire blanket Relevance rating: 2	Intention & Actual	Path Analysis	<i>Presence of smoke detector (A), presence of fire extinguisher (B) & presence of fire blanket (C) - Paths to DV are reported</i> outcome expectancy, NS (A & C), +ev (B) perceived knowledge, +ev (All) personal experience, NS (A & B), +ev (C) self-efficacy, NS (A & C), +ev (B) personal experience, +ev (A & B), NS (C)	

Tej <i>et al.</i> ⁵⁷	Slovak Republic	"Natural Disaster"	Collective protection	Actual	Chi-Square Test Of Independence	“There are statistically significant differences in responses between public administration employees and respondents who are not public administration employees (residents) to the question”: - concerning the shelters in the residence - concerning the evacuation rules - concerning the hygiene and health care - concerning the appropriate toiletries - concerning the behaviour in the evacuation shelter	
			Relevance rating: 2				
Tomio <i>et al.</i> ⁵⁸	Japan	"Natural Disaster" (e.g. earthquakes and tsunamis)	Household preparedness	Actual	Logistic Regression	Living in a suburb, NS VDPO, NS Length of residence, NS Single household, NS Living with children under 15, NS Living with someone aged 75 or older, NS	Living with those requiring special assistance, NS Female, NS Age, SIG College graduate, SIG Occupational (e.g. Farming), NS Concerned - natural disaster, NS
Wei <i>et al.</i> ⁵⁹	USA	Volcanic	Household emergency preparedness & evacuation preparedness	Actual	Ordinary Least Squares Regression	<i>DV: household emergency preparedness (A), evacuation preparedness (B)</i> Risk perception, NS (A & B) Hazard intrusiveness, NS (A & B) Affective response, NS (A & B) Community boundedness, +ev (A & B) Past info search, +ev (A & B) Lahar zone location, NS (A & B)	Crater proximity, +ev (A & B) Age, NS (A & B) Education, NS (A & B) White, NS (A & B) Female, NS (A & B) Income, NS (A & B) Tenure, NS (A & B) Own Home, NS (A & B)
Wei <i>et al.</i> ⁶⁰	Taiwan	Natural Hazards (Typhoon & Earthquake)	Degree of preparedness	Actual	Poisson Regression	(<i>Prepare3 - Table A1, Full results</i>) Significant: Confidence, Membership, Daily contact, SIG Neighbour, Disaster experience - Typhoon, Residence, Education, New town, Typhoon probability, Typhoon consequence, Typhoon anxiety, Earthquake probability, Earthquake consequence, Earthquake anxiety. Non-significant: Disaster experience - Earthquake, Disaster experience - Both, Religion, Married, Divorced, Widowed, Small city, Traditional town, General town, Remote town, Owner, Having children, Status, Job, Income, Male, Age	
Wirtz <i>et al.</i> ⁶¹	USA	Terrorism	Preparedness	Actual	Poisson Regression	Vulnerability, +ev Severity, NS	Self-efficacy, +ev Anxiety, -ev
Wood <i>et al.</i> ⁶²	USA	Terrorism	Preparedness Actions Taken	Actual	Path Analysis	<i>Paths to Preparedness Actions taken</i> Content of Preparedness Information Received, +ev Density of Preparedness Information Received, NS Preparedness Action Information Observed, +ev Knowledge of Preparedness Actions, +ev	
			Relevance rating: 2				

						Perceived Effectiveness of Preparedness Actions, + ev Milling About Preparedness Actions, + ev
Wu <i>et al.</i> ⁶³	USA	Earthquake	Actual Adoption of hazard adjustment activities & the likelihood of adopting these hazard adjustment activities Relevance rating: 2	Intention & Actual	Regression	(Note, see Table 5 for the full list of DV's e.g. use of Latches) DV: Strap Item (A), Plan (B), Insurance (C) - adoption intentions Protect persons effectively, + ev (A & B), NS (C) Protect property effectively, NS (A & B), + ev (C) Cost Money, NS (A, B & C) Require knowledge, NS (A, B & C) Require effort, - ev (A), NS (B & C) Require cooperation, + ev (A), NS (A & B) Useful for other hazards, + ev (A, B & C)
Xu <i>et al.</i> ⁶⁴	China	Landslide	Household disaster preparedness Relevance rating: 2	Actual	Logit Tobit Model	Model 5- Logit Models (A), Model 6 - Tobit model (B) Probability, NS (A), + ev (B) Worry, NS (A), NS (B) Unknown, + ev (A), NS (B) Controllability, - ev (A), - ev (B) Threat, + ev (A), + ev (B) Place dependence, NS (A),+ ev (B) Place identity, NS (A), NS (B) Place attachment, + ev (A), NS (B) Education, NS (A), + ev (B) Experience, NS (A), NS (B) Gender, + ev (A), NS (B) Age, NS (A), NS (B) Income, + ev (A), NS (B) Financial help, - ev (A), NS (B) Loss, NS (A), NS (B) Distance, NS (A), + ev (B) Official info, + ev (A), + ev (B) All information, NS (A), + ev (B) Member, - ev (A), NS (B) Child, + ev (A), NS (B) Old, NS (A), NS (B) Housing material, NS (A), NS (B)
Yong and Lemyre ⁶⁵	Canada	"Natural Disaster"	Preparedness behaviors Relevance rating: 2	Actual	Multivariate Regression	Study 1: "beliefs in external responsibility predicted an increased likelihood of intent to evacuate." "Beliefs in self-preparedness responsibility predicted an increased likelihood of emergency planning, intent to evacuate, and post-disaster search." Study 2: "community-level social capital indicators were meaningful predictors of individuals' preparedness behaviours, even after controlling for personal demographics and risk perception beliefs" "Findings suggest that community social capital is an important factor in individuals' decisions to uptake disaster preparedness."

References

1. Ablah E, Konda K, Kelley CL. Factors predicting individual emergency preparedness: A multi-state analysis of 2006 BRFSS data. *Biosecurity and Bioterrorism*. 2009;7(3):317-330. doi:10.1089/bsp.2009.0022
2. Abunyawah M, Gajendran T, Maund K. Conceptual Framework for Motivating Actions towards Disaster Preparedness Through Risk Communication. *Procedia Eng*. 2018;212(2017):246-253. doi:10.1016/j.proeng.2018.01.032
3. Adame B, Miller CH. Vested interest: developing scales for assessing flooding preparedness. *Disaster Prev Manag An Int J*. 2016;25(3):282-297. doi:10.1108/DPM-08-2015-0196

4. Annis H, Jacoby I, De Mers G. Disaster preparedness among active duty personnel, retirees, veterans, and dependents. *Prehosp Disaster Med.* 2016;31(2):132-140. doi:10.1017/S1049023X16000157
5. Appleby-Arnold S, Brockdorff N, Jakovljević I, Zdravković S. Applying cultural values to encourage disaster preparedness: Lessons from a low-hazard country. *Int J Disaster Risk Reduct.* 2018;31(October 2018):37-44. doi:10.1016/j.ijdr.2018.04.015
6. Basolo V, Steinberg LJ, Burby RJ, Levine J, Cruz AM, Huang C. The effects of confidence in government and information on perceived and actual preparedness for disasters. *Environ Behav.* 2009;41(3):338-364. doi:10.1177/0013916508317222
7. Basolo V, Steinberg LJ, Gant S. Hurricane threat in Florida: examining household perceptions, beliefs, and actions. *Environ Hazards.* 2017;16(3):253-275. doi:10.1080/17477891.2016.1277968
8. Baytiyeh H, Naja M. The effects of fatalism and denial on earthquake preparedness levels. *Disaster Prev Manag An Int J.* 2016;25(2):154-167. doi:10.1108/DPM-07-2015-0168
9. Becker JS, Paton D, Johnston DM, Ronan KR. A model of household preparedness for earthquakes: How individuals make meaning of earthquake information and how this influences preparedness. *Nat Hazards.* 2012;64(1):107-137. doi:10.1007/s11069-012-0238-x
10. Becker JS, Paton D, Johnston DM, Ronan KR, McClure J. The role of prior experience in informing and motivating earthquake preparedness. *Int J Disaster Risk Reduct.* 2017;22(June 2017):179-193. doi:10.1016/j.ijdr.2017.03.006
11. Becker JS, Paton D, Johnston DM, Ronan KR. Salient beliefs about earthquake hazards and household preparedness. *Risk Anal.* 2013;33(9):1710-1727. doi:10.1111/risa.12014
12. Bodas M, Siman-Tov M, Kreitler S, Peleg K. Assessment of Emergency Preparedness of Households in Israel for War - Current Status. *Disaster Med Public Health Prep.* 2015;9(4):382-390. doi:10.1017/dmp.2015.56
13. Bodas M, Siman-Tov M, Kreitler S, Peleg K. The Role of Victimization in Shaping Households' Preparedness for Armed Conflicts in Israel. *Disaster Med Public Health Prep.* 2018;12(1):67-75. doi:10.1017/dmp.2017.38
14. Bourque LB, Regan R, Kelley MM, Wood MM, Kano M, Mileti DS. An Examination of the Effect of Perceived Risk on Preparedness Behavior. *Environ Behav.* 2013;45(5):615-649. doi:10.1177/0013916512437596
15. Bradford RA, O'Sullivan JJ, Van Der Craats IM, et al. Risk perception - Issues for flood management in Europe. *Nat Hazards Earth Syst Sci.* 2012;12(7):2299-2309. doi:10.5194/nhess-12-2299-2012
16. Chen CY, Xu W, Dai Y, et al. Household preparedness for emergency events: A cross-sectional survey on residents in four regions of China. *BMJ Open.* 2019;9(11):1-9. doi:10.1136/bmjopen-2019-032462
17. Cope MR, Lee MR, Slack T, et al. Geographically distant social networks elevate perceived preparedness for coastal environmental threats. *Popul Environ.* 2018;39(3):277-296. doi:10.1007/s11111-017-0292-0
18. Corwin KA, Brand BD, Hubbard ML, Johnston DM. Household preparedness motivation in lahar hazard zones: assessing the adoption of preparedness behaviors among laypeople and response professionals in communities downstream from Mount Baker and Glacier Peak (USA) volcanoes. *J Appl Volcanol.* 2017;6(1):1-19. doi:10.1186/s13617-017-0055-8
19. DeBastiani SD, Strine TW, Vagi SJ, Barnett DJ, Kahn EB. Preparedness Perceptions, Sociodemographic Characteristics, and Level of Household Preparedness for Public Health Emergencies: Behavioral Risk Factor Surveillance System, 2006-2010. *Heal Secur.* 2015;13(5):317-326. doi:10.1089/hs.2014.0093
20. DeYoung S, Peters M. My community, my preparedness: The role of sense of place, community, and confidence in government in disaster readiness.

- Int J Mass Emerg Disasters*. 2016;34(2):250-282.
21. DeYoung SE, Lewis DC, Seponski DM, Augustine DA, Phal M. Disaster preparedness and well-being among Cambodian– and Laotian–Americans. *Disaster Prev Manag An Int J*. 2019;(NO.ahead-of-print). doi:10.1108/DPM-01-2019-0034
22. Donahue AK, Eckel CC, Wilson RK. Ready or Not? How Citizens and Public Officials Perceive Risk and Preparedness. *Am Rev Public Adm*. 2014;44(4S):89S–111S. doi:10.1177/0275074013506517
23. Donner WR, Lavariega-Montforti J. Ethnicity, income, and disaster preparedness in Deep South Texas, United States. *Disasters*. 2018;42(4):719-733. doi:10.1111/disa.12277
24. Ejeta LT, Ardalan A, Paton D, Yaseri M. Predictors of community preparedness for flood in Dire-Dawa town, Eastern Ethiopia: Applying adapted version of Health Belief Model. *Int J Disaster Risk Reduct*. 2016;19(October 2016):341-354. doi:10.1016/j.ijdrr.2016.09.005
25. Ejeta LT, Ardalan A, Paton D, Yaseri M. Emotional and cognitive factors influencing flood preparedness in Dire Dawa town, Ethiopia. *Nat Hazards*. 2018;93(2):715-737. doi:10.1007/s11069-018-3321-0
26. Espina E, Teng-calleja M. A Social Cognitive Approach to Disaster Preparedness. *Philipp J Psycology*. 2015;48(2):161-174. https://www.pap.org.ph/includes/view/default/uploads/pjp-journals/PJP1502_Final_7Espina_and_Calleja.pdf
27. Han Z, Lu X, Hörhager EI, Yan J. The effects of trust in government on earthquake survivors' risk perception and preparedness in China. *Nat Hazards*. 2017;86(1):437-452. doi:10.1007/s11069-016-2699-9
28. Henly-Shepard S, Anderson C, Burnett K, Cox LJ, Kittinger JN, Ka'aumoana M. Quantifying household social resilience: a place-based approach in a rapidly transforming community. *Nat Hazards*. 2015;75(1):343-363. doi:10.1007/s11069-014-1328-8
29. Hoffmann R, Muttarak R. Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand. *World Dev*. 2017;69(August 2017):32-51. doi:10.1016/j.worlddev.2017.02.016
30. Hung LS. Comparing spousal agreement on perceived responsibility for household natural hazard preparedness to actual behavior. *PLoS One*. 2019;14(8):1-19. doi:10.1371/journal.pone.0221217
31. Jang LJ, Wang JJ, Paton D, Tsai NY. Cross-cultural comparisons between the earthquake preparedness models of Taiwan and New Zealand. *Disasters*. 2016;40(2):327-345. doi:10.1111/disa.12144
32. Jassempour K, Shirazi KK, Fararoei M, Shams M, Shirazi AR. The impact of educational intervention for providing disaster survival kit: Applying precaution adoption process model. *Int J Disaster Risk Reduct*. 2014;10(December 2014):374-380. doi:10.1016/j.ijdrr.2014.10.012
33. Joffe H, Perez-Fuentes G, Potts HWW, Rossetto T. How to increase earthquake and home fire preparedness: the fix-it intervention. *Nat Hazards*. 2016;84(3):1943-1965. doi:10.1007/s11069-016-2528-1
34. Kelly B, Ronan KR. Preparedness for natural hazards: Testing an expanded education- and engagement-enhanced social cognitive model. *Nat Hazards*. 2018;91(1):19-35. doi:10.1007/s11069-017-3093-y
35. Kerstholt J, Duijnhoven H, Paton D. Flooding in The Netherlands: How people's interpretation of personal, social and institutional resources influence flooding preparedness. *Int J Disaster Risk Reduct*. 2017;24(September 2017):52-57. doi:10.1016/j.ijdrr.2017.05.013
36. Kirschenbaum A. Generic sources of disaster communities: A social network approach. *Int J Sociol Soc Policy*. 2004;24(10-11):94-129. doi:10.1108/01443330410791073
37. Kirschenbaum A. Preparing For The Inevitable: Environmental Risk Perceptions and Disaster Preparedness. *Int J Mass Emerg Disasters*. 2005;23(2):97-127.

38. Kirschenbaum A. Families and Disaster Behavior: A Reassessment of Family Preparedness Alan. *Int J Mass Emerg Disasters*. 2006;24(1):111-143.
39. Kirschenbaum A (Avi), Rapaport C, Canetti D. The impact of information sources on earthquake preparedness. *Int J Disaster Risk Reduct*. 2017;21(March 2017):99-109. doi:10.1016/j.ijdr.2016.10.018
40. Knuth D, Schulz S, Kietzmann D, Stumpf K, Schmidt S. Better safe than sorry - Emergency knowledge and preparedness in the German population. *Fire Saf J*. 2017;93(September):98-101. doi:10.1016/j.firesaf.2017.08.003
41. Kruger J, Chen B, Heitfeld S, Witbart L, Bruce C, Pitts DL. Attitudes, Motivators, and Barriers to Emergency Preparedness Using the 2016 Styles Survey. *Health Promot Pract*. 2018;Vol. XX(No. (X)):1-9. doi:10.1177/1524839918794940
42. Kyne D, Cisneros L, Delacruz J, et al. Empirical evaluation of disaster preparedness for hurricanes in the Rio Grande Valley. *Prog Disaster Sci*. 2020;5(January 2020):100061. doi:10.1016/j.pdisas.2019.100061
43. Landahl M, Cox C. Beyond the Plan: Individual Responder and Family Preparedness in the Resilient Organization. *Homel Secur Aff*. 2009;5(3):1-22.
44. Mabuku MP, Senzanje A, Mudhara M, Jewitt G, Mulwafu W. Rural households' flood preparedness and social determinants in Mwandia district of Zambia and Eastern Zambezi Region of Namibia. *Int J Disaster Risk Reduct*. 2018;28(June 2018):284-297. doi:10.1016/j.ijdr.2018.03.014
45. McNeill IM, Dunlop PD, Heath JB, Skinner TC, Morrison DL. Expecting the unexpected: Predicting physiological and psychological wildfire preparedness from perceived risk, responsibility, and obstacles. *Risk Anal*. 2013;33(10):1829-1843. doi:10.1111/risa.12037
46. Muttarak R, Pothisiri W. The role of education on disaster preparedness: Case study of 2012 Indian Ocean earthquakes on Thailand's Andaman coast. *Ecol Soc*. 2013;18(4):1-16. doi:10.5751/ES-06101-180451
47. Nguyen LH, Shen H, Ershoff D, Afifi AA, Bourque LB. Exploring the causal relationship between exposure to the 1994 Northridge earthquake and pre- and post- earthquake preparedness activities. *Earthq Spectra*. 2006;22(3):569-587. doi:10.1193/1.2219108
48. Oral M, Yenel A, Oral E, Aydin N, Aydin N. Earthquake experience and preparedness in Turkey. *Disaster Prev Manag An Int J*. 2015;24(1):21-37. doi:10.1108/DPM-01-2013-0008
49. Oriangi G, Albrecht F, Di Baldassarre G, et al. Household resilience to climate change hazards in Uganda. *Int J Clim Chang Strateg Manag*. 2019;12(1):59-73. doi:10.1108/IJCCSM-10-2018-0069
50. Paton D. Preparing for natural hazards: The role of community trust. *Disaster Prev Manag An Int J*. 2007;16(3):370-379. doi:10.1108/09653560710758323
51. Paton D, Kelly G, Buerget PT, Doherty M. Preparing for bushfires: Understanding intentions. *Disaster Prev Manag An Int J*. 2006;15(4):566-575. doi:10.1108/09653560610685893
52. Paton D, Bajek R, Okada N, McIvor D. Predicting community earthquake preparedness: A cross-cultural comparison of Japan and New Zealand. *Nat Hazards*. 2010;54(3):765-781. doi:10.1007/s11069-010-9500-2
53. Prati G, Pietrantonio L, Zani B. A Social-Cognitive Model of Pandemic Influenza H1N1 Risk Perception and Recommended Behaviors in Italy. *Risk Anal*. 2011;31(4):645-656. doi:10.1111/j.1539-6924.2010.01529.x
54. Ranjbar M, Soleimani AA, Sedghpour BS, Shahboulaghi FM, Paton D, Noroozi M. The predictors of earthquake preparedness in Tehran households Maryam. *Electron Physician*. 2018;10(3):6478-6486. doi:http://dx.doi.org/10.19082/6478
55. Rebmann T, Strawn AM, Swick Z, Reddick D. Personal Disaster and Pandemic Preparedness of U.S. Human Resource Professionals. *J Biosaf Heal Educ*. 2013;1(1):1-7. doi:10.4172/2332-0893.1000102

56. Stumpf K, Knuth D, Kietzmann D, Schmidt S. Adoption of fire prevention measures – Predictors in a representative German sample. *Saf Sci.* 2017;94(April 2017):94-102. doi:10.1016/j.ssci.2016.12.023
57. Tej J, Živčák P, Ali Taha V, Sirkova M. Crisis Awareness of the Municipal District Residents: Implication for Crisis Management At the Local Government Level. *Qual Innov Prosper.* 2014;18(2):1-14. doi:10.12776/qip.v18i2.295
58. Tomio J, Sato H, Matsuda Y, Koga T, Mizumura H. Household and Community Disaster Preparedness in Japanese Provincial City: A Population-Based Household Survey. *Adv Anthropol.* 2014;4(2):68-77. doi:10.4236/aa.2014.42010
59. Wei HL, Lindell MK. Washington households' expected responses to lahar threat from Mt. Rainier. *Int J Disaster Risk Reduct.* 2017;22(June 2017):77-94. doi:10.1016/j.ijdrr.2016.10.014
60. Wei HH, Sim T, Han Z. Confidence in authorities, neighborhood cohesion and natural hazards preparedness in Taiwan. *Int J Disaster Risk Reduct.* 2019;40(November 2019):101265. doi:10.1016/j.ijdrr.2019.101265
61. Wirtz PW, Rohrbeck CA, Burns KM. Anxiety effects on disaster precautionary behaviors: A multi-path cognitive model. *J Health Psychol.* 2019;24(10):1401-1411. doi:10.1177/1359105317720277
62. Wood MM, Mileti DS, Kano M, Kelley MM, Regan R, Bourque LB. Communicating Actionable Risk for Terrorism and Other Hazards. *Risk Anal.* 2012;32(4):601-615. doi:10.1111/j.1539-6924.2011.01645.x
63. Wu HC, Greer A, Murphy HC, Chang R. Preparing for the new normal: Students and earthquake hazard adjustments in Oklahoma. *Int J Disaster Risk Reduct.* 2017;25(October 2017):312-323. doi:10.1016/j.ijdrr.2017.09.033
64. Xu D, Peng L, Liu S, Wang X. Influences of Risk Perception and Sense of Place on Landslide Disaster Preparedness in Southwestern China. *Int J Disaster Risk Sci.* 2018;9(2):167-180. doi:10.1007/s13753-018-0170-0
65. Yong AG, Lemyre L. Getting Canadians prepared for natural disasters: a multi-method analysis of risk perception, behaviors, and the social environment. *Nat Hazards.* 2019;98(1):319-341. doi:10.1007/s11069-019-03669-2

10.4 Appendix Chapter 6 – Paper 5

Supplementary Material - 1: Relevant questions from the questionnaire

Were you in Ireland during Storm Emma (Feb/March 2018)?

- Yes
- No

As a result of the weather warnings, did you seek any further information on how to prepare?

- Yes
- No

In response to which of the Met Éireann weather warnings would you take action to prepare for severe weather? *(Multiple choice)*

- Status Yellow
- Status Orange
- Status Red
- Don't Know

How satisfied are you with the current Met Éireann weather warning system?

- Extremely satisfied
- Mostly satisfied
- Somewhat satisfied
- Neither satisfied nor dissatisfied
- Somewhat dissatisfied
- Mostly dissatisfied
- Extremely dissatisfied

Do you believe the weather warnings are... *(Tick all that apply)*

- issued too frequently?
- difficult to understand?
- Other _____

From where do you get your information during major emergencies in Ireland?

- News Media – e.g. newspapers, radio, TV and websites
- Family & friends
- The Government/Authorities

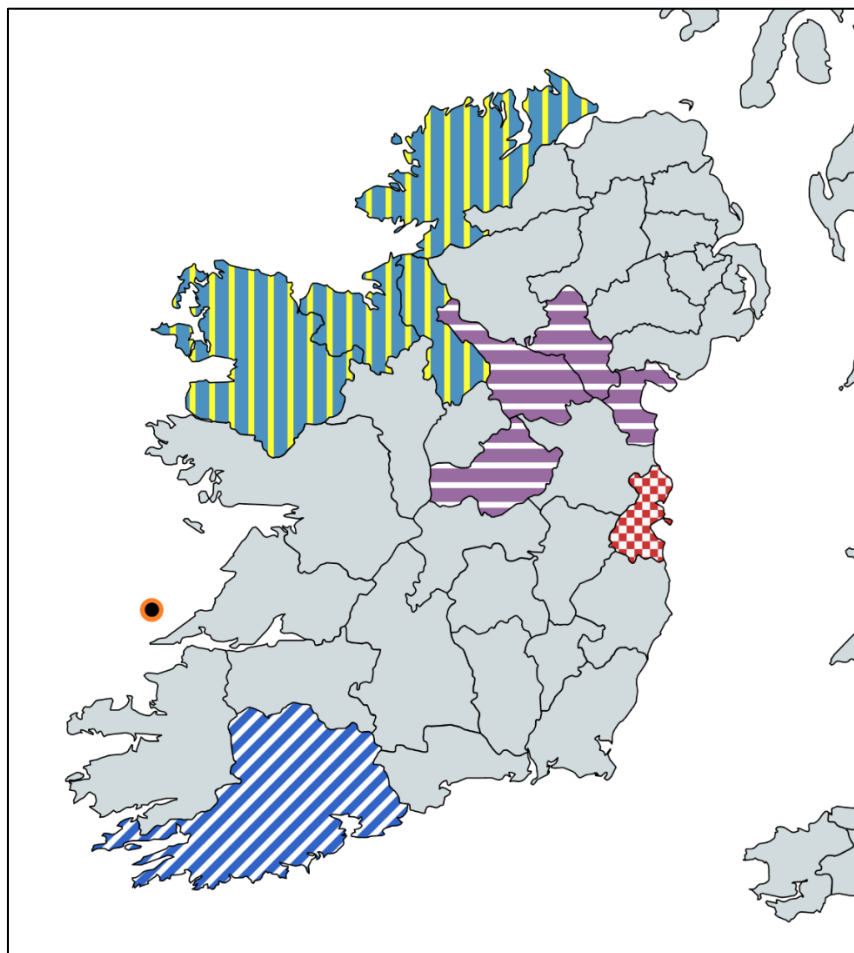
- Social media or Websites – sources other than news outlets, authorities and family, friends and acquaintances
- Don't Know

I live in...

- A city
- The suburbs or outskirts of a city
- A town
- A village
- A rural area
- Other (please specify) _____

Supplementary Material - 2: Focus Group Locations

Figure A1: Focus Groups Mapped



Focus Groups	Code
Dublin (Urban)	U1 Red/White Checked Boxes
Cork (Urban)	U2 Blue/White Diagonal Lines
Donegal / Mayo / Leitrim / Sligo	R1 Green/Yellow Vertical Lines
Westmeath / Cavan / Monaghan / Louth	R2 Purple/White Horizontal Lines
Island (Inishbofin)	S4 Orange/Black Circle

Note: 3rd Level Students, Marine (Recreational) and the Agriculture Focus Groups were drawn from across Ireland.

Supplementary Material - 3: Focus Group Questions

Weather Forecasting: Accuracy / Uncertainty

How important are accurate weather forecasts to you in general?

- How often would you check the forecast to find out that information?
- How many days in advance do you want to get accurate weather forecasts?
- Does anybody else feel like that?

How many days ahead do you think the weather can be forecast accurately?

- How accurate do you think weather forecasts are?

When it comes to scheduling your daily or weekly activities would you plan these activities to take advantage of forecasted good weather, or to avoid bad weather conditions?

Weather Forecasts:

From which service do you get your weather forecast?

- (If more than one service) Which one do you prefer?
- Why is that?

Are there any particular reasons why you use this service?

- Why do you like the particular service you use?
- Is there anything you don't like about a particular service?

How do you access this weather forecast (using what device)?

Is anybody aware of the Met Éireann app?

- If yes, do you use the Met Éireann app?
- If yes, please share your feedback on it (user experience, accessibility).

Weather Warnings:

Are you familiar with the weather warnings system used in Ireland?

- How many different warning categories are there?
- Do you know their colours?
- What is the lowest/highest category?

Warnings

What would you do if there is a **yellow** snow/ice warning issued for your area?

What would you do if there is an **orange** snow/ice warning issued for your area?

What would you do if there is a **red** snow/ice warning issued for your area?

- Do the warnings influence your behaviour in any other way?

Do you think the weather warning system works?

- Do you feel you are given enough time to prepare when a severe weather warning is issued?
- How do you feel when the severe weather that was predicted doesn't happen?

How do you become aware of a weather warning being issued for your area?

How could awareness of the weather warning system be improved?

- Why do you think that would help?
- Does anybody else agree with that suggestion?

Weather Service Needs:

What do you see as the key roles or services delivered by Met Éireann at present?

Prompts:

- Do you think it succeeds in these roles?

What changes would you like to see to the services they provide?

How could their services be improved?

- Why do you think that would make a difference?
- Would you be prepared to pay to see that change?

Would you be willing to pay for weather and climate information in the future? Either the current services or those you have suggested?

Supplementary Material - 4: Thematic Analysis Results

Tables A1 to A7 provide an overview of the final structure of the thematic analysis.

Table A1: Thematic Analysis – Forecast Sources and Preferences

Themes and sub-themes	Focus Group	Codes
Accessing the Forecast		
Source	8	193
Device	8	82
Why check Forecasting		
Scheduling & Social	7	19
Scheduling & Work	7	52
Exercise & Activities	6	59
Safety	6	24
Other	6	34
Clothing Choices	3	24
Forecasting – Accuracy		
Long-term	3	6
Short-term	8	28
Days	8	67
Forecasting – Importance		
Importance	8	78
Specialists	7	69
Professional	6	33
Marine Behaviour – influence of forecasting	4	32
Regional	1	4
General Public	7	32
Planning & Activities	7	32
Forecasting – confidence		
Negative	8	119
Inaccuracy	7	39
Forecasting range	7	23
Lack of trust	6	35
Inherent uncertainty	6	9
Cross-checking	5	10
Personal judgement	5	9
Cry wolf effect	4	20
Other	4	18
Positive	7	57
Trust in forecast	7	22
Accuracy	6	27

Trust in Met Éireann	4	18
Presentation	3	4
Other	3	11
Forecasting – Frequency of use		
Frequent	8	36
Activity Driven	6	32
Infrequent	3	11
COVID Changed	3	15
Seasonal	2	6
Marine Observations & Sea Area Forecast	2	9

Table A2: Thematic Analysis – Forecasting Apps

Themes and sub-themes	Focus Group	Codes
Met Éireann App		
Negative	8	63
User interface	6	45
Awareness	5	13
Superior competition	5	11
Keeps minimal apps on phone	3	5
Limited features	2	4
Accuracy	2	5
Positive	7	39
Accuracy	6	13
Trust	4	10
Rainfall radar feature	4	9
Inferior competition	3	5
Location features	3	8
User interface	3	4
Forecast range	1	2
Weather Apps (non-Met Éireann)		
Positive	8	65
Accuracy	6	17
Detailed information	6	29
Convenience	4	12
User interface	3	6
Trust	2	7
Negative	5	21
Met Éireann superior	3	3
Accuracy	3	14
Trust	3	6

Prefer internet search	1	2
Improvements	6	40
Better advertising	3	3
New services	3	4
User interface	3	16
More frequent updates	3	4
Improved accuracy	2	3
Accessibility	2	3
More convenient	2	3
Desirable features	1	3
Other	4	8

Table A3: Thematic Analysis – Marine Services & App

Themes and sub-themes	Focus Group	Codes
Marine Services & Apps Used		
Positive	3	70
Radio (shipping forecast) & VHF	2	3
Websites & Apps	2	22
Combination	1	7
Buoys	1	4
Improvements	1	6
Negative	1	40
Services	1	13
Information	1	9

Table A4: Thematic Analysis – Met Éireann Roles & Services

Themes and sub-themes	Focus Group	Codes
Met Éireann Roles & Services		
Met Éireann Roles & Services - Current	8	32
Met Éireann Roles & Services – Future Requirements	6	22
Met Éireann Suggestions for Improvement		
Brand & Image	8	42
Awareness raising	8	31
Forecasting – Probabilistic	8	25
New Services	8	44
Audiences	8	82

Communication	7	49
Specialist Audiences	6	12
Segmentation of Audience	5	21
Localised	6	21
Weather Services		
Improvements	6	18
Other services (NOT Met Éireann)		
Positive	8	23
Accuracy	6	7
Information	5	14
Other	2	2
Negative	5	5
Superior competition	4	4
Accuracy	1	1
Met Éireann		
Positive	8	59
Accuracy	5	10
Interface - Access	5	7
Other	5	9
Trust	4	11
Rainfall radar feature	3	15
Inferior competition	2	4
Detailed information	1	3
Negative	7	43
Accuracy	4	9
Interface	3	10
Other	3	5
Awareness	2	5
Insufficient information	2	8
Superior competition	2	2
Trust	2	4
Willingness to Pay for Services		
No	8	57
Maybe	8	24
Yes	3	7

Table A5: Thematic Analysis – Weather Warnings

Themes and sub-themes	Focus Group	Codes
Source of Alert		
News	8	43
Online (Social Media)	6	14
Met Éireann	5	8

Phone	4	5
Word of mouth	4	16
Other	3	16
Unsure	1	1
Familiarity with Colour Scheme		
Yes	8	58
No	4	5
Unsure	4	7
Familiarity in practice		
Low: Limited	7	38
Medium	5	7
High: Expert	1	1
Effectiveness of the system		
Negative	8	150
Accuracy	8	65
Complacency (links to Accuracy)	8	30
Too frequent	8	45
Issue with Yellow Warnings	6	18
Overly cautious	5	13
Knowledge	6	26
Sensationalism	3	12
Positive	7	65
System Works (Overall)	7	41
Provides Critical Information	5	8
Increases Awareness	4	12
Clear Meaning	3	4
Suggestions for Improvement		
Education	5	30
Alerts	5	18
Accuracy (& Time)	8	48

Table A6: Thematic Analysis – Satisfaction with the Weather Warnings (Questionnaire Data)

Negative	564
Too Frequent	102
More Localised Warnings	101
Not Taken Seriously	98
Warning not Clear	84
Overly Dramatic	78
Inaccurate	53
Issued too Late	33
Better Communication Needed	7
Other	5
Positive	444
Acceptable	203
Not too Frequent	91
Clear Warning	73
Accurate	39
Cautious	19
In Good Time	11
Taken Seriously	8

Total Comments: 1008 collected from 818 respondents.

Table A7: Thematic Analysis – Weather Warnings Response & No Responses

Themes and sub-themes	Focus Group	Codes
Chance in Behaviour	8	259
Behaviour – Activity	8	114
Red Warning -Behaviour	8	44
Alertness - Driving & Travel (leaving the home)	6	25
Alertness - General	6	18
Sitrep	2	2
Work	1	2
Orange Warning -Behaviour	7	38
Alertness - General	7	17
Alertness - Driving & Travel	3	14
Sitrep	3	7
Work	2	2
Yellow Warning -Behaviour	5	20
Alertness - Driving & Travel	5	12
Sitrep	1	4
Avoid Travel - Travel Less	1	2

Alertness - General	1	6
Forecast	2	12
Alertness - Driving & Travel	1	2
Threat appraisal (Fear OR Worry)	7	40
Protective Action Taken	6	95
Red Warning -Action	6	59
Planning and Preparedness - Supplies & Equipment	6	30
Planning and Preparedness - Electricity, Gas, Oil	5	21
Readiness - House (& Garden) & Workplace	4	8
Planning and Preparedness - Other	3	6
Planning and Preparedness - Water	2	8
Support - Relatives - Neighbours	2	3
Yellow Warning -Action	4	12
Planning and Preparedness - Supplies	2	2
Garden & House Readiness	2	4
Planning and Preparedness - Clothing	1	1
Orange Warning -Action	4	17
Planning and Preparedness - Other	4	4
Planning and Preparedness - Supplies & Equipment	3	8
Readiness - House (& Garden) & Workplace	2	3
Planning and Preparedness - Water	1	3
Driving	1	1
Community Actions - social capital	1	1
Forecast -Action	4	7
Planning and Preparedness - Other	2	3
Planning and Preparedness - Power Loss	1	1
Planning and Preparedness - Supplies	1	1
Other	4	10
No Action or Behaviour Change	8	102
Orange WW	8	35
Ignore - disregard	6	15
Cope as I am	4	4
Type of event (action vs no action)	2	3
Limited Impact = Limited affect on behaviours	2	4
Wait And See (Sitrep)	2	11
Limited Understanding of the Warning	1	2
Yellow Warning	8	54
Ignore - disregard	8	20
Lost meaning	1	6
Limited Impact = Limited affect on behaviours	5	30
Wait And See (Sitrep) - Some Alertness	4	8
Role - Job	2	4
Type of event (action vs no action)	2	2

Don't know (what to do)	1	1
Limited Understanding of the Warning	1	2
Red Warning	4	7
Ignore - disregard	3	4
Don't know (what to do)	2	2
Cope as I am	2	2
Nothing can be done (probably)	1	1
Wait And See (Sitrep)	1	1
Other	2	6

Supplementary Material - 5: Additional Results related to Gender and Weather Warnings Sentiment

Survey respondents rated their satisfaction with the NMHS weather warning system from extremely dissatisfied (coded as 1) to extremely satisfied (coded as 7).

The overall satisfaction with the Met Éireann weather warning system was 5.91. The difference in average satisfaction with Met Éireann weather warning system between males and females is small but highly significant based on a t-test ($t = 6.20$, $p < 0.001$). The average satisfaction for males is lower than that for females, 5.71 compared to 5.99.

There was an approximate 3:1 ratio of females (603) to males (190) proportionately represented at a macro level in comments about respondents' assessment of weather warnings. Table A8 below shows the gender balance in both positive and negative themes related to weather warnings by sentiment.

Table A8: Thematic Analysis – Satisfaction with the NMHS weather warnings by gender

Weather Warnings by Gender	Female	Male	Proportional Representation*
Negative	324	101	-4
Inaccurate	40	12	-2
Issued too Late	28	4	-15
More Localised Warnings	71	24	5
Not Taken Seriously	78	19	-18
Overly Dramatic	51	27	35
Too Frequent	79	22	-9
Better Communication	6	1	-3
Warning not Clear	66	16	-15
Positive	276	85	-7
Acceptable	139	55	35
Accurate	29	10	3
Cautious	15	4	-2
Clear Warning	56	13	-15
In Good Time	9	2	-3
Not too Frequent	74	14	-30
Taken Seriously	8	0	-8

*Proportional representation = number of female responses – predicted number of male responses, where predicted number of male responses = female responses $\times$ 3.17, reflecting the exact ratio of females to males.

Table A8 shows that females placed proportionately greater emphasis on warnings being issued too late; warnings not being taken seriously; warnings being too frequent; and unclear in their negative comments. However, in their positive comments, the opposite viewpoint was evident with females also emphasizing that warnings were clear and not too frequent. Males placed greater emphasis on reports being overly dramatized by mainstream media and standards being acceptable.

10.5 Appendix Chapter 7 – Paper 6

Appendix 1 Table A1 Summary of literature review

Notes: +ve = Positive and significant relationship, -ve = negative and significant relationship, NS = non-significant.

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
1	Earthquake	Actual preparedness	Actual	Regression	NS	NS	-	-	-	+ve	-	-	-	-	-	-	+ve	-	Living in risk zone, NS Religion, -ve Trust in information source, NS Past experience*trust, NS
		Actual preparedness for Israeli Jews	Actual	Regression	NS	NS	-	-	-	NS	-	-	-	-	-	-	+ve	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, -ev
		Actual preparedness for Israeli Arabs	Actual	Regression	NS	NS	-	-	-	+ve	-	-	-	-	-	-	NS	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, +ev
		Perceived preparedness	Perceived	Regression	+ve	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in a risk zone, +ve Religion, NS Trust in information source, NS Past experience*trust, NS
		Perceived preparedness for Israeli Jews	Perceived	Regression	+ve	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, NS
		Perceived preparedness for Israeli Arabs	Perceived	Regression	NS	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in risk zone, +ev Trust in information source, NS Past experience*trust, NS
	Earthquakes / Hurricane	Perceived level of preparedness for earthquakes	Perceived	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
2																			Confidence in government, +ve Information sources, +ve
		Perceived level of preparedness for hurricanes	Perceived	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, -ve Happen, NS <u>Other Factors</u> Confidence in government, +ve Information sources, +ve
	Earthquakes	Preparedness actions for earthquakes - family plan	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, +ve
		Preparedness actions for earthquakes - supplies	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for earthquakes - mitigation	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for earthquakes - shut off utilities	Actual	Logit	NS	NS	+ve	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, +ve

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
	Hurricane	Preparedness actions for hurricanes - family plan	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	+ve	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, +ve Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, +ve Information sources, NS
		Preparedness actions for hurricanes - supplies	Actual	Logit	NS	NS	+ve	-	-	NS	+ve	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for hurricanes - shut off utilities	Actual	Logits	-ve	+ve	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
3	Hurricane	Perceived level of preparedness	Perceived	Ordered Logit	NS	+ve	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	+ve	Immigrant, -ve Information, NS Perceived readiness of local government, +ve
		House preparedness (sandbags on site)	Actual	Logit	-ve	NS	NS	-	-	NS	+ve	NS	-ve	+ve	-	-	NS	+ve	Immigrant, NS Information, NS Perceived readiness of local government, NS
		Household preparedness (family plan)	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	+ve	NS	Information (a lot), +ve Perceived readiness of local government, +ve
		Preparedness (all recommended items on hand)	Actual	Logit	NS	NS	+ve	-	-	NS	NS	NS	NS	+ve	-	-	NS	NS	Immigrant, NS Information (a lot), NS Perceived readiness of local government, NS
4	Volcanic	Composite score for preparedness -Planning	Actual	T-tests	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A statistically significant difference in preparedness exists for five of the 20 preparedness measures listed. Please see original paper for list.

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
		Score -Supplies Score -Action Score																	
5	Multi-Hazard Context	Preparedness	Actual	Summary statistics	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Please see paper for full results. Responder and family preparedness - finding listed. 65.9% of organisations provide general emergency preparedness training and education opportunities for employees.
6	Terrorism	Preparedness	Actual	Path Analysis	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	<u>Direct paths only</u> <u>Risk Rating / Risk Perception</u> Note: Perceived risk = Likelihood <u>Other Factors</u> Knowledge, +ve Response efficacy, +ve Milling behaviour, +ve
7	Natural Hazard - Multi-Hazard Context	Household perceived preparedness	Perceived	Regression	NS	-	NS	NS	-	-	-	-	-	-	-	-	-	-	Know how to fish, NS Know how to preserve food, NS Origin: Mainland, NS Trade fish, NS The profession - Teacher, +ve Have a safe place to evacuate to, NS Know of safe places to evacuate to, NS Know of public awareness programs, NS Think early warning systems are very effective, NS
					NS	NS	-	-ve	-	-	-	-	-	-	-	-	NS	-	The profession - Teacher, NS Have a safe place to evacuate to, +ve Participation in a Community Group, NS
					NS	NS	-	-ve	-	-	-	NS	-	-	-	-	+ve	-	Have a safe place to evacuate to, NS
					NS	NS	-	-ve	-	-	-	-	NS	-	-	-	-	-	Know of public awareness programs, +ve Think early warning systems are somewhat effective, NS
		Coping capacity (e.g. stocked food/water supplies/emergency rations)	Actual	Regression	NS	-	-	-ve	-	NS	-	NS	-	-	-	-	-	-	Perceived as Prepared, NS Feel the community is prepared, NS Origin, NS Participation in a Community Group, +ve
					NS	-	-	NS	-	-	-	-	-	-	-	-	-	-	Perceived as Prepared, NS Feel the community is prepared, +ve Origin, NS
8	Natural Hazard	Perceived preparedness	Perceived	Logit	NS	-ve	+ve	-	-	-ve	NS	NS	NS	NS	NS	-ve	-	+ve	<u>Model 1</u> <u>Risk Rating / Risk Perception</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
	"environmental threat (coastal)"																		Note: At-risk (risk perception) <u>Other Factors</u> Local resources (social capital), NS Extra-local resources (social capital), +ve Regional resources (social capital), +ve Community associations (social capital), NS General trust (social capital), NS Number of adults know - name (social capital), NS Length of residence (social capital), NS Work in the oil industry, -ve Work in the fishing industry, NS
9	Flooding	Perceptions of preparedness	Perceived	Linear Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Susceptibility, NS Certainty, +ve Immediacy, +ve <u>Other Factors</u> Response-efficacy, -ve Self-efficacy, +ve Salience (perceived threat salience), NS
10	Flooding	Preparedness	Perceived	T-test	-ve	-	-	-	-	-	-	-	-	-	-	-	+ve	-	Hazard Awareness, NS Worry, NS Evacuated properties in the previous flood, +ve
11	Public Health Emergencies	Level of perceived preparedness	Perceived	Logit	-ve	+ve	-	-	-	-ve	-	-	+ve	-	-	-	-	-	Survey language, English, +ve
		Number of preparedness items	Actual	Logit	-ve	+ve	-	-	-	-ve	-	-	-ve	-	-	-	-	-	(5-Items) Survey language, English, +ve
12	Disaster	Preparedness (self-assessment)	Perceived	Ordered Logit	NS	NS	+ve	-	-	NS	-	-	+ve	NS	-	-	+ve	> See next column	<u>Risk Rating / Risk Perception</u> Likelihood, NS Consequence, +ve <u>Other Factors</u> Average loss, NS Risk tolerance, +ve Self-reliance, +ve Future orientation, NS Compliance, +ve Informed, +ve

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors	
13	Earthquake	Perceived preparedness	Perceived	Multivariate Regression	-	-	-	-	-	-	-	-	-	-	-	NS	NS	-	Trust, +ve Residence region, NS Family members, -ve	
		Actual preparedness behaviour	Actual	Multivariate Regression	-ve	NS	NS	-	-	-	-	-	-	-	-	-	NS	-	Trust, +ve Family members, +ve Monthly income, +ve	
14	Climate Change	Perceived capacity to prepare	Perceived	Linear Regression	NS	NS	-	-	-	-	-	+ve	-	-	-ve	-	-	-	(Prepare: 4) Household head, NS Expenditure, +ve Exp*income = 1, -ve Exp*income = 2, NS	Exp*income = 3, NS Friends (network), NS Relatives (Network), +ve NGO (Network), NS Government, NS
15	Disasters	Perceived preparedness	Perceived	Multivariate Logits	NS	+ve	-	-	-	+ve	NS	NS	NS	-	-	-	-	-	US census region (South), +ve Metropolitan statistical area, NS	
16	Earthquakes	Preparedness	Perceived	Ordinal Logit	-	-	-	-	-	-	-	-	-	-	-	-	-	+ve	Impact, +ve Family trust, NS General trust, NS Specific trust, NS Government trust -ve, Support, +ve	
17	Disasters	72-hour disaster kit	Actual	Logit	-ve	-	-	-	-	+ve	NS	+ve	-	+ve	-	-	+ve	-	Duty Status, +ve (Veterans) Deployed Member, NS Chronic Health Condition, +ve Will, +ve Disaster Kit for Two Weeks, +ve Safe Shelter, +ve Secondary Shelter, +ve Emergency Plan, +ve Communication Plan, +ve Evacuation Plan, +ve Taken a Preparatory Class, +ve Live in Disaster Area, +ve	
18	Fire and Medical	Fire extinguisher	Actual	Logit	NS	NS	+ve	-	-	NS	+ve	-	-	NS	+ve	-	NS	NS	Note: Risk Perception = risk likelihood Civil Defence/ Medical Sector, NS	
		Fire blanket	Actual	Logit	-ve	NS	+ve	-	-	NS	NS	-	-	NS	+ve	-	NS	NS	Note: Risk Perception = risk likelihood Civil Defence/ Medical Sector, NS	
		Smoke detectors	Actual	Logit	NS	NS	+ve	-	-	NS	NS	-	-	NS	+ve	-	NS	NS	Note: Risk Perception = risk likelihood Civil Defence/ Medical Sector, NS	
		First aid kit	Actual	Logit	NS	+ve	+ve	-	-	NS	+ve	-	-	NS	+ve	-	NS	NS	Note: Risk Perception = risk likelihood Civil Defence/ Medical Sector, NS	

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owens Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
19	Hurricane	Emergency contact	Actual	Logit	-	-	NS	-	-	-	NS	-	-	+ve	NS	-	NS	NS	Mobile home, NS Agreement, +ve
		Insurance	Actual	Logit	-	-	-ve	-	-	-	NS	-	-	+ve	NS	-	NS	NS	Mobile home, NS Agreement, -ve
		Evacuation zone	Actual	Logit	-	-	NS	-	-	-	NS	-	-	+ve	NS	-	NS	NS	Mobile home, NS Agreement, +ve
20	Flooding	Preparedness scale	Actual	Tobit model	NS	-	-	-	-	-	-	-	-	NS	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Risk Perception (likelihood), NS Risk perception (feeling of worry), NS <u>Other Factors</u> Critical awareness (think about flood), NS Critical awareness (talk about flood), NS Country, -ve Sense of community, +ve Self-efficacy, -ve Responsibility efficacy, +ve Outcome expectancy, +ve Size of land, +ve Land ownership, NS Access to land, +ve
21	Earthquake	Earthquake readiness scale	Actual	multiple linear Regression	NS	NS	-ve	-	-	NS	-	-	-	-	-	NS	-ve	-	Who the person lives with, NS
22	Earthquake	Post-earthquake activities - some 1-5 vs. no preparation	Actual	Multinomial Logit	-	-	-	-	-	-	-	-	-	+ve	-	-	-	-	Physical injury, +ve Emotional injury, +ve Financial injury, NS Immigrant status, NS 8-item scale of survival preparedness, +ve 4-item scale of hazard mitigation, NS Perceived pre-quake preparedness, NS MMI (Modified Mercalli intensity), +ve Interaction: Financial injury & mitigation, +ve Interaction: Survival preparedness & hazard mitigation, -ve Interaction: Survival preparedness and preparedness feelings, -ve
		Post-earthquake activities - many 6 or more vs. no preparation	Actual	Multinomial Logit	-	-	-	-	-	-	-	-	-	+ve	-	-	-	-	Physical injury, +ve Emotional injury, +ve Financial injury, +ve Immigrant status, +ve 8-item scale of survival preparedness, +ve

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			4-item scale of hazard mitigation, NS Perceived pre-quake preparedness, NS MMI (Modified Mercalli intensity), +ve Interaction: Financial injury & mitigation, +ve Interaction: Survival preparedness & hazard mitigation, -ve Interaction: Survival preparedness and preparedness feelings, -ve
23	War (Armed Conflict)	Preparedness index (preparedness behaviour)	Actual	Linear Analysis	-ve	+ve	-	-	-	-	-	-	-	-	-	-	-	-	Sense of preparedness, +ve Ignoring instructions, -ve
24	Flooding	Household preparedness	Actual	Structural Equation Model	-	-	-	-	-	-	-	-	-	-	-	-	-	NS	<u>Table 5: Household Preparedness</u> Community participation, NS Collective efficacy, NS Perceived susceptibility, NS Perceived severity, NS Cues to action, -ve Perceived benefits minus barriers, -ve
25	Flooding (Typhoons & Heavy Rains)	Disaster preparedness behaviours	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	+ve	+ve	Community Disaster Preparedness, +ve
26	Disaster	Preparedness	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	+ve	Financial coping, +ve Trust in local government to respond, +ve Confidence for engaging in preparedness, +ve
27	Natural Hazards (Typhoon & Earthquake)	Degree of preparedness	Actual	Poisson Regression	NS	NS	NS	-	-ve	+ve	NS	NS	-	NS	-	NS	> See next column	> See next column	<u>Disaster Exposure</u> Typhoon, +ve Earthquake, NS Both, NS <u>Risk Rating / Risk Perception</u> Typhoon probability, +ve Typhoon consequence, -ve Earthquake probability, +ve Earthquake consequence, <u>Other Factors</u> Confidence, +ve Membership, +ve Daily contact, +ve Neighbour, +ve Residence, -ve status (Social), NS Religion, NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			-ve Typhoon anxiety, +ve Earthquake anxiety, +ve
28	Terrorism	Preparedness actions taken	Actual	Path analysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Paths to Preparedness Actions taken Preparedness Information Received, +ve Density of Preparedness Information Received, NS Preparedness Action Information Observed, +ve Knowledge of Preparedness Actions, +ve Perceived Effectiveness of Preparedness, +ve Milling About Preparedness Actions, +ve <u>Risk Rating / Risk Perception</u> Note: Severity of impact on family's routine
29	War (Armed Conflict)	Preparedness index (preparedness behaviour)	Actual	Multi-variant linear Regression	NS	-	-	-	-	-	-	-	-	-	-	-	-	-ve	<u>Other Factors</u> Place of birth, +ve Place of residence, +ve Willingness to search for information, +ve Sense of preparedness, +ve
30	Disasters (hurricanes, tornados, severe thunderstorms, and ice storms)	Disaster preparedness	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	+ve	Psychological sense of community, +ve Sense of place, -ve Preparedness self-efficacy, +ve Confidence in government, NS
31	Earthquake	Disaster preparedness	Actual	Multiple Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Hazard and vulnerability awareness +ve Fatalistic beliefs -ve Denial beliefs -ve
32	"Natural disasters" and Pandemics	Personal preparedness: disaster	Actual	Linear Regression	-	-	-	-	-	-	+ve	-	-	-	-	-	-	-	Perception of personal preparedness - Natural Disaster, +ve Perception of personal preparedness - Pandemic, +ve Years working in HR, +ve Employer encouragement to have a plan, +ve Disaster preparedness training in the last 2 years, +ve

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
		Personal preparedness: pandemic	Actual	Linear Regression	-ve	-	-	-	-	-	+ve	-	-	-	-	-	-	-	Perception of personal preparedness - Natural Disaster, +ve Perception of personal preparedness - Pandemic, +ve
33	Landslide	Household prepared some necessary items	Actual	Logit Model	NS	NS	-	-	-	NS	NS	NS	-	-	NS	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve Threat, NS Worry, -ve Unknown, +ve Controllability, NS <u>Other Factors</u> Place dependence, +ve Place identity, NS Place attachment, NS Financial help, NS Loss, NS Distance, +ve Official information, NS All information, NS Old, NS Housing material, NS
		Household learned knowledge of disaster prevention and mitigation	Actual	Logit Model	NS	NS	-	-	-	+ve	NS	NS	-	-	NS	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve Threat, +ve Worry, NS Unknown, -ve Controllability, -ve <u>Other Factors</u> Place dependence, +ve Place identity, NS Place attachment, NS Financial help, NS Loss, +ve Distance, +ve Official information, +ve All information, NS Old, NS Housing material, -ve
		Household participated in government organized disaster-related training and drills	Actual	Logit Model	NS	NS	-	-	-	+ve	NS	NS	-	-	NS	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve Threat, NS Worry, NS Unknown, NS Controllability, NS <u>Other Factors</u> Place dependence, NS Place identity, NS Place attachment, NS Financial help, NS Loss, NS Distance, NS Official information, NS All information, NS Old, NS Housing material, NS
		Household made some	Actual	Logit Model	NS	NS	-	-	-	NS	NS	-ve	-	-	+ve	-	+ve	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve <u>Other Factors</u> Place dependence, NS Place identity, NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors	
		changes to home																	Threat, NS Worry, NS Unknown, NS Controllability, NS	Place attachment, NS Financial help, NS Loss, NS Distance, NS Official information, +ve All information, +ve Old, -ve Housing material, +ve
		Household purchased any kind of insurance against natural hazard-induced disasters	Actual	Logit Model	+ve	NS	-	-	-	NS	+ve	+ve	-	-	-ve	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Probability, NS Threat, +ve Worry, NS Unknown, +ve Controllability, -ve	<u>Other Factors</u> Place dependence, NS Place identity, NS Place attachment, +ve Financial help, -ve Loss, NS Distance, NS Official information, +ve All information, NS Old, NS Housing material, NS
		Total number of adopted disaster preparedness behaviours	Actual	Tobit mode	NS	NS	-	-	-	+ve	NS	NS	-	-	NS	-	+ve	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve Threat, +ve Worry, NS Unknown, NS Controllability, -ve	<u>Other Factors</u> Place dependence, +ve Place identity, NS Place attachment, NS Financial help, NS Loss, NS Distance, +ve Official information, +ve All information, +ve Old, NS Housing material, NS
34	"Natural disaster"	Disaster preparedness - Philippines	Actual	Logit	-	NS	-	+ve	-	+ve	+ve	-	-	NS	-ve	NS	+ve	-	Health status, NS Mother has a secondary education, NS Father has a secondary education, NS Started working at age <12, -ve % older people (aged >65) in hh, NS % with secondary education in hh, NS House located near a river, NS House located near a mountain, -ve Area, +ve	

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
		No. of measures (preparedness) - Philippines	Actual	Ordered Logit	-	NS	-	NS	-	+ve	+ve	-	-	NS	-ve	NS	+ve	-	Health status, +ve Mother has a secondary education, NS Father has a secondary education, +ve Started working at age <12, NS % older people (aged >65) in hh, NS % with secondary education in hh, NS House located near a river, NS House located near a mountain, NS Area, +ve
		Disaster preparedness - Thailand	Actual	Logit	NS	+ve	NS	NS	-	+ve	NS	-	-	NS	NS	NS	+ve	-	Health status, NS % older people (aged >65) in hh, NS % with secondary education in hh, NS Own land, NS House located near the coast, +ve House located near a river, NS House located near a mountain, NS Area, -ve
		No. of measures (preparedness) - Thailand	Actual	Ordered Logit	+ve	NS	NS	NS	-	+ve	NS	-	-	NS	NS	NS	+ve	-	Health status, NS % older people (aged >65) in hh, NS % with secondary education in hh, NS Own land, NS House located near the coast, +ve House located near a river, NS House located near a mountain, NS Area, +ve
35	Multi-Hazards	Preparedness component: supply	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Self-Family (e.g. Chemical Weapons), +ve National (e.g. War), +ve Natural (e.g. Earthquakes), NS Accident (e.g. Road and Work), -ve Industry (e.g. Industrial Accidents), NS Technology (e.g. Power Outage), NS
		Preparedness component: skill	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Self-Family (e.g. Chemical Weapons), NS National (e.g. War), NS Natural (e.g. Earthquakes), +ve Accident (e.g. Road and Work), +ve Industry (e.g. Industrial Accidents), NS Technology (e.g. Power Outage), NS
		Preparedness component: planning	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Self-Family (e.g. Chemical Weapons), NS National (e.g. War), NS Natural (e.g. Earthquakes), NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			Accident (e.g. Road and Work), NS Industry (e.g. Industrial Accidents), NS Technology (e.g. Power Outage), NS
		Preparedness component: protection.	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Self-Family (e.g. Chemical Weapons), NS National (e.g. War), NS Natural (e.g. Earthquakes), NS Accident (e.g. Road and Work), NS Industry (e.g. Industrial Accidents), NS Technology (e.g. Power Outage), NS
36	Multi-Hazard Context	Preparedness: provisions/supplies	Actual	Regression	NS	-	-	-	-	-	NS	-	-	NS	-	-	-	-	Frequency of Visits (Family Networks), +ve Telephone Family /Relatives (Family Networks), NS Seek Family Advice (Family Networks), NS Proximity to Relatives (Family Networks), +ve (A) State of Family Relations (Family Networks), NS
		Preparedness: skills	Actual	Regression	+ve	-	-	-	-	-	NS	-	-	NS	-	-	-	-	Frequency of Visits (Family Networks), +ve Telephone Family /Relatives (Family Networks), NS Seek Family Advice (Family Networks), NS Proximity to Relatives (Family Networks), NS State of Family Relations (Family Networks), NS
		Preparedness: planning	Actual	Regression	NS	-	-	-	-	-	NS	-	-	NS	-	-	-	-	Frequency of Visits (Family Networks), NS Telephone Family /Relatives (Family Networks), NS Seek Family Advice (Family Networks), NS Proximity to Relatives (Family Networks), NS State of Family Relations (Family Networks), -ve
		Preparedness: protection	Actual	Regression	+ve	-	-	-	-	-	NS	-	-	NS	-	-	-	-	Frequency of Visits (Family Networks), NS Telephone Family /Relatives (Family Networks), NS Seek Family Advice (Family Networks), NS Proximity to Relatives (Family Networks), -ve State of Family Relations (Family Networks), NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
37	Wildfire	Defence preparation	Actual	Regression	-ve	+ve	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Risk likelihood, NS Risk Severity, +ve <u>Other Factors</u> Area, +ve Protection responsibility, NS Warning reliability, NS Lose water (no vs yes), -ve Lose electricity (no vs yes), NS Lose mobile phone (no vs yes), NS Lose water (NA vs yes), +ve Lose electricity (NA vs yes) NS Lose mobile phone (NA vs Yes) NS
		Evacuation preparation	Actual	Regression	-ve	+ve	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Risk likelihood, NS Risk Severity, +ve <u>Other Factors</u> Area, +ve Protection responsibility, +ve Warning reliability, NS Lose water (no vs yes), -ve Lose electricity (no vs yes), -ve Lose mobile phone (no vs yes), -ve Lose water (NA vs yes), NS Lose electricity (NA vs yes) NS Lose mobile phone (NA vs Yes) NS
		House resilience	Actual	Regression	NS	+ve	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Risk likelihood, NS Risk Severity, +ve <u>Other Factors</u> Area, +ve Protection responsibility, NS Warning reliability, -ve Lose water (no vs yes), -ve Lose electricity (no vs yes), -ve Lose mobile phone (no vs yes), -ve Lose water (NA vs yes), NS Lose electricity (NA vs yes) NS Lose mobile phone (NA vs Yes) NS
		Planning	Actual	Regression	-ve	+ve	-	-	-	-	-	-	-	-	-	-	-	>	<u>Risk Rating / Risk Perception</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors	
																		See next column >	Risk likelihood, NS Risk Severity, +ve <u>Other Factors</u> Area, NS Protection responsibility, +ve Warning reliability, NS Lose water (no vs yes), -ve Lose electricity (no vs yes), NS Lose mobile phone (no vs yes), NS Lose water (NA vs yes), NS Lose electricity (NA vs yes) NS Lose mobile phone (NA vs Yes) NS	
38	Earthquake & Tsunami	Disaster preparedness	Actual	Ordered logit	NS	-ve	-	-	-	+ve	-ve	NS	-	NS	NS	NS	NS	-	Head of household, NS Participated in evacuation drills and disaster education, NS Number of sources of information, +ve Education (one or more persons) +ve Number of members aged ≥ 60 years, -ve Number of members with a disability, +ve House location, NS Village characteristics: Percentage of men with at least secondary education, NS Percentage of women with at least secondary education, +ve Percentage of members aged 65 years and over, NS Percentage of women, -ve	
39	Fire (Residential)	Presence of smoke detector	Actual	path analysis	-	-	-	-	-	-	-	-	-	-	-	-	+ve	> See next column	<u>Risk Rating / Risk Perception</u> Perceived Likelihood, NS	<u>Other Factors</u> outcome expectancy, NS perceived knowledge, +ve self-efficacy, NS
		Presence of fire extinguisher	Actual	path analysis	-	-	-	-	-	-	-	-	-	-	-	-	+ve	> See next column	<u>Risk Rating / Risk Perception</u> Perceived Likelihood, NS	<u>Other Factors</u> outcome expectancy, +ve perceived knowledge, +ve self-efficacy, +ve
		Presence of fire blanket	Actual	path analysis	-	-	-	-	-	-	-	-	-	-	-	-	NS	>	<u>Risk Rating / Risk Perception</u>	<u>Other Factors</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors	
																		See next column	Perceived Likelihood, +ve	outcome expectancy, NS perceived knowledge, +ve self-efficacy, NS
40	Earthquakes & Household Fires	Overall preparedness, earthquake preparedness, & fire preparedness)	Actual	Multivariate & univariate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(Note, Table 8 Significant predictors only of preparedness - multivariate analysis) Intervention (A), Control (B) Dependent Variable: Predictors overall preparedness Self-efficacy, +ve (A & B) Collective efficacy, -ve (A & B) Anxiety (earthquake), +ve (A & B) Trust, +ve (A), -ve (B) Dependent Variable: Predictors of earthquake preparedness Anxiety (earthquake), , +ve (A & B) Trust, -ve (A & B) Dependent Variable: Predictors of fire preparedness Self-efficacy, -ve (A), +ve (B)
41	Multi-Hazard Context	Preparedness	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Regressions for Supply (A), Skills (B), Plans (C), Protect (D) Family Based Networks, +ve (A), NS (B), NS (C), +ve (D) Micro-Neighborhood Network, +ve (A), NS (B), +ve (C), NS (D) Macro-Community Networks, +ve (A), +ve (B), NS (C), NS (D)
42	"Natural disaster"	Collective protection	Actual	Chi-square test of independence	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	There are statistically significant differences in responses between public administration employees and respondents who are not public administration employees (residents) to the question: - concerning the shelters in the residence (p = 0.059); - concerning the evacuation rules (p = 0.000); - concerning the hygiene and health care (p = 0.002); - concerning the appropriate toiletries (p = 0.029); -

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			concerning the behaviour in the evacuation shelter (p = 0.042)
43	Earthquake	Actual adoption of hazard adjustment activities & the likelihood of adopting these hazard adjustment activities	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(Note, see Table 5 for full list of DV's e.g. use of Latches) DV: Strap Item (A), Plan (B), Insurance (C) - adoption intentions Protect persons effectively, +ve (A & B), NS (C) Protect property effectively, NS (A & B), +ve (C) Cost Money, NS (A, B & C) Require knowledge, NS (A, B & C) Require effort, -ve (A), NS (B & C) Require cooperation, +ve (A), NS (A & B) Useful for other hazards, +ve (A, B & C)
44	"Natural disaster"	Preparedness behaviours	Actual	Multivariate Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Self-preparedness responsibility, +ve
45	Terrorism	Preparedness	Actual	Poisson Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Severity, NS Vulnerability, +ve Anxiety, -ve <u>Other Factors</u> Self-efficacy, +ve VDPO, NS
46	"Natural disaster" (e.g. earthquakes and tsunamis)	Household preparedness	Actual	Logit	+ve	+ve	-	NS	NS	+ve	NS	-	-	-	NS	NS	-	-	Living with someone aged 75 or older, NS Living with those requiring special assistance, NS Concerned about a natural disaster, NS
47	Disasters	Preparedness (deemed to be "prepared")	Actual	Logit	-	+ve	-	-	NS	NS	NS	+ve	NS	-	-	-ve	-	-	Medical factors (List), +ve & NS Unable to afford a doctor in the past year, NS Subjective Preparedness (List), +ve
48	Disasters (notes earthquakes, typhoons, infectious diseases)	Household preparedness	Actual	Logit	NS	NS	-	-	NS	-ve	-	+ve	-	-	-	-	+ve	NS	<u>Risk Rating / Risk Perception</u> Note: Risk awareness score <u>Other Factors</u> Regions, +ve Participation in emergency training - last year, +ve Emergency knowledge score, +ve Attitudes towards emergency preparedness,

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			+ve Self-reliance, +ve Fate submissiveness, +ve
49	Disasters (Flooding, Hail, High Winds, and Hurricanes)	Preparedness	Actual	OLS	NS	+ve	-	-	-	-	-	+ve	NS	-	-	-	+ve	-	
50	Natural Hazards	Preparedness & Intention	Actual	Hierarchical Multiple Regression	+ve	NS	-	-	-	-	-	-	-	-	-	NS	-	-	Aust/NZ (Location), +ve Participation (Community), NS Children hazard education, NS Confidence (Government), NS Collective efficacy, NS Empowerment, NS Trust, NS Distrust, NS Negative outcome expectancy, -ve Positive outcome expectancy, NS Responsibility for others, NS Personal responsibility, +ve
51	Flooding	Preparations	Actual	Regression	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Probability, +ve Consequences, +ve <u>Other Factors</u> Affect, -ve Response efficacy, NS Participation, +ve Community efficacy, NS Trust, NS Empowerment, NS
52	Pandemic Influenza	Recommended behaviours (affective response)	Actual	Structural Equation Modelling	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Risk Rating / Risk Perception</u> Likelihood, +ve Severity, +ve Affective Response (worry about pandemic), +ve Affective Response (worry about pandemic), +ve <u>Other Factors</u> Level of preparedness of institutions, NS
53	"Natural disaster"	Disaster survival kit (decision stages, unaware to have a kit)	Actual	Ordered Logit	-	-	-	-	-	-	-	-	-	-	-	-	-	> See next column	<u>Note: Predictors of changes in stages for providing disaster survival kit</u> <u>Risk Rating / Risk Perception</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
																			Perceived susceptibility, NS Perceived severity, NS <u>Other Factors</u> Perceived benefits, +ve Perceived barriers, -ve Self-efficacy, NS
54	Volcanic	Household emergency preparedness	Actual	OLS	NS	NS	NS	NS	-	NS	-	NS	NS	-	-	-	-	NS	Hazard intrusiveness, NS Affective response, NS Community boundedness, +ve Past information search, +ve Lahar zone location, NS Crater proximity, +ve

References

1. Kirschenbaum A (Avi), Rapaport C, Canetti D. The impact of information sources on earthquake preparedness. *Int J Disaster Risk Reduct.* 2017;21(July 2016):99-109. doi:10.1016/j.ijdr.2016.10.018
2. Basolo V, Steinberg LJ, Burby RJ, Levine J, Cruz AM, Huang C. The effects of confidence in government and information on perceived and actual preparedness for disasters. *Environ Behav.* 2009;41(3):338-364. doi:10.1177/0013916508317222
3. Basolo V, Steinberg LJ, Gant S. Hurricane threat in Florida: examining household perceptions, beliefs, and actions. *Environ Hazards.* 2017;16(3):253-275. doi:10.1080/17477891.2016.1277968
4. Corwin KA, Brand BD, Hubbard ML, Johnston DM. Household preparedness motivation in lahar hazard zones: assessing the adoption of preparedness behaviors among laypeople and response professionals in communities downstream from Mount Baker and Glacier Peak (USA) volcanoes. *J Appl Volcanol.* 2017;6(1):1-19. doi:10.1186/s13617-017-0055-8
5. Landahl M, Cox C. Beyond the Plan: Individual Responder and Family Preparedness in the Resilient Organization. *Homel Secur Aff.* 2009;5(3):1-22.
6. Bourque LB, Regan R, Kelley MM, Wood MM, Kano M, Mileti DS. An Examination of the Effect of Perceived Risk on Preparedness Behavior. *Environ Behav.* 2013;45(5):615-649. doi:10.1177/0013916512437596
7. Henly-Shepard S, Anderson C, Burnett K, Cox LJ, Kittinger JN, Ka'aumoana M. Quantifying household social resilience: a place-based approach in a rapidly transforming community. *Nat Hazards.* 2015;75(1):343-363. doi:10.1007/s11069-014-1328-8
8. Cope MR, Lee MR, Slack T, et al. Geographically distant social networks elevate perceived preparedness for coastal environmental threats. *Popul Environ.* 2018;39(3):277-296. doi:10.1007/s11111-017-0292-0
9. Adame B, Miller CH. Vested interest: developing scales for assessing flooding preparedness. *Disaster Prev Manag An Int J.*

- 2016;25(3):282-297. doi:10.1108/DPM-08-2015-0196
10. Bradford RA, O'Sullivan JJ, Van Der Craats IM, et al. Risk perception - Issues for flood management in Europe. *Nat Hazards Earth Syst Sci.* 2012;12(7):2299-2309. doi:10.5194/nhess-12-2299-2012
11. DeBastiani SD, Strine TW, Vagi SJ, Barnett DJ, Kahn EB. Preparedness Perceptions, Sociodemographic Characteristics, and Level of Household Preparedness for Public Health Emergencies: Behavioral Risk Factor Surveillance System, 2006-2010. *Heal Secur.* 2015;13(5):317-326. doi:10.1089/hs.2014.0093
12. Donahue AK, Eckel CC, Wilson RK. Ready or Not? How Citizens and Public Officials Perceive Risk and Preparedness. *Am Rev Public Adm.* 2014;44(4S):89S –111S. doi:10.1177/0275074013506517
13. Ranjbar M, Soleimani AA, Sedghpour BS, Shahboulaghi FM, Paton D, Noroozi M. The predictors of earthquake preparedness in Tehran households Maryam. *Electron Physician.* 2018;10(3):6478-6486. doi:http://dx.doi.org/10.19082/6478
14. Oriangi G, Albrecht F, Di Baldassarre G, et al. Household resilience to climate change hazards in Uganda. *Int J Clim Chang Strateg Manag.* 2019;12(1):59-73. doi:10.1108/IJCCSM-10-2018-0069
15. Kruger J, Chen B, Heitfeld S, Witbart L, Bruce C, Pitts DL. Attitudes, Motivators, and Barriers to Emergency Preparedness Using the 2016 Styles Survey. *Health Promot Pract.* 2018;Vol. XX(No. (X)):1-9. doi:10.1177/1524839918794940
16. Han Z, Lu X, Hörhager EI, Yan J. The effects of trust in government on earthquake survivors' risk perception and preparedness in China. *Nat Hazards.* 2017;86(1):437-452. doi:10.1007/s11069-016-2699-9
17. Annis H, Jacoby I, De Mers G. Disaster preparedness among active duty personnel, retirees, veterans, and dependents. *Prehosp Disaster Med.* 2016;31(2):132-140. doi:10.1017/S1049023X16000157
18. Knuth D, Schulz S, Kietzmann D, Stumpf K, Schmidt S. Better safe than sorry - Emergency knowledge and preparedness in the German population. *Fire Saf J.* 2017;93(September):98-101. doi:10.1016/j.firesaf.2017.08.003
19. Hung LS. Comparing spousal agreement on perceived responsibility for household natural hazard preparedness to actual behavior. *PLoS One.* 2019;14(8):1-19. doi:10.1371/journal.pone.0221217
20. Mabuku MP, Senzanje A, Mudhara M, Jewitt G, Mulwafu W. Rural households' flood preparedness and social determinants in Mwandi district of Zambia and Eastern Zambezi Region of Namibia. *Int J Disaster Risk Reduct.* 2018;28(June 2018):284-297. doi:10.1016/j.ijdr.2018.03.014
21. Oral M, Yenel A, Oral E, Aydin N, Aydin N. Earthquake experience and preparedness in Turkey. *Disaster Prev Manag An Int J.* 2015;24(1):21-37. doi:10.1108/DPM-01-2013-0008
22. Nguyen LH, Shen H, Ershoff D, Afifi AA, Bourque LB. Exploring the causal relationship between exposure to the 1994 Northridge earthquake and pre- and post- earthquake preparedness activities. *Earthq Spectra.* 2006;22(3):569-587. doi:10.1193/1.2219108
23. Bodas M, Siman-Tov M, Kreitler S, Peleg K. The Role of Victimization in Shaping Households' Preparedness for Armed Conflicts in Israel. *Disaster Med Public Health Prep.* 2018;12(1):67-75. doi:10.1017/dmp.2017.38
24. Ejeta LT, Ardalan A, Paton D, Yaseri M. Predictors of community preparedness for flood in Dire-Dawa town, Eastern Ethiopia:

- Applying adapted version of Health Belief Model. *Int J Disaster Risk Reduct.* 2016;19(October 2016):341-354. doi:10.1016/j.ijdrr.2016.09.005
25. Espina E, Teng-calleja M. A Social Cognitive Approach to Disaster Preparedness. *Philipp J Psycology.* 2015;48(2):161-174. https://www.pap.org.ph/includes/view/default/uploads/pjp-journals/PJP1502_Final_7Espina_and_Calleja.pdf
 26. DeYoung SE, Lewis DC, Seponski DM, Augustine DA, Phal M. Disaster preparedness and well-being among Cambodian– and Laotian– Americans. *Disaster Prev Manag An Int J.* 2019;(NO.ahead-of-print). doi:10.1108/DPM-01-2019-0034
 27. Wei HH, Sim T, Han Z. Confidence in authorities, neighborhood cohesion and natural hazards preparedness in Taiwan. *Int J Disaster Risk Reduct.* 2019;40(November 2019):101265. doi:10.1016/j.ijdrr.2019.101265
 28. Wood MM, Mileti DS, Kano M, Kelley MM, Regan R, Bourque LB. Communicating Actionable Risk for Terrorism and Other Hazards. *Risk Anal.* 2012;32(4):601-615. doi:10.1111/j.1539-6924.2011.01645.x
 29. Bodas M, Siman-Tov M, Kreitler S, Peleg K. Assessment of Emergency Preparedness of Households in Israel for War - Current Status. *Disaster Med Public Health Prep.* 2015;9(4):382-390. doi:10.1017/dmp.2015.56
 30. DeYoung S, Peters M. My community, my preparedness: The role of sense of place, community, and confidence in government in disaster readiness. *Int J Mass Emerg Disasters.* 2016;34(2):250-282.
 31. Baytiyeh H, Naja M. The effects of fatalism and denial on earthquake preparedness levels. *Disaster Prev Manag An Int J.* 2016;25(2):154-167. doi:10.1108/DPM-07-2015-0168
 32. Rebmann T, Strawn AM, Swick Z, Reddick D. Personal Disaster and Pandemic Preparedness of U.S. Human Resource Professionals. *J Biosaf Heal Educ.* 2013;1(1):1-7. doi:10.4172/2332-0893.1000102
 33. Xu D, Peng L, Liu S, Wang X. Influences of Risk Perception and Sense of Place on Landslide Disaster Preparedness in Southwestern China. *Int J Disaster Risk Sci.* 2018;9(2):167-180. doi:10.1007/s13753-018-0170-0
 34. Hoffmann R, Muttarak R. Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand. *World Dev.* 2017;69(August 2017):32-51. doi:10.1016/j.worlddev.2017.02.016
 35. Kirschenbaum A. Preparing For The Inevitable: Environmental Risk Perceptions and Disaster Preparedness. *Int J Mass Emerg Disasters.* 2005;23(2):97-127.
 36. Kirschenbaum A. Families and Disaster Behavior: A Reassessment of Family Preparedness Alan. *Int J Mass Emerg Disasters.* 2006;24(1):111-143.
 37. McNeill IM, Dunlop PD, Heath JB, Skinner TC, Morrison DL. Expecting the unexpected: Predicting physiological and psychological wildfire preparedness from perceived risk, responsibility, and obstacles. *Risk Anal.* 2013;33(10):1829-1843. doi:10.1111/risa.12037
 38. Muttarak R, Pothisiri W. The role of education on disaster preparedness: Case study of 2012 Indian Ocean earthquakes on Thailand's Andaman coast. *Ecol Soc.* 2013;18(4):1-16. doi:10.5751/ES-06101-180451
 39. Stumpf K, Knuth D, Kietzmann D, Schmidt S. Adoption of fire prevention measures – Predictors in a representative German sample. *Saf Sci.* 2017;94(April 2017):94-102. doi:10.1016/j.ssci.2016.12.023

40. Joffe H, Perez-Fuentes G, Potts HWW, Rossetto T. How to increase earthquake and home fire preparedness: the fix-it intervention. *Nat Hazards*. 2016;84(3):1943-1965. doi:10.1007/s11069-016-2528-1
41. Kirschenbaum A. Generic sources of disaster communities: A social network approach. *Int J Sociol Soc Policy*. 2004;24(10-11):94-129. doi:10.1108/01443330410791073
42. Tej J, Živčák P, Ali Taha V, Sirkova M. Crisis Awareness of the Municipal District Residents: Implication for Crisis Management At the Local Government Level. *Qual Innov Prosper*. 2014;18(2):1-14. doi:10.12776/qip.v18i2.295
43. Wu HC, Greer A, Murphy HC, Chang R. Preparing for the new normal: Students and earthquake hazard adjustments in Oklahoma. *Int J Disaster Risk Reduct*. 2017;25(October 2017):312-323. doi:10.1016/j.ijdr.2017.09.033
44. Yong AG, Lemyre L. Getting Canadians prepared for natural disasters: a multi-method analysis of risk perception, behaviors, and the social environment. *Nat Hazards*. 2019;98(1):319-341. doi:10.1007/s11069-019-03669-2
45. Wirtz PW, Rohrbeck CA, Burns KM. Anxiety effects on disaster precautionary behaviors: A multi-path cognitive model. *J Health Psychol*. 2019;24(10):1401-1411. doi:10.1177/1359105317720277
46. Tomio J, Sato H, Matsuda Y, Koga T, Mizumura H. Household and Community Disaster Preparedness in Japanese Provincial City: A Population-Based Household Survey. *Adv Anthropol*. 2014;4(2):68-77. doi:10.4236/aa.2014.42010
47. Ablah E, Konda K, Kelley CL. Factors predicting individual emergency preparedness: A multi-state analysis of 2006 BRFSS data. *Biosecurity and Bioterrorism*. 2009;7(3):317-330. doi:10.1089/bsp.2009.0022
48. Chen CY, Xu W, Dai Y, et al. Household preparedness for emergency events: A cross-sectional survey on residents in four regions of China. *BMJ Open*. 2019;9(11):1-9. doi:10.1136/bmjopen-2019-032462
49. Donner WR, Lavariega-Montforti J. Ethnicity, income, and disaster preparedness in Deep South Texas, United States. *Disasters*. 2018;42(4):719-733. doi:10.1111/disa.12277
50. Kelly B, Ronan KR. Preparedness for natural hazards: Testing an expanded education- and engagement-enhanced social cognitive model. *Nat Hazards*. 2018;91(1):19-35. doi:10.1007/s11069-017-3093-y
51. Kerstholt J, Duijnhoven H, Paton D. Flooding in The Netherlands: How people's interpretation of personal, social and institutional resources influence flooding preparedness. *Int J Disaster Risk Reduct*. 2017;24(September 2017):52-57. doi:10.1016/j.ijdr.2017.05.013
52. Prati G, Pietrantonio L, Zani B. A Social-Cognitive Model of Pandemic Influenza H1N1 Risk Perception and Recommended Behaviors in Italy. *Risk Anal*. 2011;31(4):645-656. doi:10.1111/j.1539-6924.2010.01529.x
53. Jassempour K, Shirazi KK, Fararoei M, Shams M, Shirazi AR. The impact of educational intervention for providing disaster survival kit: Applying precaution adoption process model. *Int J Disaster Risk Reduct*. 2014;10(December 2014):374-380. doi:10.1016/j.ijdr.2014.10.012
54. Wei HL, Lindell MK. Washington households' expected responses to lahar threat from Mt. Rainier. *Int J Disaster Risk Reduct*. 2017;22(June 2017):77-94. doi:10.1016/j.ijdr.2016.10.014

Appendix 2 Table A2 Summary of the studies that examined perceived & actual preparedness using regression analysis

Notes: +ve = Positive and significant relationship, -ve = negative and significant relationship, NS = non-significant.

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
1	Earthquake	Actual preparedness	Actual	Regression	NS	NS	-	-	-	+ve	-	-	-	-	-	-	+ve	-	Living in risk zone, NS Religion, -ve Trust in information source, NS Past experience*trust, NS
		Actual preparedness for Israeli Jews	Actual	Regression	NS	NS	-	-	-	NS	-	-	-	-	-	-	+ve	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, -ev
		Actual preparedness for Israeli Arabs	Actual	Regression	NS	NS	-	-	-	+ve	-	-	-	-	-	-	NS	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, +ev
		Perceived preparedness	Perceived	Regression	+ve	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in a risk zone, +ve Religion, NS Trust in information source, NS Past experience*trust, NS
		Perceived preparedness for Israeli Jews	Perceived	Regression	+ve	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in risk zone, NS Trust in information source, NS Past experience*trust, NS
		Perceived preparedness for Israeli Arabs	Perceived	Regression	NS	-ve	-	-	-	NS	-	-	-	-	-	-	NS	-	Living in risk zone, +ev Trust in information source, NS Past experience*trust, NS
2	Earthquakes / Hurricane	Perceived level of preparedness for earthquakes	Perceived	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, +ve Information sources, +ve
		Perceived level of preparedness for hurricanes	Perceived	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, -ve Happen, NS <u>Other Factors</u>

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
	Earthquakes																		Confidence in government, +ve Information sources, +ve
		Preparedness actions for earthquakes - family plan	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, +ve
		Preparedness actions for earthquakes - supplies	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for earthquakes - mitigation	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for earthquakes - shut off utilities	Actual	Logit	NS	NS	+ve	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, +ve
	Hurricane	Preparedness actions for hurricanes - family plan	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	+ve	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, +ve Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, +ve Information sources, NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
		Preparedness actions for hurricanes - supplies	Actual	Logit	NS	NS	+ve	-	-	NS	+ve	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
		Preparedness actions for hurricanes - shut off utilities	Actual	Logits	-ve	+ve	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	> See next column	<u>Risk Rating / Risk Perception</u> Dread, NS Fatal, NS Happen, NS <u>Other Factors</u> Confidence in government, NS Information sources, NS
3	Hurricane	Perceived level of preparedness	Perceived	Ordered Logit	NS	+ve	NS	-	-	NS	NS	NS	NS	NS	-	-	NS	+ve	Immigrant, -ve Information, NS Perceived readiness of local government, +ve
		House preparedness (sandbags on site)	Actual	Logit	-ve	NS	NS	-	-	NS	+ve	NS	-ve	+ve	-	-	NS	+ve	Immigrant, NS Information, NS Perceived readiness of local government, NS
		Household preparedness (family plan)	Actual	Logit	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-	+ve	NS	Information (a lot), +ve Perceived readiness of local government, +ve
		Preparedness (all recommended items on hand)	Actual	Logit	NS	NS	+ve	-	-	NS	NS	NS	NS	+ve	-	-	NS	NS	Immigrant, NS Information (a lot), NS Perceived readiness of local government, NS
7	Natural Hazard - Multi-Hazard Context	Household perceived preparedness	Perceived	Regression	NS	-	NS	NS	-	-	-	-	-	-	-	-	-	-	Know how to fish, NS Know how to preserve food, NS Origin: Mainland, NS Trade fish, NS The profession - Teacher, +ve Have a safe place to evacuate to, NS Know of safe places to evacuate to, NS Know of public awareness programs, NS Think early warning systems are very effective, NS

Ref	Disaster	Preparedness Variable	Model	Analysis	Female	Age	Owns Home	Years of residence	Urban (Inc. Town)	Education	Children	Income	Race	Marital Status	Household Size	Employed	Disaster Exposure	Risk Rating / Risk Perception	Other Factors
					NS	NS	-	-ve	-	-	-	-	-	-	-	-	NS	-	The profession - Teacher, NS Have a safe place to evacuate to, +ve Participation in a Community Group, NS
					NS	NS	-	-ve	-	-	-	NS	-	-	-	-	+ve	-	Have a safe place to evacuate to, NS
					NS	NS	-	-ve	-	-	-	-	NS	-	-	-	-	-	Know of public awareness programs, +ve Think early warning systems are somewhat effective, NS
		Coping capacity (e.g. stocked food/water supplies/emergency rations)	Actual	Regression	NS	-	-	-ve	-	NS	-	NS	-	-	-	-	-	-	Perceived as Prepared, NS Feel the community is prepared, NS Origin, NS Participation in a Community Group, +ve
					NS	-	-	NS	-	-	-	-	-	-	-	-	-	-	Perceived as Prepared, NS Feel the community is prepared, +ve Origin, NS
11	Public Health Emergencies	Level of perceived preparedness	Perceived	Logit	-ve	+ve	-	-	-	-ve	-	-	+ve	-	-	-	-	-	Survey language, English, +ve
		Number of preparedness items	Actual	Logit	-ve	+ve	-	-	-	-ve	-	-	-ve	-	-	-	-	-	(5-Items) Survey language, English, +ve
13	Earthquake	Perceived preparedness	Perceived	Multivariate Regression	-	-	-	-	-	-	-	-	-	-	-	NS	NS	-	Trust, +ve Residence region, NS Family members, -ve
		Actual preparedness behaviour	Actual	Multivariate Regression	-ve	NS	NS	-	-	-	-	-	-	-	-	-	NS	-	Trust, +ve Family members, +ve Monthly income, +ve

Appendix 3 Table A3 Regression Analysis of Perceived and Actual Preparedness

Explanatory variables	Dependent Variable: Household Preparedness Score (Z-Score) †			Dependent Variable: Perceived Preparedness ‡		
	Coef.	Robust Std. Err.	P	Coef.	Robust Std. Err.	P
Female	0.032	0.149	0.829	0.305	0.263	0.245
Age 35-44	0.039	0.117	0.740	-0.313 0.162	0.249	0.208
Age 45 & Older	-0.073	0.161	0.651	-0.409	0.270	0.129
Live – village	-0.236	0.139	0.091	-0.315	0.261	0.228
		0.110	0.563	-0.467*	0.215	0.039
Live – town	-0.236			0.389‡		0.070
Live – suburbs/outskirts of a city	-0.412***	0.125	0.001	-0.145	0.223	0.515
Live – city	-0.410**	0.147	0.006	-0.657**	0.246	0.007
Owns home	0.511***	0.109	0.001	0.400**	0.173	0.021
Years at address	0.003	0.006	0.626	0.010	0.010	0.296
Number of adults at household	0.061	0.046	0.191	0.019	0.085	0.827
Number of children (age <18) at household	-0.035	0.037	0.346	-0.189**	0.066	0.004
Income 30,000-70,000	0.483**	0.160	0.003	0.449	0.291	0.123
Income Over 70,000	0.707***	0.177	0.001	0.424	0.322	0.188
Years practicing	0.003	0.006	0.613	-0.004	0.011	0.695
Risk rating Max: socio-natural	-0.013	0.009	0.173	-0.021	0.017	0.217
Risk rating Max: technological	0.008	0.012	0.520	0.003	0.021	0.873
Risk rating Max: civil	0.003	0.011	0.754	-0.020	0.019	0.293
Exposure to socio-natural emergencies	0.075*	0.033	0.025	0.166**	0.061	0.007
Exposure to technological emergencies	0.072	0.064	0.266	0.142	0.102	0.164
Exposure to civil emergencies	0.019	0.035	0.597	-0.009	0.063	0.883
	-1.130***					
Constant		-3.66	0.001			
Cut 1				-0.457	0.559	
Cut 2				1.664	0.564	
R ²		.264				
F		5.39***				
Wald Chi-squared (df = 20)					χ ² =50.20***	
N		322			298	

Notes: † OLS Regression; ‡ Ordered Probit Regression; † $p \leq 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

S3.2 Table Marginal Effects

	Dependent Variable: Perceived Preparedness					
	Marginal Effects (dy/dx)					
	No	P	Somewhat	P	Yes	P
Female	-0.065	0.249	-0.004	0.680	0.070	0.246
Age 35-44	0.067	0.211	-0.104*	0.040	0.037	0.511
Age 45 & Older	0.087	0.135	0.006	0.671	-0.093	0.130
Live – village	0.067	0.232	0.005	0.676	-0.072	0.226
Live – town	0.100*	0.038	-0.189***	0.001	0.089†	0.071
Live – suburbs/outskirts of a city	0.031	0.516	0.002	0.709	-0.033	0.513
Live – city	0.140**	0.010	0.010	0.665	-0.150**	0.009
Owns home	-0.085*	0.021	-0.006	0.674	0.091*	0.025
Years at address	-0.002	0.301	0.000	0.678	0.002	0.294
Number of adults at household	-0.004	0.827	0.000	0.843	0.004	0.827
Number of children (age <18) at household	0.040**	0.004	0.003	0.669	-0.043**	0.005
Income 30,000-70,000	-0.096	0.129	-0.007	0.666	0.103	0.120
Income Over 70,000	-0.091	0.193	-0.006	0.670	0.097	0.184
Years practicing	0.001	0.695	0.000	0.767	-0.001	0.695
Risk rating max: socio-natural	0.004	0.219	0.000	0.677	-0.005	0.215
Risk rating max: tech.	-0.001	0.873	0.000	0.882	0.001	0.873
Risk rating: civil	0.004	0.292	0.000	0.694	-0.005	0.297
Exposure to socio-natural emergencies	-0.035**	0.009	-0.002	0.661	0.038**	0.006
Exposure to tech. emergencies	-0.030	0.169	-0.002	0.676	0.032	0.167
Exposure to civil emergencies	0.002	0.884	0.000	0.884	-0.002	0.883

Notes: Marginal effects are estimated using the mean values for all other explanatory variables

† $p \leq 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

10.6 Appendix Chapter 8 - Discussion & Conclusion

Appendix 1 Storm Emma

In 2018, Ireland experienced three significant snow and low-temperature events, including 2018, 2010, and 1982. The 2018 event, from late February to early March, caused record low temperatures and blizzard-like conditions, leading to nationwide disruption. A countrywide Status Red warning was issued, indicating a rare, extremely dangerous event with stay-at-home restrictions (Met Éireann, 2019; NDFEM, 2019). This event, resulting from Storm Emma and The Beast from the East convergence, is referred to as Storm Emma within our paper.

On February 23rd 2018, Met Éireann, the Irish National Meteorological and Hydrological Service (NMHS), advised of a weather system likely to bring low temperatures and significant snowfalls from February 27th (Met Éireann, 2019). By February 25th, they confirmed widespread snow showers with potentially disruptive accumulations (Met Éireann, 2019; NDFEM, 2019), prompting Irish media coverage (McGreevy, 2018).

Modest snow showers began on February 27th, prompting the Irish National Emergency Coordination Group (NECG) to urge the public to take preparatory mitigation measures, such as purchasing extra food supplies (NECG, 2018). On February 28th, a Status Red warning was issued, forecasting significant snow accumulations and blizzard-like conditions (Met Éireann, 2019). On March 1st, the NECG issued a stay-at-home advisory, instructing everyone to be indoors by 4pm due to sub-zero temperatures, icy conditions, and high snow accumulations. Taoiseach Leo Varadkar emphasized the advice, cautioning that "everyone should be at home after 4pm, nobody should be on the roads after that" (Melia *et al.*, 2018).

Blizzard conditions subsided overnight into March 2nd, lifting the shelter-in-place advisory, though unnecessary travel remained discouraged due to ongoing snow accumulations. On March 3rd and 4th, widespread snow and hazardous conditions persisted, with potential for localized flooding due to snowmelt. By March 5th, deep snow remained in some areas, thawing slowly, with warnings of possible flooding and water shortages continuing until March 7th (Met Éireann, 2019; NECG, 2018).

Appendix 2 Krippendorff eight-phase process

This study utilized content analysis of qualitative responses, adhering to the eight-phase analytical process delineated by Krippendorff (2018). A summary of the process is provided below:

- Phase 1: Qualitative data and socio-demographic information was imported into NVivo R1;
- Phase 2: An initial set of codes was generated through open coding. These codes were labeled according to themes identified by the participants themselves, to encapsulate their personal experiences and perspectives.
- Phase 3: The preliminary codes established in Phase 2 were categorized, facilitating further data analysis. Categories underwent revision by distillation, relabeling, and merging to ensure their labels accurately represented the coded content.
- Phase 4: The restructured categories were subdivided into sub-categories, enhancing the comprehension of the data.
- Phase 5: Data reduction entailed the consolidation and refinement of codes into a final model.
- Phase 6: Analytical memos were prepared, encapsulating the content of each category (summarizing the content).
- Phase 7: The analytical memos were validated via a self-audit of the findings through the examination of relationships among and between categories.
- Phase 8: Synthesizing - providing a descriptive account of participants' thoughts related to the Storm.

Appendix 3 Table 1: Satisfaction with Met Éireann weather warnings: qualitative responses

Negative	564
Too frequent	102
Not localized enough	101
Not taken seriously	98
Warnings are not Clear	84
Conditions exaggerated	78
Inaccurate	53
Issued too Late	33
Better communication needed	7
Other	5
Positive	444
Acceptable	203
Not too Frequent	91
Clear	73
Accurate	39
Cautious	19
In good time	11
Taken seriously	8

Total Comments: 1008 collected from 818 households.

Appendix 3 Table 2: Additional preparedness actions or inaction: qualitative responses

Code	Count
Stocked up on supplies	543
No specific preparations taken	463
Battened down the hatches	312
Helped friends and family	264
Stayed in house	179
Appropriate clothing	163
Charged batteries	99
Prepared to work from home	87
Watching the news	70

Kept pets safe	59
Moved closer to work	51
Protected livestock	47
Alternative transport organised	41
Stocking up on tools	42
Travelled home	34
Travel bag	34
Removing snow	33
Completed work before storm	31
Already prepared	31
Alternative power source	21
Prepared tyres	21
Alternative heat source	20
More time for travel	17
Alternate entertainment	17
Alternative cooking source	12
Preparing for emergency service work	5
Emergency contact numbers	5
Childcare	4
Other	3

Total Comments: 2708 collected from 2,220 households

Appendix 3 Table 3: Actions households felt they should have taken with benefit of hindsight: qualitative responses

Code	Count
Stocked up on supplies (more supplies)	1104
No additional preparations were needed	525
Stocked up on tools (more tools)	148
Alternate heat source	111
Removed snow and ice	92
Prepared for loss of utilities	78
Alternative means of cooking	72
Stayed at home	70
Appropriate clothing	67
Alternate entertainment	65
No need to prepare	64
Communicated better with work	63
Battened down the hatches	55
Medical supplies emergency	53
Alternative power source	51
Believe the news/weather warnings	45
Help friends and family	41
Emergency contact numbers	34
Cash	32
Bug out bag	31
Alternative means of transport	31
Prepared tyres	29
Charged batteries	25
Moved closer to town	20
Travelled home	19
Prepared to work from home	13
Prepared a bug out plan/bag	10
Protect livestock	8
Stayed in work	8
Checked heating working properly	7
Travel bag	7
Access to car	6
Kept pets safe	2
Other	2

Total Comments: 2,988 collected from 2,460 households

Appendix 3 Table 4: Causes of decreases in worry levels: qualitative responses

Code	Count
The storm was not as bad as expected	492
Being prepared and safe within the home	109
Having access to a news source	92
Not having to travel	85
Not losing utilities	44
Enjoyed the snow (not worried)	44
Knowing friends/family were safe	39
No negative impact	17
Government action	17
Still able to travel	16
Time with friends and family	13
Shops remained open	9
Roads cleared quickly	5
Other	3

Total Comments: 985 collected from 808 households

Appendix 3 Table 5: Causes of increases in worry levels: qualitative responses

Code	Count
Travel to or from the home	591
Snowfall/trapped in the home	348
Concerns over friends and family safety	169
Watching the news/storm	161
Lack of preparedness	138
Loss of utilities	135
Storm being worse than expected	104
Damage to house	76
Lack of communication (from employer)	52
No access to medical services	44
Roads not cleared	42
Shops out of stock	37
The unknown	35
No public transport	31
High winds	29
Livestock in danger	26
Shops closed	24
Poor government response	24
Cancelled flight	16
Falling trees	15
Going outside	11
Other	7
Lack of childcare	6

Total Comments: 2,121 collected from 1,314 households