The Girls Active Project (GAP): Co-design and feasibility of an after-school physical activity intervention

A thesis presented to Dublin City University for the Degree of Doctor of Philosophy (PhD)

By

Sara McQuinn (MSc, BSc)

Supervisors:

Dr. Mary Rose Sweeney

Dr. Sarahjane Belton

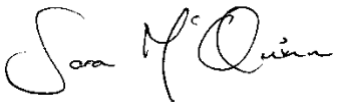
Prof. Anthony Staines

August 2022

School of Nursing, Psychotherapy and Community Health

Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy 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: _  (Candidate)

I.D. Number.: 15211776

Date: 23rd August 2022

Funding

This research was funded by the Health Research Board SPHeRE/2013/1. The Health Research Board (HRB) supports excellent research that improves people's health, patient care and health service delivery. The Health Research Board aims to ensure that new knowledge is created and then used in policy and practice. In doing so, the Health Research Board support health system innovation and create new enterprise opportunities.

Dedication

To my mother, Sylvia Angel-McQuinn, and late father, George McQuinn,
who taught me to work hard and instilled in me
the belief that anything is possible.

Acknowledgements

First and foremost, a sincere thank you to my supervisory team, Dr. Mary Rose Sweeney, Dr. Sarahjane Belton, and Prof. Anthony Staines, for their continued guidance and support. Sj, MR and Anthony, I will be forever grateful for your kindness, reassurance and unwavering belief in me and my "capabilities". I would also like to thank my doctoral panel member, Dr. Denise Proudfoot for her expertise and advice throughout this project.

This work would not have been possible without the participating school in this programme of research. I would like to express my heartfelt appreciation to the students, teachers, parents, principal and staff for their enthusiasm and commitment to this project. A special thank you to the student 'Project Leaders' for being an undeniable source of positivity and inspiration.

I am extremely appreciative to have had so much support and encouragement from the Health Research Board SPHeRE programme. Thank you to the entire SPHeRE team and my 'SPHeRE10' classmates, including the greatest co-workers, Louise, Nerilee, Rikke, Niamh and Lisa who I've had the pleasure of always sharing this rollercoaster journey with.

A huge thank you to all the staff at DCU for their compassion, patience and invaluable assistance. Thank you to my fellow postgraduate students (past and present) from DCU and beyond who have since become my lifelong friends. Our shared victories, infinite cups of coffee, ice-cream adventures and never-ending voice notes kept me going through all the years. A special shout out to Éadaoin, Eibhlín and the 'DCU H block' crew. I'm very grateful to Dineke, EUPHAnxt and the EUPHA family for their endless support and trust. To my clients and everyone at DCU Sport, BodyWorX and CrossFit Waterford, thank you for the constant reminders of my love for exercise!

Finally, I would like to thank my incredible friends and family for always being there for me and the many welcome distractions. To Cillian, my love, thank you for your willingness to listen to me (all the time) and making me laugh every single day. To my brothers, Tony and Oisín, thank you for encouraging me to go on every adventure, especially this one. A special thank you to the ever so creative Oisín for designing the GAP logo that brought this project to life. To my Mam, I'm so grateful you shared with me your passion for health and fitness, I love you to the moon and back. Thank you to my Dad who started this journey with me and has continued to watch over me, I kept my promise Georgie. If someone ever spoke highly of me to you, you used to proudly say *'you reap what you sow'* – how right you were!

Table of Contents

List of abbreviations

Abbreviation	Meaning
APEASE	Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity
BCTs	Behaviour Change Techniques
BCW	Behaviour Change Wheel
COM-B	Capability, Opportunity, Motivation – Behaviour
CSPPA	Children's Sport Participation and Physical Activity
GAP	Girls Active Project
MVPA	Moderate-To-Vigorous Intensity Physical Activity
PA	Physical Activity
PE	Physical Education
PPI	Public and Patient Involvement
SC	Steering Committee
SES	Socio-Economic Status
TDF	Theoretical Domains Framework
WHO	World Health Organisation
YAG	Youth Advisory Group

List of tables

List of figures

Abstract

The Girls Active Project (GAP):
Co-design and feasibility of an after-school physical activity intervention

Sara McQuinn

Background
Adolescent females physical activity (PA) participation rates are low globally, particularly among females of lower socio-economic status (SES). Evidence suggests theory-based, multi-component interventions are most effective at improving PA levels. Following the Medical Research Council framework, this research aimed to co-design, with adolescent females, a theory-driven, multi-component, extra-curricular school-based PA intervention, the Girls Active Project (GAP), and assess its feasibility.

Setting
One single-sex, female-only, designated disadvantaged post-primary school in Dublin, Ireland.

Methods
The Behaviour Change Wheel (BCW) and Public and Patient Involvement (PPI) were used to develop the GAP programme. Mixed-methods with students (n=287, aged 12-18) and teachers (n=7) captured students' self-reported PA levels and identified factors influencing PA behaviour at school. These data were subsequently used in discussion groups with PPI contributors (n=8, students aged 15-17) to co-design the intervention. Mixed-methods were applied with multiple stakeholders to assess the feasibility of implementing and evaluating the GAP programme over a 12-week single-arm feasibility trial.

Results
Just 1.4% of the students in this sample (n=287, aged 12-18) reported meeting the recommended PA guidelines. Time, social influences, beliefs about capabilities, environmental context and resources, goals, reinforcement, and behavioural regulation emerged from the data as factors influencing PA behaviour. A peer-led, after-school PA programme was co-designed. The feasibility study encountered significant contextual barriers and challenges with recruitment. Recruitment (n=8, 10%) was low, yet retention (n=7, 88%) was high. Despite the COVID-19 pandemic hindering implementation, results suggested the GAP programme was implemented with high fidelity (87%), well-received by stakeholders and perceived as compatible with the after school-setting.

Conclusions
PA levels of females in this sample were far below recommended guidelines for optimum health. The novel approach applied to systematically co-design the intervention could facilitate future replication. Whilst further thought must be given on how to increase enrolment, the in-person delivered PA programme showed promise as an intervention that can be feasibly implemented and evaluated. Future research should examine the GAP's preliminary-effectiveness at increasing PA levels in a pilot-cluster randomised controlled trial.

Research outputs

Publications relating to thesis

Research article	Journal	Status
McQuinn, S., Belton, S., Staines, A. *et al.* Co-design of a school-based physical activity intervention for adolescent females in a disadvantaged community: insights from the Girls Active Project (GAP).	BMC Public Health	Accepted (November 2021) https://doi.org/10.1186/s12889-022-12635-w
McQuinn, S., Belton, S., Staines, A. *et al.* Feasibility of a peer-led, after-school physical activity intervention for disadvantaged adolescent females during the COVID-19 pandemic: Results from the Girls Active Project (GAP).	BMC Pilot and Feasibility Studies	Accepted (August 2022)

Published abstracts

S Mc Quinn, S Belton, A Staines, M Sweeney, The Girls Active Project: a school-based intervention to increase adolescent girls' physical activity, *European Journal of Public Health*, Volume 30, Issue Supplement_5, September 2020, ckaa165.1134, https://doi.org/10.1093/eurpub/ckaa165.1134

Conference proceedings

Oral presentation: Health-Enhancing Physical Activity (HEPA) Europe (August 2022)

Oral presentation: World Congress of Public Health, Virtual Edition (Oct 2020)

Poster presentations: Annual Expo, School of Nursing, Psychotherapy and Community Health, DCU (Dec 2018 & Dec 2021)
7th Annual SPHeRE conference (Feb 2021)

Other forms of research dissemination relating to thesis

- RTÉ Brainstorm article (Aug 2021) and podcast (Jan 2022), 'Why do girls stop playing sport? Let's ask them

- Regional radio interview, Deise Today, WLRFM Radio Interview. (Aug 2021)
- Podcast: Roundtable discussion on girl's physical activity and sport with Dr. Bronagh McGrane and Emma Cowley. Available: Spotify. Apple Podcast, Youtube The Fallowers (Mar 2021)
- Invited speaker at a research seminar, Physical Activity for Health Research Centre (PAHRC), The University of Edinburgh (Jan 2021)
- Interview with the Health Research Board 'SPHeRE Scholar takes a personal approach to Public Health' (December 2019)

Chapter 1 Introduction

1.1 Introduction

1.1.1 Researcher position and contribution

As a researcher, I approached this research project from a background in public health. I started this Ph.D. in October 2017, as part of the Health Research Board SPHeRE (Structured Population and Health-services Research Education) programme. I had just finished a two-year M.Sc. by Research, funded by the European Commission, on Child and Young People's Health and Well-being across Europe. This research was part of a larger European project, called BRIDGE Health (Bridging Information and Data Generation for Evidence-based Health policy and research). Before my M.Sc., I had completed a B.Sc. in Public Health and Health Promotion (Grade 1.1) from University College Cork. Alongside my studies, I am a self-employed personal trainer who enjoys working with clients to promote a holistic approach to health and well-being.

Hopeful and excited, as I combined my interests in exercise, research and public health, I applied to the SPHeRE Ph.D. programme. I secured funding and chose to be placed in Dublin City University with my supportive supervisory team. The SPHeRE Ph.D. programme provides a comprehensive set of capacity building and training activities to scholars throughout the four-year course. This included six expert-led, taught modules delivered in the first year and an eight-week national placement at the North East Inner City (NEIC) of Dublin (May to June 2018). As a physical activity (PA) researcher for Dublin City Council, my role was to identify and report on the PA needs of young people in the disadvantaged community. I was responsible for engaging with multiple stakeholders in the community, including the schools (primary and post-primary), sport clubs and youth groups, to gather data on the strengths, challenges and opportunities for PA in the area. At the end of year one, I presented my proposed thesis. From there, I prepared an application for ethical approval. After ethical approval was granted, I sought to recruit a post-primary school and operationalised the tasks required for the research presented in this thesis.

1.1.2 Introduction to topic

Physical inactivity is a leading cause of non-communicable disease and premature mortality worldwide (Lee et al., 2012; Strain et al., 2020; WHO, 2009). Globally, the most recent

estimates show that one in four (27.5%) adults (Guthold et al., 2018) and more than three-quarters (81%) of adolescents (aged 11 to 17 years) (Guthold et al., 2020) do not currently meet the recommendations for PA set by the World Health Organisation (WHO) (WHO, 2018). The WHO recommends that children and adolescents (aged 5 to 17, including those living with disability) accumulate at least an average of 60 minutes a day of moderate-to-vigorous intensity PA (MVPA) across the week (Bull et al., 2020). Despite the well-documented evidence on the health benefits of regular PA for adolescents, including physical fitness, cardiometabolic health and mental health (Bailey et al., 2012; Chaput et al., 2020; Janssen and LeBlanc, 2010), the data reveals no overall improvement in global levels of PA participation over the last two decades (Guthold et al., 2020). Moreover, participation in PA during adolescence can be a predictor to adulthood activity (Hallal et al., 2006; Huotari et al., 2011; Telama et al., 2005). Given that adolescence is a transitional period of growth and development, it presents an important opportunity to promote healthy attitudes and behaviours to positively influence the adults they will become.

There is compelling evidence to suggest there is an age-related decline in PA during adolescence (Corder et al., 2016b, 2019; Dumith et al., 2011). Gender differences in PA participation have been identified worldwide (Guthold et al., 2020, 2018) where females are significantly less likely to meet PA guidelines compared to males. In fact, the PA gap between males and females begins early (Guthold et al., 2020; Hallal et al., 2012; Inchley et al., 2020) with the decline notably steeper for females than for males (Dumith et al., 2011; Woods et al., 2018). In addition to gender and age, data consistently show inequalities in PA participation by socio-economic status (SES) (WHO, 2018). Research indicates adolescents of higher SES are more likely to meet PA guidelines than those of lower SES (Borraccino et al., 2009; Inchley et al., 2020; Stalsberg and Pedersen, 2010). Notably, when PA levels were assessed by SES and gender across countries in the Health Behaviour in School-aged Children (HBSC) survey, females of lower SES were consistently the least active (Borraccino et al., 2009; Inchley et al., 2020), amplifying the need to tackle the inequalities in PA participation by gender and SES early.

1.1.2.1 Setting the scene in Ireland

The most recent census data from 2016 in Ireland, reported that youth of post-primary level (also known as second-level) school age (13-18 years) represented 8% (371,588) of the population (Central Statistics Office Ireland, 2016). Similar to international findings, the national Children's Sport Participation and Physical Activity (CSPPA) study (Woods et al.,

2018) identified significant gender differences and age-related decline in PA participation when comparing students who reported meeting the guidelines at primary (13% females Vs. 23% males) and post-primary (7% females Vs. 14% males) schools (Woods et al., 2018). Particularly, Murphy et al. (2020) found a decline in PA participation through post-primary school year groups from first year (13.9%) to sixth year (2.2%), with females, in general, less likely to meet the WHO's PA guidelines than males (5.3% females Vs 11.5% males) (Murphy et al., 2020). Regarding SES, at post-primary school level, adolescents of the highest SES were more likely to meet PA guidelines (12%) than those in the medium (10%) and lower (10%) groups (Woods et al., 2018). There are various national policies, strategies, and action plans, such as the 'National Physical Activity Plan' (Department of Health Ireland, 2016) aimed to promote and engage the population with PA. Specifically to females, Sport Ireland published a 'Women in Sport Policy' in 2019 (Sport Ireland, 2019). As part of its outputs, Sport Ireland developed and published an 'Adolescent Girls Get Active' research resource for PA programme designers to encourage adolescent females to participate in regular PA (Sport Ireland, 2021).

1.1.3 Promoting physical activity

Despite the expanding evidence base on how PA can be promoted among adolescents (Messing et al., 2019), evidence suggests important knowledge gaps still exist, and efforts to improve adolescent PA surveillance, research, intervention implementation, and policy development are required (van Sluijs et al., 2021). The factors that influence adolescent females PA participation are believed to be multifactorial, including psychological, social and environmental factors (Graham et al., 2014), such as time constraints (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021; Slater and Tiggemann, 2010; Woods et al., 2010), PA enjoyment (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021), social influences, including peers (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021; Slater and Tiggemann, 2010; Woods et al., 2010) and perceived competence related to PA (Corr et al., 2018; Slater and Tiggemann, 2010; Woods et al., 2010). Understanding the factors that influence adolescent PA behaviour can enhance the development of tailored interventions aimed to promote meaningful PA opportunities for adolescents (Graham et al., 2014; Martins et al., 2021).

The school setting is often used for PA promotion due to its convenience (e.g., ability to reach large numbers of adolescents, location, facilities, equipment) and the significant amount of time adolescents spend at school (Cale and Harris, 2006; Hills et al., 2015). Evidence suggests

PA delivered during extra-curricular periods (i.e., PA which happens within a school setting but is not part of the formal physical education curriculum, also known as non-curricular activities) in school could potentially increase adolescents' PA (Jago and Baranowski, 2004) including after-school PA programmes (Demetriou et al., 2017).

1.1.4 Developing and evaluating interventions

The Medical Research Council (MRC) framework for developing and evaluating complex interventions is a tool used to develop, evaluate, and implement a complex intervention to improve health (Craig et al., 2008). The guidance for using this framework was updated in 2021, by Skivington et al. (2021). The framework divides complex intervention research into four phases: development or identification of the intervention, feasibility, evaluation, and implementation. These phases do not automatically occur in a linear order, but the framework can aid researchers define where they are in the research process.

Meaningful stakeholder engagement is recommended at all phases in the MRC framework as it can maximise the potential of developing an intervention that is likely to have positive impacts on health and to improve prospects of achieving changes in policy or practice (Skivington et al., 2021). Patients and the public are key stakeholders. A Public and Patient Involvement (PPI) approach is research which is "co-produced" with patients, carers, or members of the public (INVOLVE, 2012). PPI 'young people's advisory groups' has become an increasingly common approach to actively involve young people in the research process (Sellars et al., 2020).

This Ph.D. thesis focused on the 'development of the intervention' and 'feasibility' phases of the MRC framework (Skivington et al., 2021) outlined below.

1.1.4.1 Intervention development

This phase is considered essential because it supports the identification of mechanisms of change, important contextual factors and relevant outcome measures (Skivington et al., 2021). Best practice guidelines recommend developing interventions systematically using the most robust evidence available and relevant theory (Craig et al., 2008). Indeed, evidence suggests theory-based interventions (Lai et al., 2014; Owen et al., 2017; Pearson et al., 2015) are more likely to be effective in increasing adolescents' PA levels than non-theory based interventions. The four main theoretical frameworks that have been used to understand and change PA include social cognitive approaches, humanistic/organismic approaches, dual

process approaches and socio-ecological approaches (Rhodes et al., 2019). This research used the Behaviour Change Wheel (BCW) (Michie et al., 2014) as a guide to intervention development because it aligned with our objectives. The BCW framework seeks to capture both the factors influencing the target behaviour (e.g., PA) using the COM-B model, and the different types of interventions that can be used to change the behaviour. Moreover, I attended a two-day workshop at NUIG (National University of Ireland Galway) in October, 2018 on how to develop a behaviour change intervention using the BCW. This Ph.D. research applied the BCW in combination with a PPI approach to co-design, with adolescent females, an extra-curricular school-based PA intervention, the Girls Active Project (GAP).

1.1.4.2 Feasibility study

A feasibility study of the GAP intervention programme was carried out after-school. Feasibility studies are an umbrella term used to describe any type of study relating to the preparation for a main study (Eldridge et al., 2016b). Feasibility studies are not designed or powered to assess efficacy or effectiveness (El-Kotob and Giangregorio, 2018; Lancaster, 2015). Instead, they are essentially designed to answer the overarching question: *Can it work?* (Orsmond and Cohn, 2015) i.e., does the intervention show promise of being successful with the intended population? Indeed, due to the growing appreciation of the significant role feasibility studies play in the development and evaluation of complex interventions (Beets et al., 2021; Hallingberg et al., 2018; Skivington et al., 2021), PA researchers are encouraged to use feasibility studies to enhance the rigor of future trials (El-Kotob and Giangregorio, 2018).

1.2 Research aim and objectives

Aim: to work with key stakeholders in a single-sex, female-only, designated disadvantaged post-primary school in Dublin, to co-design a school-based physical activity intervention based on theory, and trial the intervention in the school setting.

Objectives:

1. To identify the factors influencing adolescent females' physical activity behaviour in the school setting using the COM-B model and Theoretical Domains Framework.
2. To co-design, with adolescent females, an extra-curricular school-based physical activity intervention (Girls Active Project) using the Behaviour Change Wheel in combination with a Public and Patient Involvement approach.

3. To conduct a feasibility trial of the Girls Active Project, a peer-led, after-school physical activity intervention aimed to positively impact the physical activity behaviour of adolescent females.

1.3 Thesis outline

Chapter 2 provides an overview of the key aspects of the literature on adolescents' PA with a particular emphasis on the literature pertinent to females of lower SES. The most common behaviour change theories used by researchers to understand and change PA, and the different approaches used to promote PA among adolescents are summarised. This chapter aims to highlight the current gaps in the literature, and the limitations of the approaches currently used to promote PA among adolescent females. Chapter 2 also provides a rationale for the current thesis and its aims and objectives.

Chapter 3-6. Chapter 3 contains a general overview of the methodology and methods used for each of the three studies in this thesis: Study 1, Study 2, and Study 3. It describes the procedures used as regards PPI, ethical considerations and adaptations required in light of the COVID-19 pandemic. Research objectives are addressed in the form of three studies presented below (Figure 1). The three studies (Study 1, Study 2, and Study 3) are included in chapter four to six.

Chapter 7 presents a general discussion of the overall findings of the three studies, the strengths and limitations of this research, and suggestions are outlined for future research and practice.

Aim: to work with key stakeholders in a single-sex, female-only, designated disadvantaged post-primary school in Dublin, to co-design a school-based physical activity intervention based on theory, and trial the intervention in the school setting.

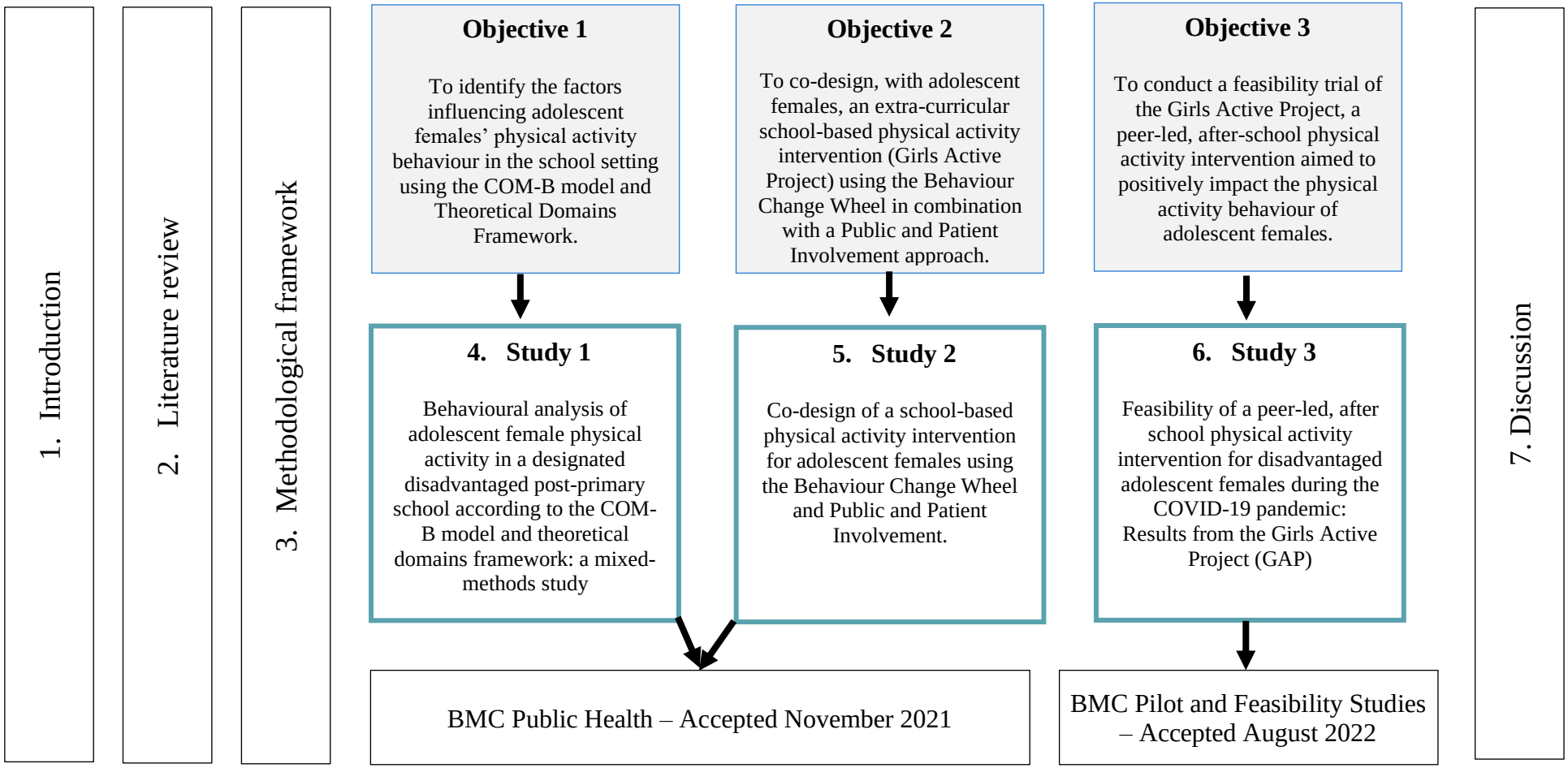


Figure 1: Thesis outline

Chapter 2 Literature review

2.1 Physical activity and adolescents

2.1.1 What defines an adolescent?

The WHO defines an ‘adolescent’ as any person aged 10 to 19, and describes ‘adolescence’ as the transitional phase of life between childhood and adulthood (WHO, 2022).

2.1.2 What is physical activity?

Physical activity (PA) is defined as ‘any bodily movement produced by skeletal muscles that results in energy expenditure’ (Caspersen et al., 1985). It takes many forms, occurs in many settings, and has many purposes (e.g., daily activity, active recreation, and sport).

2.1.3 Recommended guidelines

The WHO divides PA into intensity levels that refer to the rate at which the activity is being performed, or the magnitude of the effort required to perform an activity (Bull et al., 2020; WHO, 2010). On a scale of 0-10 relative to an individual’s personal capacity, moderate intensity PA is usually a 5 or 6, and vigorous intensity PA is usually a 7 or 8. For example, moderate-intensity PA would cause an individual to breathe faster and an increased heart rate, whereas vigorous-intensity PA requires a larger amount of effort and a substantial increase in heart rate.

The WHO recommends that children and adolescents (aged 5 to 17) including those living with disability, accumulate at least an average of 60 minutes a day of moderate-to-vigorous intensity PA (MVPA) across the week (Bull et al., 2020). It is also recommended that vigorous-intensity aerobic activities, as well as those that strengthen muscle and bone should be incorporated at least 3 days a week.

A systematic review of the health benefits of PA and fitness in school-aged youth found that PA should be of at least moderate intensity to achieve substantive health benefits, and vigorous intensity activities may provide even greater benefit (Janssen and LeBlanc, 2010). Indeed, many of the benefits of PA participation are observed with an average of 60 minutes of MVPA daily, although activity beyond 60 minutes of MVPA daily provides additional health benefits (Bull et al., 2020).

"Some physical activity is better than none for those not currently meeting these recommendations" (Bull et al., 2020, p. 1460).

2.1.4 Benefits of physical activity participation

Evidence continues to accumulate on the health benefits of regular PA for adolescents (Bailey et al., 2012; Janssen and LeBlanc, 2010). The robust evidence that informed the 2020 WHO guidelines on PA for adolescents (Chaput et al., 2020) indicated that PA participation is associated with multiple beneficial health outcomes. These included: physical fitness (cardiorespiratory and muscular fitness), cardiometabolic health (blood pressure, dyslipidaemia, glucose, and insulin resistance), bone health, cognitive outcomes (academic performance, executive function) and mental health (reduced symptoms of depression) and reduced adiposity. All forms of PA, such as physical education, active travel, play, after-school activities, and sports, can provide health benefits if undertaken regularly and of sufficient duration and intensity (WHO, 2018).

2.1.5 Current trends

Despite the well-documented health implications of physical inactivity, globally, more than three-quarters (81%) of adolescents (aged 11 to 17 years) do not currently meet the recommendations for PA set by the WHO (Guthold et al., 2020). These data also reveal no overall improvement in global levels of participation over the last two decades. Inactive adolescents are at greater risk of long-term ill health (Shrestha and Copenhaver, 2015) and given that participation in PA during adolescence can be a significant contributor to levels of PA in adulthood (Hallal et al., 2006; Huotari et al., 2011; Telama et al., 2005), tackling the decline in PA during adolescence is a major public health priority.

2.1.5.1 Age and gender

Adolescence represents a period of transition, with the move from primary to post-primary (otherwise known as second-level) education shown to negatively influence young people's PA behaviour (Nader et al., 2008; Riddoch et al., 2004; Woods et al., 2018). This decline of PA during adolescence is a consistent finding in the literature internationally (Corder et al., 2016b, 2019; Dumith et al., 2011). A national study (Murphy et al., 2020) found that the percentage of adolescents meeting PA guidelines declined through post-primary school, from first year (13.9%) through second (12.2%), third (8.8%), fourth (6%) and fifth year (3.7%) with the lowest percentage in sixth year (2.2%). Notably, the decline starts sooner and

becomes steeper for females than for males (Dumith et al., 2011; Woods et al., 2018). This trend has been identified worldwide, where adolescent females appear to consistently spend less time engaged in MVPA compared to males (Guthold et al., 2020; Hallal et al., 2012; Inchley et al., 2020). In Ireland, the Children's Sport Participation and Physical Activity (CSPPA) study (Woods et al., 2018) identified clear gender differences between PA levels of females and males, with females less likely to meet recommended levels. The decline by age and gender differences were evident when comparing students who reported meeting the guidelines at primary (13% females Vs. 23% males) and post-primary (7% females Vs. 14% males) schools (Woods et al., 2018).

2.1.5.2 Socio-economic status

Evidence suggests socio-economic status (SES) is correlated to adolescents' PA behaviour, such that adolescents of higher SES are significantly more likely to meet PA guidelines than those of lower SES (Borraccino et al., 2009; Inchley et al., 2020; Stalsberg and Pedersen, 2010). The nationally representative Children's Sport Participation and Physical Activity (CSPPA) study found that at post-primary school level in Ireland, adolescents of the highest socio-economic background were more likely to meet PA guidelines (12%) than those in the medium (10%) and lower (10%) groups (Woods et al., 2018). When examining PA levels across gender and SES, the Health Behaviour in School-Aged Children (HBSC) survey found that females of lower SES were consistently the least active (Borraccino et al., 2009; Inchley et al., 2020). Notably, the effect of gender was greatest, for example, the 2017/2018 HBSC study that surveyed 227,441 young people aged 11 to 15 years across Europe and Canada found that high-affluent females reported lower levels of vigorous PA than low-affluent males (Inchley et al., 2020).

2.1.6 What's happening at policy level?

Insufficient PA is the fourth leading risk factor for mortality worldwide, accounting for approximately 5.5% (3.2 million) deaths each year (WHO, 2009) and has become an increasing economic burden for health systems (Scarborough et al., 2011). The WHO encourages countries to direct efforts and resources to implementing evidence-based PA programmes and policy for more physically active populations as benefits extend beyond the health sector, including intersected social, economic and environmental impacts (Bull et al., 2020). In 2016, about 80% of countries globally reported having national PA policies or plans, however, these policies were operationalised in just about 56% of countries, indicating

that there are barriers to PA policy implementation that need to be addressed (Sallis et al., 2016).

The WHO published a 'Global Action Plan On Physical Activity 2018-2030', with a target of 15% relative reduction in the global prevalence of physical inactivity in adolescents by 2030 (WHO, 2018). A PA 'system map' was created by Rutter et al. (2019) that illustrates the range of factors influencing PA, including individual, biological, transport and environmental, societal, and socio-political factors, emphasising the notion that a single approach to increasing PA is unsuitable. In 2021, the International Society for Physical Activity and Health (ISPAH) published an updated advocacy document that endorsed implementing a system-based approach to PA promotion (Milton et al., 2021). It outlined eight investment areas *'that work'* to change PA behaviour including whole-of-school programmes, active transport, active urban design, health care, public education, sport and recreation, workplaces, and community-wide programmes. Indeed, given the range of factors that influence PA (Rutter et al., 2019), a systems-based approach for action, across multiple sectors and domains, to support the promotion of PA is recommended. This approach is reflected in the WHO 'Global Action Plan on Physical Activity 2018-2030' (WHO, 2018). The action plan provides information and recommendations on 20 evidence-based policy actions for national Member States and stakeholders to implement and monitor. The policy actions support 13 out of the 17 United Nations Sustainable Development Goals 2015-2030, demonstrating the significance of PA promotion to reaching global health targets. Notably, the global action plan specified the need to strengthen the development and implementation of behavioural public health interventions targeted at females and vulnerable or marginalised populations, that engage with and increase PA opportunities. To date, and to my knowledge, there are no specific global PA policies targeted at adolescent females. At a European level, the WHO Regional Office for Europe, published a PA strategy 2016-2025, inspired by their policy framework for health and well-being, to specifically focus on PA as a leading factor in health and well-being in the European Region (WHO and Regional Office for Europe, 2016).

In Ireland, the Department of Health published the national framework 'Healthy Ireland – A Framework for Improved Health and Well-being 2013-2025' (Department of Health Ireland, 2013). The national framework draws on new and existing national policies, strategies, and action plans. Ireland's first 'National Physical Activity Plan' (Department of Health Ireland, 2016) was subsequently published. It set two targets and formulated 14 specific action areas to engage children and young people (aged 0 to 18) with PA. The two targets included to increase by 1% per year the proportion of youth undertaking at least 60 minutes of MVPA

every day, and secondly, to decrease by 0.5% per year the proportion who do not partake in any weekly PA. Amongst the specific action areas, the National PA Plan supports the 'Active School Flag' initiative and aims to expand the whole-school, multi-component programme developed by the Department of Education and Skills (Active School Flag, 2020) to more schools across Ireland. In 2019, Sport Ireland published a 'Women in Sport Policy' (Sport Ireland, 2019) that aligns with the Department of Transport, Tourism and Sports objectives in the 'National Sports Policy 2018-2027' (Department of Transport, Tourism and Sport, 2019). Explicitly, as part of their Women in Sport Policy outputs, Sport Ireland developed an 'Adolescent Girls Get Active' research resource for PA programme designers to encourage adolescent females to participate in regular PA (Sport Ireland, 2021). Similar to international-level PA policies, to my knowledge, there are no specific national-level PA policies that exclusively target adolescent females. Lastly and most recently, the Department of the Taoiseach launched its first report on a new cross-government initiative, the 'Well-being Framework for Ireland' in July 2021 (Department of the Taoiseach, 2021). The conceptual framework covers 11 dimensions, including 'Mental and Physical Health'. This Well-being Framework is currently being developed and will become clearer over time but reflects an important step towards a multi-dimensional approach to understanding the impact of public policy and population well-being.

2.1.7 Measuring physical activity

Measurement of PA is essential to identify and track current PA levels, and the effectiveness of the interventions designed to increase adolescent PA levels (Sirard and Pate, 2001). Employing high quality, valid and reliable PA measures that also adequately satisfies the research question or design, however, can be a challenge (Sylvia et al., 2014). The methods of measuring PA include subjective methods, such as self-reported questionnaires, logs, recalls, and diaries, and objective methods, including measures of energy expenditure (e.g., the doubly labelled water method), direct observation, and physiological measures (e.g., accelerometers, pedometers, heart-rate monitors) (Strath et al., 2013). Each method used to evaluate PA in adolescents has its own strengths and limitations (Sirard and Pate, 2001). For example, self-report questionnaires are the most common method of PA assessment, where many have been shown to have reliability and validity for determining general PA type, amount, intensity, and duration (Haskell, 2012; Sylvia et al., 2014). Specifically, the two-item PACE+ questionnaire to measure self-reported minutes of daily MVPA (Prochaska et al., 2001) has been previously validated amongst 10–18 year old Irish youth against accelerometery ($r = 0.34$; ≥5 valid days) (Hardie Murphy et al., 2015). Notably, the validity

was higher in females ($r = 0.39$; males $r = 0.27$) and increased with age (post-primary $r = 0.39$; primary $r = 0.24$) using ≥5 valid days. Self-report questionnaires are also cost effective and easy to administer. Potential disadvantages are that self-report questionnaires are less robust in measuring light-or-moderate intensity PA, and may be subject to recall bias or social desirability (Sallis, 2010; Sylvia et al., 2014). In contrast, using devices, such as accelerometers, has demonstrated substantial potential to capture large amounts of data, including the pattern of light, moderate- intensity PA and vigorous-intensity PA (Haskell, 2012; Sylvia et al., 2014), however such devices do not provide data on PA type, location or context. Moreover, methodological inconsistencies between objective PA measures (Cooper et al., 2015; Hollis et al., 2017), such as the variability in accelerometer protocols (Borde et al., 2017) can make between-country analyses and a definitive conclusion challenging. Indeed, measurement methodologies for PA can be complex, with no measure that can assess all aspects of PA (Strath et al., 2013; Sylvia et al., 2014). Combining both subjective and objective approaches may provide a more comprehensive assessment of PA (Kang et al., 2016).

2.1.8 Factors influencing adolescent females' physical activity behaviour

Even though there is no widely accepted explanation for the decline in PA levels among adolescent females, the factors that influence their participation are believed to be multifactorial, including psychological, social and environmental factors (Graham et al., 2014). Understanding the factors that influence adolescent PA behaviour can enhance the development of tailored interventions aimed at promoting PA (Graham et al., 2014; Martins et al., 2021).

Research to date has clearly identified time constraints as a major barrier to adolescent PA participation (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021; Slater and Tiggemann, 2010; Woods et al., 2010). Indeed, among post-primary females in Ireland, lack of time was given as the main barrier to PA participation (Woods et al., 2010). Adolescent females have cited that changing and competing priorities, including increased academic pressures, part-time employment and responsibilities at home, often get prioritised over PA (Corr et al., 2018; Cowley et al., 2021b). There is robust evidence to suggest that peers and friends have a substantial influence on the PA behaviour of adolescents (Fitzgerald et al., 2012; Graham et al., 2014; Macdonald-Wallis et al., 2012). In a review by Corr et al. (2018), it was recognised that peers' influence on adolescent females' perceptions of PA had both positive and negative impacts. Peers could encourage and support their involvement, or

equally, their influence could be negative, leading to a disengagement from PA. Indeed, research indicates adolescents socialise in groups with similar PA levels, and over time their PA behaviours reflect those of their peers (Macdonald-Wallis et al., 2012). Parental support has also been correlated with adolescents PA participation (Martins et al., 2017). Similarly, Corr et al., (2018) found that parents' influence on adolescent females' perceptions of PA could be positive or negative. Females with parents who supported and encouraged them to participate in PA had positive perceptions, in comparison to females who lacked these supportive role models.

Enjoyment and perceiving PA as 'being fun' has been identified as a strong facilitator (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021) and one of the most important factors for the continuation of PA involvement among adolescents (Martins et al., 2021). The meaning of 'fun' in relation to PA, however, is not the same for everyone. Corr et al. (2018) found that active females with higher skill levels and perceived competence perceived being able to actively participate in PA with peers made it fun (Corr et al., 2018), whereas inactive females found trying to participate with skilled peers stressful. In contrast, less competitive or performance-focused activities have been cited by adolescent females as enjoyable and 'fun' (Corr et al., 2018; Slater and Tiggemann, 2010).

Low levels of perceived competence (Corr et al., 2018; Slater and Tiggemann, 2010; Woods et al., 2010), low levels of self-efficacy for being physically active (Graham et al., 2014; Martins et al., 2021) or a lack of confidence in skills (Cowley et al., 2021b) have often been cited by adolescent females as common barriers to PA participation. Research indicates perceived competence is correlated with PA in adolescent females (Biddle et al., 2005; Craike et al., 2014). Likewise, Martins et al. (2021) found that a reduced perception of competence and a low level of self-efficacy for being physically active were barriers to PA participation, with higher levels of these variables reported by more active adolescent females. Females with low perceived competence have reported how their lack of motivation derived from low perceived competence, a dislike of team sports, and negative feedback from peers and teachers (Corr et al., 2018). Indeed, a dislike for structured sports and how physical education is delivered in schools (Cowley et al., 2021b; Rees et al., 2006) have been cited by adolescent females as barriers to their participation. Barriers included limited variety, an emphasis on skill and competition (Corr et al., 2018), physical education not being delivered in a 'fun' way, a lack of autonomy and poor facilities (Cowley et al., 2021b; Rees et al., 2006). Notably, evidence suggests adolescents of lower SES could face even further difficulties with environmental factors perceived by adolescents as barriers to PA, including space, equipment,

infrastructure, unsuitable PA programmes, long distances from facilities, safety concerns and cost (Humbert et al., 2006; Martins et al., 2021).

Research indicates gender biases in PA and social stereotypes may also influence adolescent females' PA behaviour (Corr et al., 2018; Cowley et al., 2021b; Slater and Tiggemann, 2010). Females have reported feeling reluctant to participate in what they considered to be 'masculine' sports (Corr et al., 2018). Equally, females have cited it as not being 'cool' or feminine to play sport, and have expressed the difficulty of retaining femininity while playing particular sports, such as football (Slater and Tiggemann, 2010). Findings support biological changes experienced during puberty (Corr et al., 2018), concerns about body-image and appearance (Corr et al., 2018; Cowley et al., 2021b; Slater and Tiggemann, 2010) and off-putting sport uniforms (Slater and Tiggemann, 2010) may also discourage females to engage with PA.

2.2 Understanding and changing physical activity behaviour

2.2.1 Why focus on behaviour change?

Most recent data reveal no overall improvement in global levels of PA in adolescents over the last two decades (Guthold et al., 2020), whilst an editorial in The Lancet Public Health journal in 2019, predicted that if current trends continue, the 2025 global PA target of a 10% relative reduction in insufficient PA will not be achieved (The Lancet Public Health, 2019). Likewise, Rutter et al. (2019) forecast that without significant scaling of efforts at local, regional, national and international levels, the global targets for PA are unlikely to be met (Rutter et al., 2019). Health systems play a key role in inducing healthy behaviour change for the good of the individual, and of society as a whole (WHO Europe, 2008). Unfortunately, health promotion activities, and public health campaigns, have often failed to achieve the desired effects in terms of reducing disease incidence and burden (WHO Europe, 2008). In a report by the WHO (2008), these shortcomings are believed to be because compliance with the intended behaviour change is harder to achieve than raising awareness, providing knowledge and changing attitudes. Essentially, while raising awareness, providing knowledge and altering attitudes are necessary to change behaviour, they are rarely sufficient.

2.2.2 Theoretical frameworks

Changing PA behaviour is a complex process (Buchan et al., 2012; Perry et al., 2012). Behaviour change theories identify the factors that influence behaviour, suggest which

techniques should be incorporated into interventions, and provide a framework within which to test hypotheses and gather data (Prestwich et al., 2015). Theoretical frameworks are considered a critical feature in PA science (Rhodes and Nigg, 2011) as they create a context for understanding, explaining, and eventually intervening to effect PA (Rothman, 2004). In 2019, Rhodes and colleagues (Rhodes et al., 2019) published an overview of the four main theoretical frameworks that have been used to understand and change PA over the last three decades. These include social cognitive approaches, humanistic/organismic approaches, dual process approaches and socio-ecological approaches.

2.2.2.1 Social cognitive approaches

Primarily, social cognitive approaches are the leading frameworks used to understand PA, which centres on individuals' attitudes and beliefs. Specifically, it is based on the principle that individuals will intend to be physically active if they believe that (a) PA is important, and (b) they are genuinely capable of being active (Rhodes et al., 2019). Therefore, interventions using the social cognitive approach usually aim to appeal to one's beliefs and values, and builds an expectation of capability through factors, such as social encouragement (Biddle and Nigg, 2000). There are numerous social cognitive approaches, including Social Cognitive Theory, The Theory of Planned Behaviour, and The Transtheoretical Model, briefly described below.

Bandura's (1986), Social Cognitive Theory, proposes that human behaviour is the product of the dynamic interaction of personal, environmental, and behavioural factors. The main construct in this theory is self-efficacy, i.e., *'the belief in one's capability to accomplish a certain level of performance'* (Bandura, 1986). Social Cognitive Theory has been extensively used in school-based interventions to promote PA in adolescents (Dobbins et al., 2013), including those specific to adolescent females, such as the Trial of Activity for Adolescent Girls (TAAG) (Webber et al., 2008) and the peer-led Walking In ScHools intervention (the WISH study) (Carlin et al., 2018). According to Ajzen's, Theory of Planned Behaviour (Ajzen, 1991), individuals will engage in a behaviour if they view it positively (attitude), believe that significant others want them to engage in it (subjective norm), and perceive that the behaviour is under their control (perceived behavioural control). This theory has been used to understand the influencing factors of adoption, motivation and adherence to PA (Buchan et al., 2012), including young people's (aged 12-14) PA intentions and behaviours (Hagger et al., 2001).

Lastly, The Transtheoretical Model was developed as a comprehensive model of behaviour change, based on the premise that behaviour change is a process, and as an individual attempts to change, they move through stages (Prochaska and Velicer, 1997). This model has also been used to examine adolescent PA behaviour (Nigg and Courneya, 1998). The stages of change classifies individuals concerning their progression towards habitual PA (Nigg et al., 2011). It is hypothesised that an individuals' processes of change (facilitating movement between the stages), decisional balance (pros and cons of changing), self-efficacy, and temptation alter as they move through the stages of change. The stages include (i) precontemplation, individuals with no intention to engage in regular PA, (ii) contemplation, the intent to engage in regular PA within the next 6 months, (iii) preparation, immediate intentions and commitment to engage in regular PA (i.e., within the next 30 days), (iv) action, individuals who have actually initiated regular PA behaviour, and (v) maintenance, habitual PA behaviour for more than 6 months (Nigg et al., 2011). In the final stage, (vi) termination, individuals have zero temptation for relapse and achieve 100% self-efficacy. Since this stage is difficult to achieve, it is often not considered in health promotion programmes (Raihan and Cogburn, 2021).

Despite the social cognitive framework being the dominant approach in PA research, there has been a slow shift from a complete social cognitive explanation for PA (Rhodes et al., 2019). There are a few reasons for this. Thus far, effects of social cognitive interventions have been modest (Nigg et al., 2011; Young et al., 2014) with no particular social cognitive approach more effective in producing PA behaviour change than any other (Gourlan et al., 2016). Moreover, the assumption that individuals are willing and able to maintain PA motivation using effortful cognitive processes alone has been challenged (Conroy and Berry, 2017). For example, in a study by Dewar et al. (2013) on adolescent females' PA using the Social Cognitive Theory, authors recommended that future testing consider including ecological components to advance our understanding of PA behaviour (Dewar et al., 2013).

2.2.2.2 Humanistic/organismic approaches

The humanistic and organismic approaches propose that human action is motivated by an inherent desire to grow, develop and realise ones potential (Rhodes et al., 2019) to which, Self-Determination Theory (Deci and Ryan, 2000) is the most common theory applied to understanding PA (Rhodes et al., 2019). Self-Determination Theory is composed of five sub theories or mini-theories (causality orientations theory, cognitive evaluation theory, goal contents theory, basic psychological needs theory and organismic integration theory) that

together, seek to understand human motivation. The theory assumes that individuals are innately active and self-motivated, however, interactions between individuals and their social environment can either support or hinder that inherent active nature (Deci and Ryan, 2000). Two commonly employed mini-theories to examine PA behaviour are the basic psychological needs theory (i.e., individuals have three basic psychological needs; autonomy, relatedness and competence) and the organismic integration theory (i.e., motivation is considered as a continuum of self-determination from amotivation at the lowest end of the continuum to intrinsic motivation at the other end, with extrinsic motivation as a third general form of motivation comprising of four types of behavioural regulation) (Rhodes et al., 2019). In turn, it is hypothesised that when the three psychological needs are satisfied, an individual's inherent activity will be supported, optimal self-determined motivation will be promoted, and positive psychological, developmental, and behavioural outcomes will be produced (Buchan et al., 2012).

A review conducted on studies with adults (aged >18) by Teixeira et al. (2012), demonstrated good evidence for the value of Self-Determination Theory in understanding PA. It found that competence was a consistent positive predictor of PA, and support for a positive relation between more autonomous forms of motivation and PA, with intrinsic motivation more predictive of long-term PA adherence (Teixeira et al., 2012). Self-Determination Theory has been integrated into the design, delivery, and training content within several PA interventions for female adolescents, such as PLAN-A (Peer-Led physical Activity iNtervention for Adolescent girls) (Sebire et al., 2019, 2016), the HERizon Project (Cowley et al., 2021a) and the G-PACT (The Girls Peer Activity) project (Owen et al., 2018).

2.2.2.3 Dual process approaches

Dual process frameworks are in its infancy as PA science becomes more familiar to the non-conscious influences on behaviour (Rhodes et al., 2019). In their most basic application, dual process frameworks integrate two systems that work in parallel to regulate an individual's thoughts, feelings, and actions (Conroy and Berry, 2017; Rhodes et al., 2019). System 1 is based on the non-conscious or impulsive processes, including the comparatively less understood and less tested determinants of PA, such as habits, automatic evaluations, and automatic motivation. It is relatively fast, effortless, and usually more difficult to control. In contrast, system 2 involves reflective or controlled processes which are relatively slow, deliberative and effortful. They include the conventional social-cognitive approach constructs (e.g., values, intentions, expectations) and can result in action plans. Most dual process

approaches hypothesise that individuals are more likely to act on impulse, as a default-response (system 1), unless intervened on by distinctive reflective processes (system 2) (Evans and Stanovich, 2013; Rhodes et al., 2019). Of note, findings support that individuals who engage in more regular PA have more pleasant automatic evaluations of PA (Conroy and Berry, 2017). Therefore, targeting system 1 processes, for example using cues to activate learned associations in memory, show potential for promoting PA (Conroy and Berry, 2017).

2.2.2.4 Socio-ecological approaches

In the last 20 years, socio-ecological frameworks have attracted considerable research attention alongside the increasing recognition that despite individual-level factors being fundamental to behaviour change, individuals are merely actors within broader complex systems (Sniehotta et al., 2017). The policy and environmental levels of PA behaviour change, for example transport policies and settings-based interventions, such as schools, provide targets for governments to focus on to improve health outcomes (Heath et al., 2006). For example, the ecological model of health (Sallis and Owen, 2015) focuses on the interactions among multiple factors across five ecological domains, including intrapersonal, social networks, socio-cultural and community, environment and policy domains. Sallis and Owen (2015) describe the ecological model of health as a 'meta-model' that does not displace health behaviour theories, but instead places them in a broader context (Sallis and Owen, 2015). As an example, the Youth-Physical Activity Towards Health (Y-PATH) programme (Belton et al., 2014) is a multicomponent school-based intervention based on a combination of the socio-ecological model and the self-determination theory. Research indicates targeting ecological domains beyond the individual level is important in PA interventions for adolescents (Perry et al., 2012). Perry et al. (2012) found most PA interventions (30 reviewed) aimed at adolescents (aged 12-18) targeted factors across at least two ecological domains, predominantly the intrapersonal (e.g., teaching behavioural skills) and environmental domains (e.g., providing additional opportunities for PA and non-traditional physical education classes).

2.2.3 Using theory to design interventions

Research indicates the use of theories, and a clear description of their use, is essential in behaviour change intervention development (Davidoff et al., 2015; Prestwich et al., 2015). Best practice guidelines from the MRC framework recommend developing interventions systematically, drawing on the best available evidence and appropriate theory (Craig et al.,

2008; Skivington et al., 2021). A review by Prestwich et al. (2015) however, found that a significant proportion of behaviour change interventions are not based on theory, and those that are, tend not to apply the theory extensively.

Identifying 'active components' or 'active ingredients' in an intervention contributes to a better understanding of the effects and processes of behaviour change (Michie et al., 2013). Active components in an intervention are often identified as a 'behaviour change technique' (BCT) that are observable and replicable. They have been linked to theoretical constructs, and are defined as *"an active component of an intervention designed to change behaviour"* (Michie et al., 2014, p. 145). In 2013, Michie et al., developed a BCT Taxonomy V1, consisting of 93 BCTs (Michie et al., 2013). Importantly, the appropriate selection of a BCT, or a combination of these techniques, can influence intervention effectiveness (Prestwich et al., 2015). Effective BCTs, such as 'self-monitoring' have been identified in interventions to increase PA (Michie et al., 2009). Although, BCTs used in PA interventions can vary. For example, 26 different techniques were identified across 24 mobile apps that incorporated BCTs aimed at improving PA, diet and sedentary behaviour in adolescents (Schoeppe et al., 2017).

Over 80 theories of behaviour and behaviour change of potential relevance to public health interventions exist (Davis et al., 2015). Michie et al. (2008) remarked that although theory provides a helpful framework for designing interventions, they offer little guidance on how to do this (Michie et al., 2008). Subsequently, in recent years, tools such as the Behaviour Change Wheel (BCW) (Michie et al., 2014) have become increasingly popular choices as theoretical frameworks to guide intervention development for researchers.

2.2.4 The Behaviour Change Wheel

The BCW was developed by Michie and colleagues (2011) to provide a structured and systematic approach to designing behaviour change interventions and strategies. It was synthesised from 19 other theoretical frameworks of behaviour change, with an aim to overcome the limitations of these frameworks (Michie et al., 2011). The BCW framework seeks to capture both the factors influencing the target behaviour and the different types of interventions that can be used to change the behaviour. It has been successfully used to design interventions in different contexts, such as sexual counselling (Sharry et al., 2016), medication management (Sinnott et al., 2015), auditory rehabilitation (Barker et al., 2016), sedentary behaviour/time spent sitting in the workplace (Munir et al., 2018; Ojo et al., 2019)

and PA (Clarke et al., 2019; Murtagh et al., 2018; Webb et al., 2016). Despite the systematic and structured approach of the BCW, researchers have acknowledged challenges associated with the BCW, describing it as 'a time-consuming' process (Murtagh et al., 2018; Webb et al., 2016) and 'not a magic bullet for intervention development' (Sinnott et al., 2015).

Michie et al. (2014) published a book titled 'The Behaviour Change Wheel. A guide to designing interventions' that outlines three stages (eight steps) to follow to design a behaviour change intervention. The first stage of the BCW involves understanding the target behaviour and culminates in a behavioural analysis, identifying what factors need to change to enable behaviour in relation to the 'capability, opportunity, motivation and behaviour' (COM-B) model. Further information on the COM-B model is provided below. The second stage involves identifying intervention options, including intervention functions and policy categories. There are nine intervention functions to address the target behaviour, i.e., education; persuasion; incentivisation; coercion; training; restriction; environmental restructuring; modelling; and enablement. Seven policy categories are presented to support the delivery of the particular intervention functions: Communication/marketing; guidelines; legislation; regulation; fiscal, environmental/social planning; and service provision (Michie et al., 2014). Proposed intervention and changes to policy can be evaluated using the APEASE criteria (affordability, practicability, effectiveness/cost-effectiveness, side-effects/safety, and equity). The final stage, stage three, 'identify content and implementation options', involves selecting BCTs and the mode(s) of delivery. The taxonomy of 93 BCTs (BCT Taxonomy V1) and its application, is provided. The selection of BCTs is based upon an evaluation against the APEASE criteria, as is the mode(s) of delivery of the intervention content.

2.2.4.1 Theoretical Domains Framework and the COM-B model

The COM-B model is at the core of the BCW framework, which suggests capability, opportunity and motivation (COM) interact to influence behaviour (B) (Figure 2). There are six COM-B components: physical capability, psychological capability, social opportunity, physical opportunity, reflective motivation and automatic motivation. In essence, the COM-B model proposes that individuals' capability (physical or psychological skills to perform the behaviour), opportunity (physical or social influences that allow for the behaviour), and motivation (reflective beliefs about the good and bad consequences of changing behaviour and automatic wants and needs to change behaviour), interact to influence the target behaviour. Therefore, identifying what needs to change regarding an individual's 'capability', 'opportunity' and 'motivation' to engage in that behaviour is essential for change to occur.

The Theoretical Domains Framework (TDF), derived from 33 theories of behaviour and 128 psychological constructs (Cane et al., 2012) has been identified as a useful tool for identifying determinants of behaviour and barriers to behaviour change. It was added to the BCW, forming the second layer in Figure 2, to allow deeper exploration of the factors influencing behaviour change. The TDF has been used in many contexts to understand behaviour and design theory informed interventions (French et al., 2012). The integrative framework consists of 14 domains: knowledge; skills; memory, attention and decision processes; behavioural regulation; social/professional role and identity; beliefs about capability; optimism; belief about consequences; intentions; goals; reinforcement; emotion; environmental context and resources and social influences.

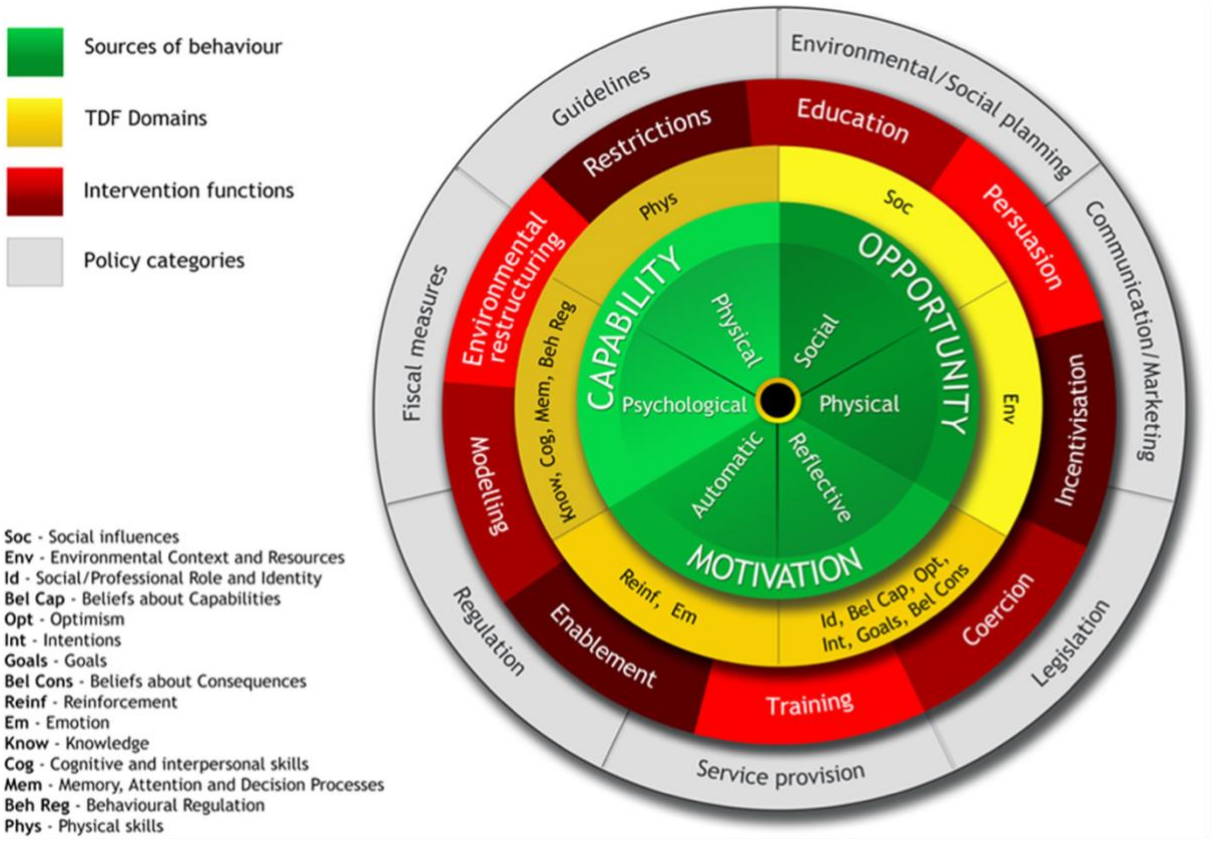


Figure 2: The Behaviour Change Wheel. Michie et al. (2014)

2.3 Physical activity interventions

2.3.1 Promoting physical activity among adolescents

There is a clear need for effective interventions that increase adolescents' levels of PA (Guthold et al., 2020). In fact, given the decline of PA during adolescence, Dumith et al. (2011) suggested that interventions that attempt to reduce the PA decline, even without an

increase in PA levels, could be considered as effective. Despite an expanding evidence base on interventions to promote PA during adolescence (Messing et al., 2019), including interventions specifically targeted at adolescent females (Camacho-Miñano et al., 2011; Owen et al., 2017; Pearson et al., 2015), evidence suggests that important knowledge gaps still exist, and efforts to improve adolescent PA surveillance, research, intervention implementation, and policy development are required (van Sluijs et al., 2021).

There is compelling evidence to suggest that multi-component interventions (Kriemler et al., 2011; Messing et al., 2019; Owen et al., 2017; Pearson et al., 2015) and interventions underpinned by theory (Lai et al., 2014; Owen et al., 2017; Pearson et al., 2015) are more likely to be effective in changing adolescents' PA behaviour than those targeting single components or non-theory based interventions. In a review on '*lessons from around the world'* on evidence-based PA interventions, Heath et al. (2012) described the importance of tailoring interventions to target specific populations. Such findings echo recommendations outlined within the MRC framework (Craig et al., 2008), emphasising that complex interventions may work best if tailored to local circumstances rather than being completely standardised. A meta-analysis conducted by Pearson et al. (2015) on the effectiveness of interventions to increase PA among adolescent females in any setting (community, parent/home, school and outside of school) found small but significant effects, with larger effects found in female-only interventions and interventions that were performed in schools.

Previous studies have explored adolescents' opinions on how to improve PA promotion (Corder et al., 2013; James et al., 2018; Whitehead and Biddle, 2008). Incorporating choice of activity type, timing and location of PA, introducing adolescents to new activities (Corder et al., 2013) and providing opportunities for adolescents to be active with friends in an environment that is fun and informal (Whitehead and Biddle, 2008) have all been identified by adolescent's as potential strategies for increasing PA.

2.3.2 The school environment

The school environment is considered to be an ideal setting for PA promotion based on the significant amount of time adolescents spend at school, and its ability to reach large numbers of adolescents across a range of differing backgrounds (Cale and Harris, 2006; Hills et al., 2015). It is the most common setting for implementing adolescent PA interventions. For example, in a systematic review of reviews on PA interventions for adolescents by Messing et al. (2019) across the three key settings (family and home, childcare, and school), most PA

interventions (28 out of 39 reviews analysed) were based in the school-setting (Messing et al., 2019). Indeed, the school setting presents various opportunities to intervene to promote PA, such as implementing extra-curricular activities, enhancing the physical education curriculum, and engaging the community (Murillo Pardo et al., 2013).

2.3.2.1 Evidence for school-based intervention

In general, evidence suggests school-based PA interventions have been minimally successful (Borde et al., 2017; Dobbins et al., 2013; Kriemler et al., 2011; Lai et al., 2014; Love et al., 2019; Owen et al., 2017). A Cochrane review by Dobbins et al. (2013) found evidence to suggest that school-based PA interventions can increase MVPA in children and adolescents aged 6 to 18, ranging from five to 45 minutes per day. In contrast, a review by Love et al. (2019) found little or no change in the amount of MVPA the young people did throughout the day. Equally, Owen et al. (2017) found very small effects on school-based interventions specifically targeted at adolescent females' PA levels. These findings indicate that changing adolescents' PA behaviours through school-based interventions can be challenging, however there are certain approaches that appear to be more successful, while Borde et al. (2017) recommends that researchers continue to explore novel approaches to increasing adolescents' PA.

Evidence suggests school-based interventions (De Meester et al., 2009; Kriemler et al., 2011; Messing et al., 2019), including after-school programmes (Atkin et al., 2011) that focus on the change of multiple health behaviours instead of focusing just on PA are less effective, indicating that single-behavioural interventions are more suited for adolescents than multiple-behavioural interventions. Incorporating a 'whole-school approach' (Heath et al., 2012; Milton et al., 2021; van Sluijs et al., 2021; WHO and United Nations Educational Scientific and Cultural Organization, 2021) has been recognised as most effective for increasing PA. For example, the Physical Activity 4 Everyone (PA4E1) programme (Sutherland et al., 2019) founded on the Health Promoting Schools Framework (Langford et al., 2015), is an evidence-based multi-component PA intervention that has been implemented, evaluated and scaled-up across many post-primary schools in Australia (Sutherland et al., 2021). The PA4E1 intervention consists of seven PA promotion strategies that targeted the curriculum (enhanced physical education lessons, individualised student PA plans, enhanced school sport programme); school environment (recess/lunchtime activities, school PA policy); parents (parent newsletters); and community (after-school community sport and fitness programmes). Similarly, in Ireland, both the 'Project Spraoi' intervention (Coppinger et al., 2016; O'Leary

et al., 2019) at primary school level, and the Youth-Physical Activity Towards Health (Y-PATH) programme (Belton et al., 2019; O'Brien et al., 2013) at post-primary school level, which adopted a multi-component whole-school approach to PA promotion have shown a positive influence on the PA behaviour of young people.

Understanding the many factors that support effective implementation of PA interventions is important (Naylor et al., 2015) particularly when scaling-up. The term "implementation strategies" is used to describe the methods or techniques (e.g., training, performance feedback) used to enhance the adoption, implementation and/or sustainability of evidence-based interventions (Pearson et al., 2020). Evidence suggests PA interventions delivered at-scale report lower effects than pre-scale trials (Lane et al., 2021). Indeed, even where small-scale feasibility and pilot studies appeared successful, previous school-based adolescent PA interventions have experienced implementation issues when scaled-up (Corder et al., 2021; Gorely et al., 2019; Jago et al., 2015; Jong et al., 2020). This indicates the challenge of designing a replicable intervention offering the flexibility required across diverse school settings. Evidence suggests 'implementation evaluation' supports scale-up of effective school-based PA interventions and thus population-level change (Naylor et al., 2015). For example, the aforementioned multi-component Physical Activity 4 Everyone (PA4E1) programme has successfully scaled-up to a large number of post-primary schools in Australia (Sutherland et al., 2021). The intervention schools were supported to implement PA4E1 with seven evidence-based implementation strategies (embedded school staff: in-school champions; obtaining executive and leadership support; external implementation support officer; teacher professional learning; resources; provision of prompts and reminders; implementation performance monitoring and feedback).

Lastly, findings support that engagement and buy-in from the school and stakeholders involved underpins any successful school-based PA intervention (Belton et al., 2020; Corder et al., 2021; James et al., 2019; Muellmann et al., 2017; van Sluijs and Kriemler, 2016). This requires those in charge (e.g., school principals, teachers) however, to be willing to allocate time in the schedule to increase opportunities for students to be active (Beets et al., 2016). It is therefore, perhaps unsurprising, an already 'crowded curriculum' and lack of time were identified in a recent review (Nathan et al., 2018) as barriers to the implementation of school PA policies, alongside the lack of school board support, and teachers' inability to implement the policy. In contrast, staff support for PA, space for PA, and teachers who believe in the importance of PA, have all been identified as facilitators to the implementation of school PA

policies (Nathan et al., 2018). School-based interventions ought to be designed with these considerations in mind (Beets et al., 2016; Nathan et al., 2018).

2.3.2.2 Extra-curricular physical activity at school

Extra-curricular PA interventions at school can be defined as interventions that do not focus on modifying the schools physical education (Jago and Baranowski, 2004), i.e. PA which happens within a school setting but is not part of the formal physical education curriculum. Unlike physical education which is mandatory to attend, participation in extra-curricular PA is voluntary. Extra-curricular PA or sport can also be referred to as 'non-curricular PA' or 'school sports'. In Ireland, Children's Sport Participation and Physical Activity (CSPPA) defines extra-curricular sport as PA or sport played before, during or after school, but not part of the curriculum (Woods et al., 2018). Evidence suggests PA delivered during extra-curricular periods, including break periods, travel to school, after-school clubs and camp, could potentially increase adolescents' PA (Jago and Baranowski, 2004). Currently, provision of extra-curricular PA within the school environment often reflects the content of the physical education curriculum, i.e., team-based, competitive, structured sports (Cale, 2000) which may be denying some students the opportunity to participate in recreational PA. Likewise, in Ireland traditional team games dominate extra-curricular PA for males and females at both primary and post-primary school levels (Woods et al., 2018). At post-primary level, the most popular extra-curricular sport for females were soccer, Gaelic football, basketball, athletics, and camogie. In Ireland, the extent and quality of extra-curricular PA depends on individual schools and their ethos, expertise, resources, facilities, and goodwill of staff volunteering to run them. In 2018, 63% of post-primary students reported participating in extra-curricular sport at school at least once per week (Woods et al., 2018). Notably, participation was higher among males (70%) than females (57%), rural schools (69%) than urban schools (54%), and in more affluent students (66%) than less affluent students (56%).

Extra-curricular PA can take part after-school in the school setting. After-school PA programmes are typically locally designed and differ from sports clubs as they are not focussed on a single competitive sport (Demetriou et al., 2017). Compared to physical education, research on after-school programmes is in its infancy (Demetriou et al., 2017). A review by Demetriou et al. (2017) found modest support of the benefits of after-school programmes, yet identified better outcomes when conducting the programmes in the school setting, providing sessions on two or more days a week, and ensuring high programme attendance rates. Messing et al. (2019) found after-school programmes focused on PA and/or

sports were effective, however similarly, attendance rates were highly important as the effectiveness of a programme strongly depended on attendance (Messing et al., 2019). Peer involvement was also linked with positive outcomes (Messing et al., 2019).

2.3.2.3 Peer-led physical activity interventions

Given that social influences, including peers, have a substantial influence on the PA behaviour of adolescents (Fitzgerald et al., 2012; Graham et al., 2014; Macdonald-Wallis et al., 2012) peer-based interventions could be an effective means of helping adolescents become more physically active and has become an increasingly popular approach in school-based PA interventions targeted at adolescent females (Carlin et al., 2018; Owen et al., 2018; Sebire et al., 2018). In fact, Ginis et al. (2013) describes it as an "overlooked opportunity" for PA promotion, where findings support peer-delivered PA interventions may be equally as effective as those delivered by professionals (Ginis et al., 2013).

2.3.3 Co-designing interventions with adolescents

Evidence suggests there is a lack of high-level participation from young people to influence the development of interventions targeting health and well-being (Larsson et al., 2018). Adolescents have previously reported a disconnect between what is available and what they want to do (James et al., 2018) and feelings of disempowerment through the belief that their shared views on PA were insignificant (McEvoy et al., 2016). Worryingly, *"without the voice of youth, research can miss the contextual input necessary to represent the unique youth experience"* (Jacquez et al., 2013, p. 177).

O'Reilly et al. (2022) describes how co-design is *"focused on harnessing local and contextualised expertise of the 'users' of programmes"* (O'Reilly et al., 2022, p. 2) The principles of co-design are becoming fundamental to promoting PA in schools (O'Reilly et al., 2022). Indeed, a co-design approach involving participatory methods can help ensure the intervention is practical, acceptable and usable, but can also be a potentially powerful way to help navigate what can be a complex and context-sensitive topic (O'Reilly et al., 2022). Over the years, research has gradually shifted from a practice of consulting young people taking part in a research study, to one of actively involving them in the research process (Bird et al., 2013; Enright and O'Sullivan, 2012; Kellett, 2005; Lundy and McEvoy, 2012; Thompson et al., 2015). Previous studies have demonstrated that adolescents can productively engage in the design, planning and implementation of PA interventions (Corder et al., 2015; James et al., 2019; Murillo Pardo et al., 2014), including PA interventions specific to adolescent females

(Corr and Murtagh, 2019). Establishing ‘young people’s advisory groups’, who work with researchers to shape different stages of the research process, has been increasingly used in health research to actively involve young people (Sellars et al., 2020). This approach is aligned with and similar to PPI.

2.3.3.1 Public and Patient Involvement

In Ireland, and the United Kingdom, research which is "co-produced" with patients, carers, or members of the public is known as Public and Patient Involvement (PPI). The Health Research Board in Ireland uses the United Kingdom’s National Institute for Health Research definition of PPI, i.e., “research being carried out ‘with’ or ‘by’ members of the public rather than ‘to’, ‘about’ or ‘for’ them” (INVOLVE, 2012). This interpretation, however, can differ internationally. For example, in Canada and the United States they describe this type of research as ‘public and patient engagement’ (Domecq et al., 2014; Doria et al., 2018; Shippee et al., 2015). INVOLVE is a United Kingdom government-funded programme to support active public involvement in the National Health Service (NHS). Similar to the National Institute for Health Research in the United Kingdom, the Health Research Board in Ireland has provided strategic and infrastructure support to embed PPI across publicly funded research (Health Research Board, 2021). The overall aims of PPI are to enhance the quality, relevance, and appropriateness of research, and through a compelling ethical rationale, encourage participative democracy in research (Brett et al., 2010). Although some reviews have found the evidence base for PPI needs improvement (Brett et al., 2014a; Mockford et al., 2012; Shippee et al., 2015), there are findings to support that PPI may facilitate the process of translating research evidence into practice and policy (Staley, 2009), contribute to reducing health research waste (Minogue et al., 2018), and can have beneficial impacts for the service users, researchers, and community (Brett et al., 2014b; Crocker et al., 2017), and on the quality and appropriateness of health research (Brett et al., 2014a). Over the past decade, PPI activity has continued to expand. Guidelines to support the reporting of PPI (Staniszewska et al., 2017, 2011), frameworks to guide ethics in PPI (Mitchell et al., 2019; Pandya-Wood et al., 2017), tools to assess impact (Popay et al., 2014) and advice on actions required for effective PPI, such as trust between the researchers and PPI contributors (Wilson et al., 2015) have all been published. Whereas, some reviews on PPI in research have identified concerns regarding power imbalances (Brett et al., 2010), costs, and an overarching worry of tokenism (Domecq et al., 2014).

Specifically, involving young people in research is intended to ensure that interventions reflect their preferences and needs and thus, improve intervention relevance, acceptability and feasibility (Kirby, 2004; Sellars et al., 2020). Despite the increasing emphasis on the involvement of young people in health research, a scoping review by Sellars et al. (2020), found that fewer than 1% of published empirical child and adolescent health studies used youth advisory groups during their research, indicating that more work needs to be done to increase young people's involvement in youth-related research. Identified studies in the review (Sellars et al., 2020) expanded across different research fields, such as cyberbullying (Dennehy et al., 2018), healthy eating interventions (McSweeney et al., 2019), sexual health (Young et al., 2019), and PA (James et al., 2019). The terms used to describe the group of young people involved in the research process varies across studies, such as 'Youth Advisory Groups', 'Youth Advisory Boards', 'Youth Advisory Panels', and 'PPI groups'. Notably, in their evaluation of using a Young Persons Advisory Group, Dennehy et al. (2018) found that young people can provide a unique perspective on the design, conduct and interpretation of research that is otherwise not accessible to adult researchers. James et al. (2019) describe how adolescents in Wales were involved in discussions regarding PA provision and barriers to being active in their local community, and thus, contributed to the design process of a multi-component PA intervention called ACTIVE (James et al., 2019).

2.4 Summary

Globally, 81% of adolescents do not meet the WHO recommended PA guidelines (Guthold et al., 2020) of at least an average of 60 minutes a day of MVPA across the week (Bull et al., 2020). Research indicates PA levels decline during adolescence (Corder et al., 2016b, 2019; Dumith et al., 2011) and that adolescent females consistently spend less time engaged in MVPA compared to males (Guthold et al., 2020; Hallal et al., 2012; Inchley et al., 2020). Coupled with evidence to suggest that SES is correlated to adolescents' PA behaviour, females of lower SES are a higher-risk group (Borraccino et al., 2009; Inchley et al., 2020). The wide-ranging health benefits of regular participation in PA on young people's health have been well-documented (Bailey et al., 2012; Chaput et al., 2020; Janssen and LeBlanc, 2010). Inactive adolescents are at greater risk of long-term ill health (Shrestha and Copenhaver, 2015) and given that participation in PA during adolescence is predictive of adult PA (Hallal et al., 2006; Huotari et al., 2011; Telama et al., 2005), promoting a healthy lifestyle at this stage is crucial to shape PA behaviours for life.

Behaviour change theories and frameworks create a context for understanding, explaining, and eventually intervening to effect PA (Rothman, 2004). There is compelling evidence to suggest that interventions underpinned by theory are more effective at changing adolescents' PA behaviour than non-theory based interventions (Lai et al., 2014; Owen et al., 2017; Pearson et al., 2015). The application of behaviour change theories can help unravel how certain influences impact adolescents' PA behaviour which is critical in order to develop effective interventions. Over the last three decades, four main theoretical frameworks have been used to understand and change PA, including social cognitive approaches, humanistic/organismic approaches, dual process approaches and socio-ecological approaches (Rhodes et al., 2019). Moreover, in recent years, theoretical framework tools such as the BCW (Michie et al., 2014) have become popular choices to guide intervention development for researchers.

Existing reviews (Borde et al., 2017; Dobbins et al., 2013; Love et al., 2019) on school-based PA interventions have shown minimal effects on adolescents' PA. Furthermore, competing demands in the school curriculum and a lack of time have been identified as barriers to the implementation of school PA policies (Nathan et al., 2018). These findings indicate that changing adolescents' PA behaviours through school-based interventions can be challenging. The expanding evidence base on PA interventions, however, has given rise to best-practice recommendations. PA promotion has increasingly adopted socio-ecological approaches that place the PA influences in their social and environmental context (Rutter et al., 2019). Notably, the important role of the physical environment at school and how it facilitates more PA in adolescents has been increasingly recognised (Perry et al., 2012). Moreover, tailoring school-based interventions to specific target populations and context is essential (Heath et al., 2012). With a specific focus on increasing PA amongst adolescent females, research has shown the importance of tailored (Murillo Pardo et al., 2013), theory-driven (Owen et al., 2017; Pearson et al., 2015) and female-only interventions (Pearson et al., 2015).

Findings support the efficacy of numerous school-based intervention strategies such as changes in the school environment, after-school PA programmes, activity breaks, and peer involvement (Messing et al., 2019). At post-primary school level in Ireland, traditional team-based, competitive, structured sports dominate extra-curricular PA (Woods et al., 2018). Notably, females (57%) are less likely to participate in extra-curricular sport than males (70%). Given that a dislike for structured sports (Cowley et al., 2021b; Rees et al., 2006) and an emphasis on skill and competition (Corr et al., 2018) have been cited by adolescent females as barriers to their participation, and in contrast, how unstructured and non-

competitive opportunities have been reported as facilitators to PA (James et al., 2018; Martins et al., 2021), a call for additional extra-curricular PA programmes that appeal to adolescent females is warranted.

Evidence suggests there is a disconnect between what is available and what adolescents want to do (James et al., 2018). Research indicates more work needs to be carried out to include young people's voices in youth-related research (Jacquez et al., 2013; Larsson et al., 2018; Sellars et al., 2020). Without youth involvement, interventions may fail to accurately represent young people's needs (Jacquez et al., 2013). PPI 'young people's advisory groups' has become an increasingly common approach to actively involve young people in the research process (Sellars et al., 2020). Involving young people in research is critical to ensure that interventions reflect their preferences and therefore, improve intervention relevance, acceptability and feasibility (Kirby, 2004; Sellars et al., 2020). Helping schools to fulfil their PA promoting role is important (Hills et al., 2015), while providing adolescent females the opportunity to co-design a multi-component, extra-curricular school-based PA intervention based on theory, may increase the likelihood of developing a contextually appropriate intervention that meets the needs of adolescent females and provides relevant and meaningful opportunities for them to be active.

Chapter 3 Methodological framework

3.1 Introduction

The aim of this chapter is to outline the overall design of this programme of research. It describes the Medical Research Council (MRC) framework for developing and evaluating complex interventions, the Behaviour Change Wheel (BCW) for designing behaviour change interventions. An overview of the methods used to address the research objectives is provided. Lastly, the implications of the COVID-19 pandemic, and the ethical considerations associated with this research are addressed.

3.2 Overview of study design

A concurrent-independent mixed-method design was used in this research (Schoonenboom and Johnson, 2017). In a concurrent-independent design, quantitative and qualitative components are executed (almost) at the same time, while both components are independent of one another (i.e., their implementation does not depend on the results of data analysis in the other component) (Schoonenboom and Johnson, 2017). The aim of mixed-methods research is to expand and strengthen a study's conclusions (Schoonenboom and Johnson, 2017). For example, a quantitative approach, such as a questionnaire, can quantify the factors influencing adolescent females' PA behaviour, while the qualitative approach, such as focus group data, can provide a deeper understanding of these factors. For this reason, both types of research methodologies were used in this research project. A parallel mixed design analysis was undertaken, otherwise known as a convergent parallel design (Schoonenboom and Johnson, 2017), whereby the quantitative and qualitative datasets were analysed separately, and the integration of data from various sources occurred at the interpretation stage (Teddlie and Tashakkori, 2009). An overview of the study design, mapping the three studies to both the MRC framework phases and the BCW stages, is presented in Figure 3.

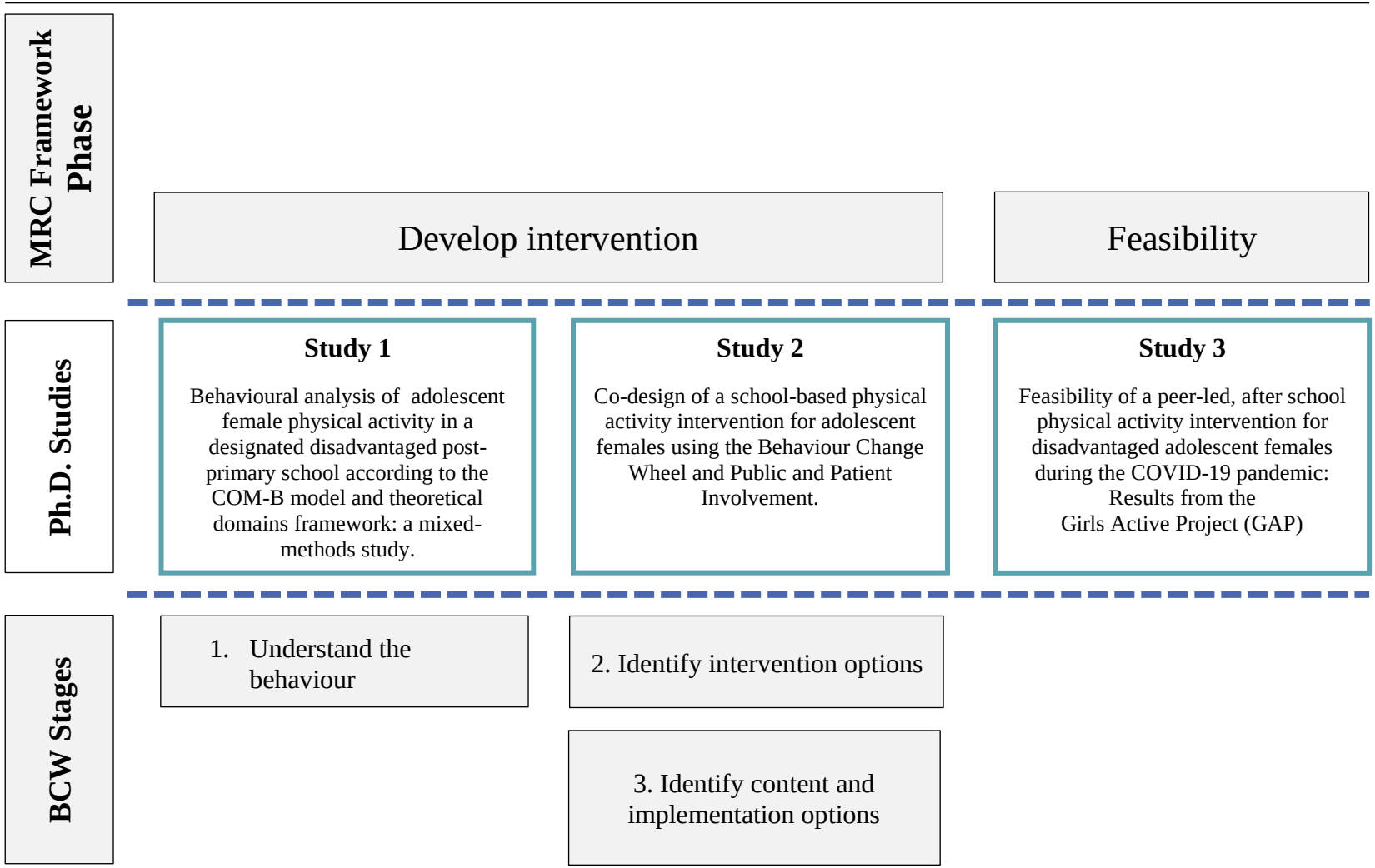
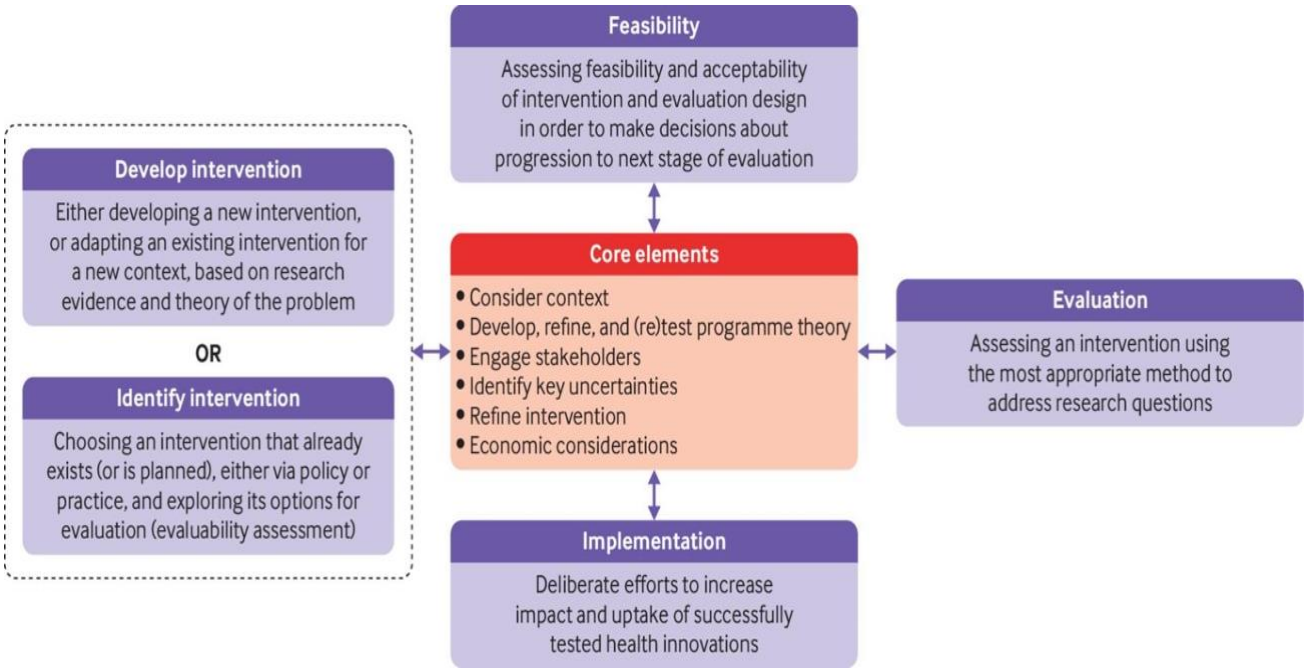


Figure 3: Ph.D. studies mapped to the Medical Research Council framework and the Behaviour Change Wheel

3.3 The medical research council framework

The MRC framework (Craig et al., 2008) for developing and evaluating complex interventions is a tool used to develop, evaluate and implement a complex intervention to improve health. The guidance for using this framework was updated in 2021, by Skivington et al. The framework divides complex intervention research into four phases: development or identification of an intervention, assessment of feasibility of the intervention and evaluation design, evaluation of the intervention, and impactful implementation (Figure 4). These phases are not necessarily sequential, but the framework can help researchers define where they are in the research process. This Ph.D. research focused on phase one (develop intervention) and phase two (feasibility) of the MRC framework.



Framework for developing and evaluating complex interventions. Context=any feature of the circumstances in which an intervention is conceived, developed, evaluated, and implemented; **programme theory**=describes how an intervention is expected to lead to its effects and under what conditions—the programme theory should be tested and refined at all stages and used to guide the identification of uncertainties and research questions; **stakeholders**=those who are targeted by the intervention or policy, involved in its development or delivery, or more broadly those whose personal or professional interests are affected (that is, who have a stake in the topic)—this includes patients and members of the public as well as those linked in a professional capacity; **uncertainties**=identifying the key uncertainties that exist, given what is already known and what the programme theory, research team, and stakeholders identify as being most important to discover—these judgments inform the framing of research questions, which in turn govern the choice of research perspective; **refinement**=the process of fine tuning or making changes to the intervention once a preliminary version (prototype) has been developed; **economic considerations**=determining the comparative resource and outcome consequences of the interventions for those people and organisations affected.

Figure 4: The new framework for developing and evaluating complex interventions: update of Medical Research Council guidance (Skivington et al. 2021)

3.3.1 Research context and stakeholders

This research was carried out in a single-sex, female-only, designated disadvantaged post-primary school in Dublin, Ireland. Context included any physical, organisational, social, spatial, cultural, economic, or political feature of the school. Meaningful engagement with key stakeholders included students, teachers, school principal and parents. Research and PPI are separate activities (Doria et al., 2018) differing in whether the public are involved as 'research participants' or as 'contributors to the research process', i.e., PPI contributors. In this research, some students were PPI contributors, while others were research participants.

3.3.1.1 School recruitment and PPI contributors

A list of all post-primary schools in the School Support Programme (SSP) under the DEIS (Delivering Equality of Opportunity in Schools) action plan for educational inclusion was obtained from the Department of Education website. In Ireland, a classification system known as DEIS is used by the Department of Education to indicate that the school is based in a community at risk of disadvantage and social exclusion. This list included a total of 198 post-primary schools. Inclusion criteria was used for the school selection process. This included: single-sex, female-only and public (non-fee paying). For the purposes of access, travel distance and time, schools in County Dublin were initially approached. A total of eleven schools met the inclusion criteria. The number of females enrolled differed across the eleven schools (157 students to 496). Two schools were removed from the list because we knew they were participating in another PA research project with Dublin City University at the time. Taking into account the normal attrition rates in such research studies, an email of invitation to participate in the Girls Active Project (GAP) was sent to each school principal of the nine remaining schools that met the inclusion criteria listed above. This was followed-up by a phone call a week later to explain the purpose of the project. A two-year (academic school year, i.e., September to May) commitment was requested from the school to fully complete the research project. In addition, since the research project involved working with a group of students (PPI contributors) for up to five double-classes (80-minutes each), it was encouraged that the school offered a Transition Year (fourth year) or a Leaving Certificate Applied (LCA) programme. In Ireland, Transition Year is not a standard academic year. It is a one-year school programme that can be taken in the year after the Junior Cycle and before the two-year Leaving Certificate programme (Department of Education, 2021), while the Leaving Certificate Applied (LCA) is a two-year Leaving Certificate available to students who wish to follow a programme with a strong practical and vocational emphasis.

From the nine schools that were contacted, three schools showed interest and two accepted the invitation. In the early stages of this research, one school dropped-out due to competing interests. Just one school was retained, thus the scope of the project was widened to include more students. In September 2019, 427 female students were enrolled in the participating school. It had 6 year groups, including a Transition Year programme (students aged 15 to 17). As part of the research project, the physical education teacher encouraged the Transition Year students to voluntarily join the GAP 'Youth Advisory Group' as PPI contributors, with an aim to recruit 10-15 students. Subsequently, eight Transition Year students joined the Youth Advisory Group.

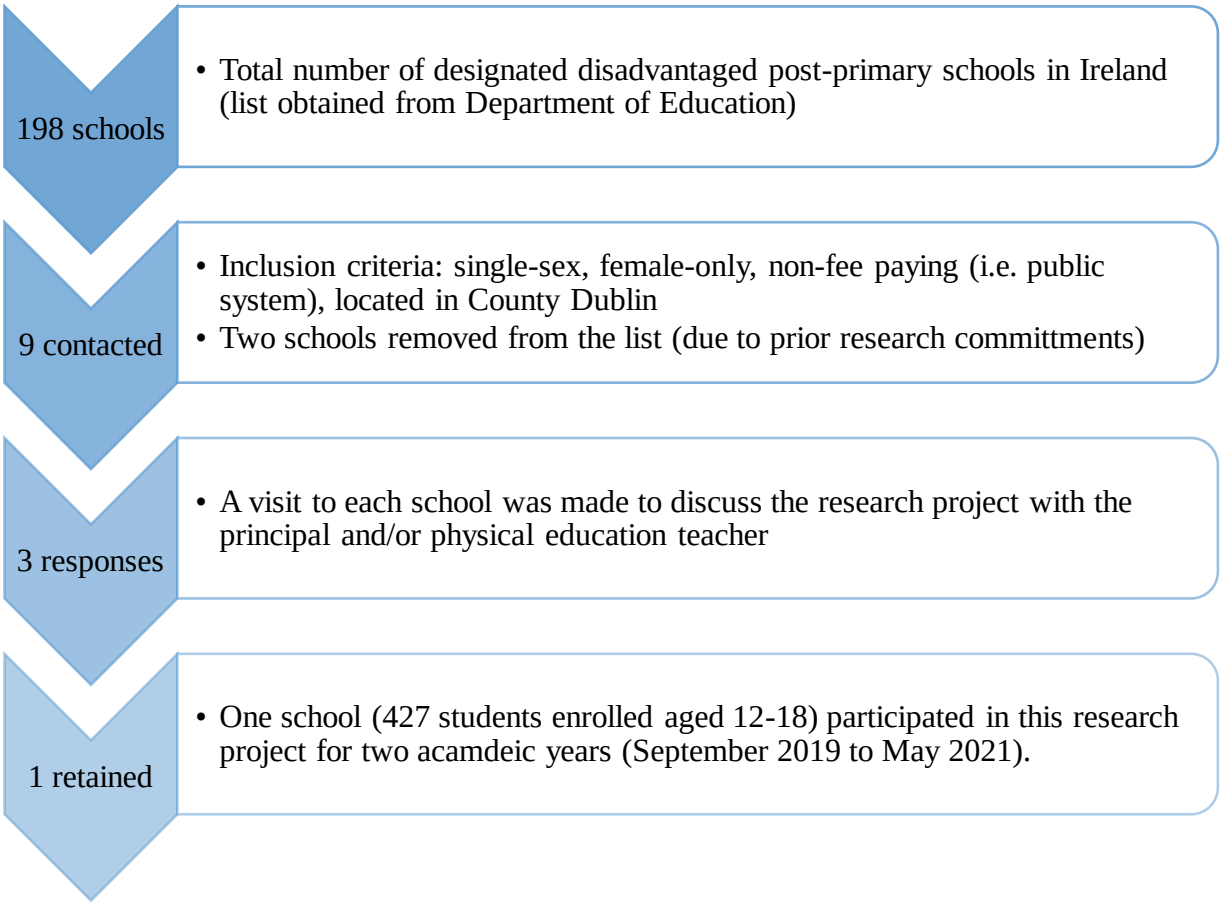


Figure 5: Post-primary school selection process

3.3.2 Develop intervention

The Behaviour Change Wheel (BCW) (Michie et al., 2014) was used in this research as the theoretical framework to guide intervention development. As detailed in Chapter 2, the COM-B (capability, opportunity, motivation – behaviour) model is at the core of the BCW framework. The Theoretical Domains Framework (TDF) provides a method for theoretically assessing health-related behaviours as a basis for intervention development (Cane et al.,

2012). It was added to the BCW to allow deeper exploration of the factors influencing behaviour change (Figure 2, Chapter 2). The BCW includes three stages (eight steps) to follow to design a behaviour change intervention (Figure 6).

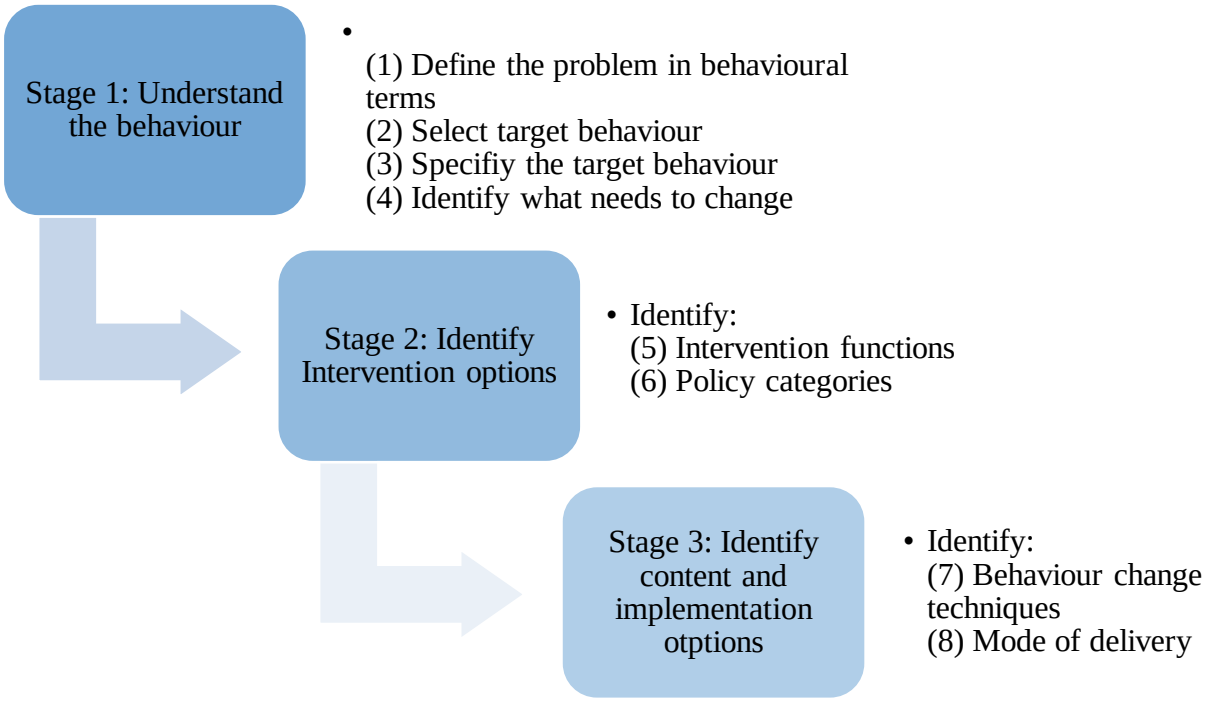


Figure 6: Stages and steps of the Behaviour Change Wheel

3.3.2.1 Study 1: Behavioural analysis of adolescent female physical activity in a designated disadvantaged post-primary school according to the COM-B model and theoretical domains framework: a mixed-methods study

Objective 1: To identify the factors influencing adolescent females' physical activity behaviour in the school setting using the COM-B model and Theoretical Domains Framework.

This study focused on step 4 of the BCW, 'identify what needs to change' (Figure 6). A concurrent-independent mixed-method approach was used via questionnaires and semi-structured focus groups with a sample of adolescent females (aged 12 to 18) and teachers to understand the target behaviour. All students in the school were invited to complete a short anonymous questionnaire during school hours via an electronic portable device. The student questionnaire captured information including age, year group, current self-reported PA levels via the two-item PACE+ scale (Prochaska et al., 2001) and a slightly adapted version of the

COM-B self-evaluation questionnaire (COM-B-Qv1) containing 23 statements categorised into 'capability', 'opportunity' and 'motivation', aimed to gain insight into what it would take for the individual to change their behaviour. Two semi-structured, audio-recorded focus groups were conducted with six Junior Cycle students (years 1-3) and six Senior Cycle students (years 4-6). A school GAP steering committee, consisting of seven teachers, completed a similar questionnaire for groups, the COM-B behavioural diagnosis form (COM-B-D) and participated in a semi-structured, audio-recorded focus group during school hours. Questions asked in the focus groups were developed using the COM-B model and TDF.

Questionnaire data was analysed using SPSS Statistics V.25. The mean, standard deviation and 95% confidence interval for each COM-B statement was calculated. The focus groups were transcribed verbatim. Focus group data analysis followed a framework approach (Gale et al., 2013). Coded transcripts were mapped onto the domains of the TDF and then, directly onto the six components of the COM-B model thus identifying factors influencing adolescent females' PA behaviour at school.

3.3.2.2 Study 2: Co-design of a school-based physical activity intervention for adolescent females using the Behaviour Change Wheel and Public and Patient Involvement.

Objective 2: To co-design, with adolescent females, an extra-curricular school-based physical activity intervention (Girls Active Project) using the Behaviour Change Wheel in combination with a Public and Patient Involvement approach.

This study focused on steps 5 to 8 of the BCW (Figure 6). The Youth Advisory Group participated in five PPI discussion groups (double-classes) to co-design the school-based PA intervention. 'Discussion groups' refer to involvement activities where the individuals' contributions are not treated as research data, but instead they help make decisions that shape the research process (Doria et al., 2018). Hand-written notes were taken at each discussion group. After linking the factors influencing adolescent females' behaviour at school (study 1) to intervention functions, potentially relevant intervention functions were identified. The BCW APEASE (Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity) criteria was used to select the most appropriate intervention functions for the GAP programme. The APEASE criteria was also used to select the policy categories most appropriate for the intervention (step 6). Step 7 required identifying the most fitting behaviour change techniques (BCTs) that could result in the increase of

adolescent females' PA levels at school. The final step (step 8) included applying the APEASE criteria to select the most appropriate modes of delivery for the intervention. The Template for Intervention Description and Replication (TIDieR) checklist (Hoffmann et al., 2014) was employed to specify details of the intervention containing the who, what, how and where of proposed intervention delivery.

3.3.3 Feasibility

This research project used the definition of a 'feasibility study' proposed by Eldridge et al. (2016) where feasibility studies are an umbrella term used to describe any type of study relating to the preparation for a main study (Eldridge et al., 2016b). Inconsistent recommendations for feasibility studies, and the variation of terms and methods used across papers has resulted in what has been described as a *"somewhat chaotic field of work"* (Hallingberg et al., 2018, p.11). This research followed Lancaster and Thabane (2019) guidelines for reporting non-randomised pilot and feasibility studies (Lancaster and Thabane, 2019) and the guidance provided by Pearson and colleagues (2020) on conducting feasibility studies for implementation trials (Pearson et al., 2020). This study was carried out to assess pre-defined progression criteria that relate to the intervention (e.g., acceptability) and the evaluation design (e.g., data collection) (Skivington et al., 2021).

3.3.3.1 Study 3: Feasibility of a peer-led, after school physical activity intervention for disadvantaged adolescent females during the COVID-19 pandemic: Results from the Girls Active Project (GAP)

Objective 3: To conduct a feasibility trial of the Girls Active Project, a peer-led, after-school physical activity intervention aimed to positively impact the physical activity behaviour of adolescent females.

A mixed-method, single-arm study design was used to test feasibility over a 12-week trial (March to May 2021). Key stakeholders included intervention recipients (students aged 13-14), intervention providers, otherwise known as 'Project Leaders' (n=6, students aged 15-17), parent/guardians (n=20) and school staff members (n=3).

Intervention providers delivered eight exercise classes to recipients across two phases: phase one (four classes online via Zoom) and phase two (four classes in person in the school setting). Intervention feasibility was explored via (i) reach; (ii) fidelity and dose; (iii) data completion rates of proposed outcome measures; (iv) stakeholders' acceptability; (v)

compatibility with the school-setting; and (vi) contextual factors affecting implementation. Self-reported provider checklists were completed by intervention providers throughout the intervention. Questionnaires were used and semi-structured, audio-recorded focus groups and interviews were conducted with stakeholders at baseline, mid and post-intervention. Descriptive analyses were performed using SPSS Statistics V.25. Focus groups and interviews were transcribed verbatim. Transcripts were analysed using a six-step thematic approach (Braun and Clarke, 2006).

3.4 COVID-19 pandemic impact statement

The original study designs for study 2 and study 3 were adapted due to school closures resulting from the on-going COVID-19 pandemic.

Study 2. In March 2020, the co-design process, with the then-current Transition Year students (PPI contributors in the Youth Advisory Group) was underway. After school closure and discussions with the principal and physical education teacher, transitioning online was not an option and it was highly advised to re-commence the study when schools reopened. In September 2020, the school agreed that the research project could continue but required that it strictly adhered to relevant COVID-19 guidelines and regulations. These included:

- I was the only researcher permitted to attend the school. I had to always wear a mask, sanitise upon entering the school, and keep 1-metre distance from everyone.
- No physical measures were permitted. All data collected must be via self-reported questionnaire and/or audio-recorded focus groups or interviews.
- Each plain language statement and consent/assent form had to acknowledge the project's adherence to the COVID-19 guidelines. To avoid physical documentation being submitted, students were provided with an option to email a photo of the signed forms to the school.

Subsequently, a new PPI Youth Advisory Group was established and study 2 was completed. A feasibility trial (study 3) protocol, arranged for January to May 2021, was developed. Due to COVID-19 policies in the school, the principal instructed that just one year group be invited to participate as 'intervention recipients' to avoid integrating students from different year groups, and to accommodate for social distancing. The intervention was originally designed to be delivered in person.

Study 3. In January 2021, nationwide school closures resulting from the COVID-19 pandemic occurred again. On this occasion, the school was better-equipped to transition online and welcomed the proposal to divide the trial into two phases (phase one online via Zoom and phase two in person in the sports hall or the playing field on school grounds). This procedure involved ethical amendments, and changes to our recruitment process. The intervention was trialled from March to May 2021.

3.5 Ethical considerations

Ethical approval (Appendix A) for this research was granted by Dublin City University (DCU) Research Ethics Committee (DCUREC/2019/005). As this research project involved adolescents under the age of 18, research specific guidelines as provided in 'Keeping Children Safe – Policies and Procedures supporting Child Protection at DCU', were adhered to, which included having safeguards and supports in place for the young people participating in the research. I received Garda vetting clearance from DCU and the participating school.

Study 1. Since the student questionnaire was of low-risk to students, parental opt-out consent (otherwise known as passive consent) was used. A plain language statement and a parental/guardian opt-out consent form was provided to each parent/guardian in the school (included in Appendix B). The students were asked to provide their assent at the start of the questionnaire. By contrast, informed parental consent (otherwise known as active consent) and student assent was obtained from all students prior to the focus groups. Informed consent was obtained from steering committee members (teachers) prior to the questionnaire and focus group. Focus groups were audio-recorded and transcribed. Participants were pseudonymised during transcription, and these transcripts were stored in a secured location.

Study 2. While ethical approval and the use of consent forms for young people or their parents are not required for PPI activities (Mitchell et al., 2019), ethical issues can still arise. Therefore, informed consent/assent was obtained from each PPI member in the Youth Advisory Group and their parent/guardian. The plain language statements and consent/assent forms were amended to declare strict adherence to the relevant COVID-19 guidelines and regulations mentioned above.

Study 3. Informed consent/assent was obtained from all participants (second-year students, Project Leaders, i.e., Transition Year students, school staff members, and parents/guardians) prior to data collection and identification codes were assigned to protect identity. Adjustments

to recruitment, data collection, and class delivery were required in light of the COVID-19 pandemic which resulted in ethical amendments being made, and subsequently approved by the DCU Research Ethics Committee. The participating school had its own secure online platform and used Zoom to deliver 'live' classes. Each week, the physical education teacher organised the online exercise class through their own account and sent a link to students and I to attend. It was important that all communication with parents and students were facilitated through the school. In addition, as part of their school policy, it was not mandatory for the students to have their cameras on nor did they have to talk. The plain language statements and consent/assent forms were amended to include this information. Given that students were not in school for phase one, letters were posted by the school secretary to each second-year student and Project Leader (Transition Year student) containing information sheets, assent and parental/guardian consent forms and a PA readiness questionnaire for them and their parent/guardian to read and sign. The physical education teacher created a 'Girls Active Project' google classroom on the school's secure online platform. Students privately uploaded photos of the relevant signed documents to the google classroom. Afterwards, the physical education teacher emailed me a copy of the documents via an encrypted and password protected email. Once enrolled, the physical education teacher emailed the second-year student an invitation to complete the baseline questionnaire online via a Qualtrics link and posted a link to the questionnaire on the GAP google classroom.. A second round of recruitment occurred in April 2021 when the school fully re-opened. On this occasion, second-year students were provided with an additional option to return the relevant signed documents in person to the physical education teacher during school hours. Interviews and focus groups were audio-recorded and transcribed. Participants were pseudonymised during transcription and these transcripts were stored in a secured location.

3.6 Summary

This chapter provided an overview of the study design and details of the methodological approach carried out in each study. The objectives of this research addressed phase one and phase two of the MRC framework for intervention research. The following chapters will describe the individual studies conducted as part of this Ph.D. research.

Chapter 4 Study 1: Behavioural analysis

Behavioural analysis of adolescent female physical activity in a designated disadvantaged post-primary school according to the COM-B model and theoretical domains framework: a mixed-methods study.

4.1 Abstract

Introduction: Globally, female adolescents' physical activity (PA) participation rates are low, particularly among lower socio-economic groups. Understanding the factors that influence adolescent PA behaviour can enhance the development of tailored interventions aimed at promoting PA. The aim of this study was to identify the factors influencing adolescent females' PA behaviour in the school setting using the COM-B model and Theoretical Domains Framework to inform intervention development using the Behaviour Change Wheel (BCW).

Setting: One single-sex, female-only, designated disadvantaged post-primary school (students aged 12-18) in Dublin, Ireland.

Methods: A concurrent-independent mixed-methods (questionnaires and focus groups) study design was used with students (n = 287, aged 12–18) and teachers (n = 7) to capture students' current self-reported PA levels and to identify factors influencing adolescent females' PA behaviour at school.

Results: Just 1.4% of the students in this sample reported meeting the recommended PA guidelines. Students identified having more *'time'* as the strongest predictor to becoming more active in school (Mean = 4.01, 95% CI 3.91 to 4.12). Social influences, environmental context and resources, behavioural regulation, beliefs about capabilities, goals, and reinforcement emerged from the qualitative data as factors influencing PA behaviour at school.

Conclusions: The behavioural analysis performed identifies and adds detail on the range of factors influencing adolescent females' PA behaviour at school, reinforcing the need for specifically tailored PA interventions. This behavioural analysis will be used to co-design a school-based PA intervention following the subsequent steps in the BCW.

4.2 Introduction

Worldwide, more than three-quarters (81%) of adolescents (aged 11-17) do not meet the WHO recommended PA guidelines (Guthold et al., 2020). The WHO recommends that adolescents accumulate at least an average of 60 minutes a day of MVPA (Bull et al., 2020). The robust evidence that informed these guidelines on PA found that greater amounts and higher intensities of PA are associated with multiple beneficial health outcomes for adolescents, including cardiometabolic health, physical fitness, bone health, cognitive outcomes, reduced adiposity and a reduced risk of experiencing depression (Chaput et al., 2020). Research indicates PA levels decline during adolescence (Corder et al., 2016b; Dumith et al., 2011; Murphy et al., 2020) and there are clear gender differences between the PA levels of adolescent females and males, with females less likely to meet recommended guidelines (Guthold et al., 2020; Inchley et al., 2020; Woods et al., 2018). Evidence also suggests SES is correlated to adolescents' PA participation (Borraccino et al., 2009; Stalsberg and Pedersen, 2010), where females of lower SES are consistently the least active (Inchley et al., 2020). Inactive adolescents are at a greater risk of long-term ill health (Shrestha and Copenhaver, 2015) and given that participation in PA during adolescence can be a significant contributor to levels of PA in adulthood (Huotari et al., 2011; Telama et al., 2014), tackling the decline in PA during adolescence is a major public health priority.

There is no widely accepted explanation for the causes of adolescent females' physical inactivity, but evidence suggests influences are multifactorial, including psychological, social and environmental factors (Graham et al., 2014; Sallis et al., 2000). Females have cited many barriers to their participation, such as time restraints, competing priorities, social influences, low perceived competence, gender social stereotypes and a dislike for structured sports (Corr et al., 2018; Cowley et al., 2021b; Martins et al., 2021; Rees et al., 2006; Slater and Tiggemann, 2010; Woods et al., 2010). In addition, evidence suggests females and adolescents of lower SES face even further difficulties with environmental factors perceived by adolescents to be barriers to PA, including space, infrastructure, equipment and unsuitable PA programmes (Martins et al., 2021). Understanding the factors that influence adolescent PA behaviour can enhance the development of tailored interventions aimed at promoting PA (Graham et al., 2014; Martins et al., 2021).

The current WHO 'Global Action Plan on Physical Activity (2018–2030)' states the need to strengthen the development and implementation of behavioural public health interventions targeted at females and vulnerable or marginalised populations, that engage with and increase

PA opportunities (WHO, 2018). There is compelling evidence to suggest multi-component interventions (Kriemler et al., 2011; Messing et al., 2019; Owen et al., 2017; Pearson et al., 2015) and interventions underpinned by theory (Lai et al., 2014; Owen et al., 2017; Pearson et al., 2015) are most effective in the promotion of PA. The school environment is well-known as a potential setting for targeting PA behaviour among adolescents (Hills et al., 2015; Story et al., 2009), yet research indicates school-based PA interventions have been minimally successful (Borde et al., 2017; Dobbins et al., 2013; Kriemler et al., 2011; Lai et al., 2014; Love et al., 2019; Owen et al., 2017). Evidence suggests changes in the school environment (Messing et al., 2019) and PA delivered during extra-curricular periods, including break periods, travel to school, after-school clubs and camp could potentially increase adolescents' PA (Jago and Baranowski, 2004).

Michie et al. (2014) developed the Behaviour Change Wheel (BCW) from 19 behaviour change frameworks (Michie et al., 2014). The COM-B model is at the centre of the BCW framework, which suggests that capability, opportunity and motivation (COM) interact to influence behaviour (B). There are six COM-B components: 'physical capability' (having the physical skills, strength or stamina to perform the behaviour); 'psychological capability' (having the knowledge, psychological skills, strength or stamina to perform the behaviour); 'physical opportunity' (what the environment allows or facilitates in terms of time, triggers, resources, locations, physical barriers, etc.); 'social opportunity' (including interpersonal influences, social cues and cultural norms); 'reflective motivation' (involving self-conscious planning and evaluations (beliefs about what is good or bad); 'automatic motivation' (processes involving wants and needs, desires, impulses and reflex responses) (Michie et al. 2014, p.59). The Theoretical Domains Framework (TDF) containing 14 domains, is an integrative framework developed for cross-disciplinary implementation and other behaviour change research (Cane et al., 2012). It was added to the BCW to allow deeper exploration of the factors influencing behaviour change (Figure 2, Chapter 2).

The COM-B model and BCW has been successfully used in different contexts to inform and design behaviour change intervention, including providing sexual counselling (Sharry et al., 2016), decreasing sedentary behaviour in the workplace (Ojo et al., 2019) and more specifically, increasing PA (Clarke et al., 2019; Ellis et al., 2019; Flannery et al., 2018; Murtagh et al., 2018; Webb et al., 2016). The BCW provides a systematic and structured approach to intervention development, however, researchers have acknowledged challenges associated with the BCW, describing it as 'a time-consuming' process (Murtagh et al., 2018; Webb et al., 2016) and 'not a magic bullet for intervention development' (Sinnott et al.,

2015). The BCW includes three stages (eight steps) in the intervention design process (Figure 6, Chapter 3): understand the behaviour (Stage 1), identify intervention options (Stage 2) and identify content and implementation options (Stage 3). This study focused on Stage 1, 'understand the behaviour'. The aim of this study was to identify the factors influencing adolescent females' PA behaviour at school using the COM-B model and TDF to inform intervention development using the BCW.

4.3 Methods

Study design

A concurrent-independent mixed-method approach was used via questionnaires and semi-structured focus groups with a sample of adolescent females (aged 12 to 18) and teachers to understand the target behaviour.

Setting

One single-sex, female-only, designated disadvantaged post-primary school in Dublin, Ireland.

Research participants

All students in the school were invited to complete a short anonymous questionnaire during school hours via an electronic portable device. Since the questionnaire was of low risk to students, parental/ guardian opt-out (passive) consent was proposed (Junghans et al., 2005; Tigges, 2003). Conversations took place with the school regarding parental/guardian opt-out consent where they welcomed this process. A week prior to data collection, every student was provided with an information sheet and a parental/ guardian opt-out consent form to read and take home to parents/guardians. Students and parents/guardians had time to understand the information and make an informed decision. At the start of the questionnaire, students were asked to provide their assent. Students were excluded from the study if they had not provided assent or if their parent/guardian had completed the parental/guardian opt- out written consent form. Six Junior Cycle students (Years 1 to 3, aged 12-15) and six Senior Cycle students (Years 4 to 6, aged 15-18) were selected by the physical education teacher and invited to take part in an audio-recorded focus group facilitated by the researcher (SMQ) during school hours. Each focus group aimed to include two students from each year group and a mix of perceived PA levels, based on, for example whether the students participated in physical

education class or were involved in sports teams or not. It was believed that the physical education teacher was best placed to have knowledge regarding this. Each student provided written informed assent and parental/guardian consent prior to taking part in the focus group. A GAP 'Steering Committee' was established in the school. The physical education teacher provided information sheets to members of school staff and parents from the parents council inviting them to join the Steering Committee. All Steering Committee members provided written informed consent before taking part in data collection.

Data Collection

The need to increase adolescent females PA levels is already well established in the literature (Guthold et al., 2020; Woods et al., 2018). Step 4 of the BCW involved identifying what factors needed to change to positively influence students PA behaviour school. The BCW guide (Michie et al., 2014) recommends that data is collected from multiple sources and from more than one method to understand what needs to change, as this will increase confidence in the analysis. Drawing from both the COM-B model and TDF, this study used a mixed-method approach (questionnaires and semi-structured focus groups) with multiple research participants (students and teachers).

Questionnaires

The student questionnaire took approximately 10-minutes to complete. It was anonymous and captured age, year group (year 1 to 6) and MVPA levels using the PACE+ scale (Prochaska et al., 2001). This short two-item PA questionnaire is used to assess the attainment of PA guidelines, i.e., an average of 60 minutes a day of MVPA for adolescents (aged 5-17) (Bull et al., 2020). This scale has been previously validated against accelerometery in a sample of 10-18 year old Irish youth ($r = 0.34$; ≥5 valid days) (Hardie Murphy et al., 2015). Validity was higher in females ($r = 0.39$; males $r = 0.27$) and increased with age (post-primary $r = 0.39$; primary $r = 0.24$) using ≥5 valid days. This instrument has been used with adolescents both nationally (Woods et al., 2018) and internationally (Currie et al., 2014) and has acceptable reliability. Michie and colleagues developed a COM-B Self-Evaluation Questionnaire (COM-B-Qv1) for individuals relevant to the COM-B model (Michie et al., 2014). It contains 23 different statements categorised into 'capability', 'opportunity' and 'motivation'. The individual responds with a yes or no answer. For example, 'For me to do physical activity at school, I would have to ... have more physical strength, e.g., build up muscles for demanding physical work'. Its aim is to gain an insight into what it would take for the individual to

change their behaviour. Similar to Murtagh et al. (2018) where they used the BCW to design the components of a community-based intervention to improve adolescent female's PA, the research team ensured that all of the examples provided in the COM-B-Qv1 were relevant to the target behaviour (PA) and target audience (adolescents aged 12–18). To gain a further understanding into the factors influencing students' participation in PA, the research team replaced the yes or no answer with a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), similar to that used by Ellis et al. (2019) when identifying factors influencing postnatal PA (Ellis et al., 2019). The questionnaire (Appendix B) was piloted amongst a sample of students (n=8, aged 15-17). The students understood the questions and no amendments were necessary based on their feedback. The questionnaires were administered using electronic portable devices over a one-day period, during which the researcher (SMQ) visited each classroom individually. Teachers and/or Special Needs Assistants were present if any child required assistance due to reading or physical difficulties. Thirty electronic portable devices were provided to the research team by Dublin City University. The questionnaires (using Survey Anyplace) were pre-loaded onto the devices prior to data collection, which allowed for data to be collected without the need for internet connection. In addition to the COM-B-Qv1, Michie et al. (2014) developed a COM-B Behavioural Diagnosis Form (COM-B-D) for groups/populations. The research team made the same slight adaptations to the COM-B-D and administered it to the Steering Committee via a paper-based questionnaire (Appendix B).

Focus groups

Three semi-structured, audio-recorded focus groups each lasting between 30 to 50 minutes were facilitated by one researcher (SMQ) during school hours; a focus group with six Junior Cycle students, a focus group with six Senior Cycle students and a focus group with the Steering Committee. The aim of the focus groups was to further investigate which of the COM-B components might influence adolescent females' PA behaviour at school. Questions asked in the focus groups were developed using the COM-B model and the TDF. The TDF has been validated for use in behaviour change and implementation research (Cane et al., 2012). This topic guide was assessed by a sample of students (n=8, aged 15-17). The students understood the questions and no amendments were necessary based on their feedback. Handwritten notes were taken by the researcher (SMQ) during each focus group to help centre the discussions around the most important points. All data collection tools used can be found in Appendix B.

Data analysis

Questionnaire data was analysed using IBM SPSS Statistics V.25, including the descriptive data analysis of participant characteristics. Physical activity (PACE+) data were scored according to recommended guidelines (Prochaska et al., 2001). The mean, standard deviation (SD) and 95% confidence interval (CI) for each COM-B statement response (22 in total) and an overall score for each of the six COM-B components were calculated and categorised into: agree (≥4), neutral (≥3<4) and disagree (<3). The focus groups were transcribed verbatim. Participant confidentiality and anonymity was maintained by using pseudonyms (Kaiser, 2009). The COM-B model and TDF were used as a combined deductive framework for the analysis (Gale et al., 2013). This involved systematically assigning the data to pre-selected themes and codes (based on the TDF and COM-B model), however, also aimed to leave space to discover other unexpected aspects of the participants' experience. Each transcript was read and re-read several times and coded by the researcher (SMQ). These coded transcripts were reviewed by the research team (SMQ, AS, SJB and MRS) and any discrepancies were resolved by discussion to generate a selection of factors influencing adolescent females' PA behaviour at school.

4.4 Results

Participants' characteristics

The student questionnaire was completed by two hundred and eighty-seven students (*n*=287). A total of 330 females were present in the school on the day of data collection, i.e., 87% of the eligible population completed the questionnaire. One class (30 students) did not participate because they were completing an exam at the time of data collection. From those who completed the questionnaire (*n*=287), there were no missing data. The students ranged from first year to sixth year, aged 12 to 18 (Mean age=14.82, SD=1.71). A total of 1.4% reported to meet the recommended PA guideline, i.e., an average of 60 minutes a day of MVPA. While almost all females achieved at least 60 minutes of MVPA 1 day a week (89%), just 15% achieved it five times a week (Figure 7). The mean number of days per week that students undertook at least 60 minutes of MVPA declined as they got older (age 12=mean number of days 3.3, to age 18 = mean number of days 2.6.). Six Junior Cycle students (age range=12 to 15) and six Senior Cycle students (age range=15 to 18) participated in the focus groups. There was a good mix of perceived PA levels across the two student groups. Perceived PA levels ranged from lower levels, including students who avoided physical

education class, disliked 'sporty activities' and did not walk or cycle to school, to higher levels of perceived PA, such as students who were very active, part of a sports teams (in school and/or outside school) and participated in physical education class. Seven teachers (3 male, 4 female) joined the Steering Committee and completed the questionnaire and focus group (*n*=7).

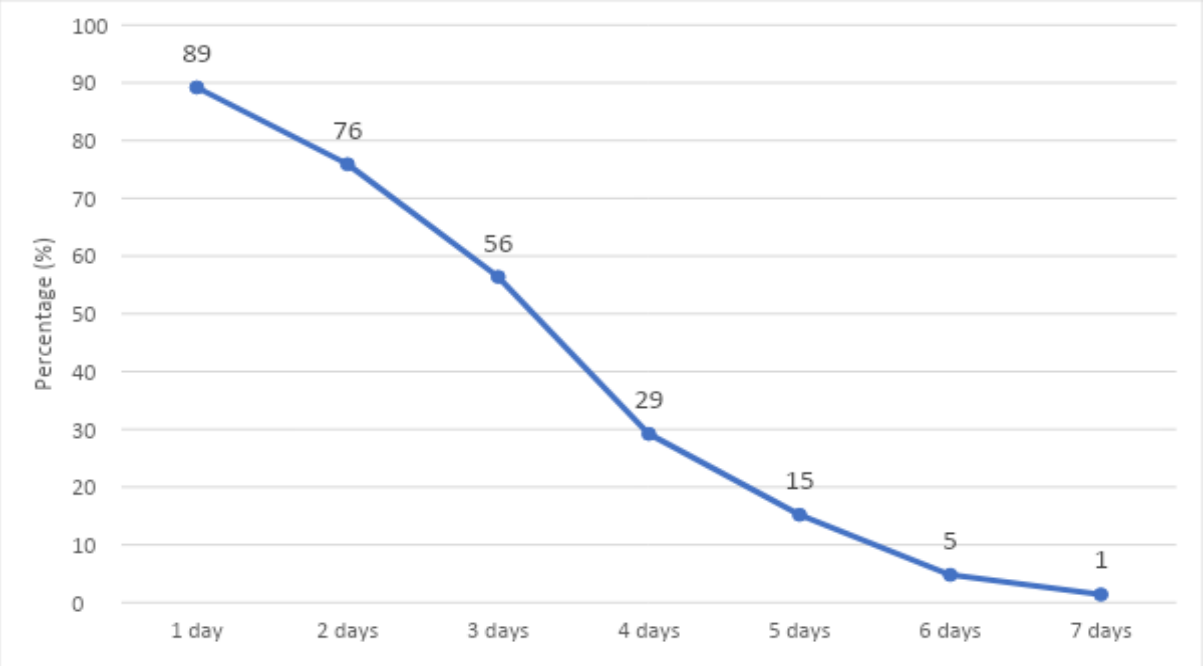


Figure 7: Proportion of students who undertook at least 60 minutes of MVPA on 1-7 days per week

What needs to change?

Given that this study aimed to identify the factors influencing adolescent females' PA behaviour in the school setting to inform development of an intervention for the 'whole school', the questionnaire results presented do not focus on group difference, such as year groups or age. Table 1 presents student responses to the COM-B statements (*n*=287). The majority of factors were identified as being 'neutral', i.e., mean scores of ≥3 and<4. ***'Have more time'*** (physical opportunity) to be active in school was identified by the students as the strongest predictor (Mean=4.01, 95% CI 3.91 to 4.12). This was followed by ***'develop a habit of doing it'*** (automatic motivation) (Mean=3.97, 95% CI 3.87 to 4.07) and ***'feel that I want to do it enough'*** (automatic motivation) (Mean=3.82, 95% CI 3.71 to 3.93). Students would not be more active if they *'have more money'* (physical opportunity) (Mean=2.99, 95% CI 2.85 to 3.12) (i.e., 'disagree' mean score<3). Across the six COM-B components, 'automatic motivation' was the strongest predictor to them being active at school with an overall mean score of 3.78 (95% CI 3.69 to 3.87) followed by 'reflective motivation' (Mean = 3.76, 95% CI 3.67 to 3.85).

According to the Steering Committee (*n*=7), the strongest predictors to increase adolescent females' PA participation at school were if the students ***'develop a habit of doing it'*** (automatic motivation) (Mean=4.71, 95% CI 4.26 to 5.17), ***'have more support from others'*** (social opportunity) (Mean=4.71, 95% CI 4.26 to 5.17) and ***'overcome mental obstacles'*** (psychological capability) (Mean=4.71, 95% CI 4.26 to 5.17). To *'have more money'* (physical opportunity) (Mean=2.29, 95% CI 1.01 to 3.56) or to '*have the necessary materials'* (physical opportunity) (Mean = 2.57, 95% CI 2.08 to 3.07) were not regarded by the Steering Committee as predictors to students' PA participation.

Table 1: COM-B Questionnaire statement responses by students (n=287)

Questionnaire statement*			**Questionnaire Response (%)**					
For me to do physical activity at school, I would have to…	**Mean (SD)**	**95% CI**	**1**	**2**	**3**	**4**	**5**	**Categorisation ** **
Capability								
1. Know more about why it is important, e.g., have a better understanding of the benefits of exercising more	3.17 (0.99)	3.06 to 3.29	4.9	20.2	35.2	32.4	7.3	Neutral
2. Know more about how to do it, e.g., have a better understanding of effective ways of exercising or being physically active	3.49 (0.99)	3.37 to 3.60	2.8	15.0	26.1	42.9	13.2	Neutral
3. Have better physical skills, e.g., learn different exercises or movements to help me be physically active	3.49 (1.02)	3.37 to 3.61	3.5	14.3	26.1	41.8	14.3	Neutral
4. Have better mental skills, e.g., learn how to reason more effectively	3.25 (1.04)	3.13 to 3.38	4.5	20.9	29.3	35.2	10.1	Neutral
5. Have more physical strength, e.g., build up muscles for demanding physical work	3.19 (1.13)	3.06 to 3.32	7.0	23.0	26.5	31.4	12.2	Neutral
6. Have more mental strength, e.g., develop stronger resilience against barriers to being more active	3.37 (1.03)	3.25 to 3.49	2.4	22.0	24.4	39.0	12.2	Neutral
7. Overcome physical limitations, e.g., to get around problems of stature of disability	3.17 (1.06)	3.05 to 3.29	7.3	19.5	29.6	35.9	7.7	Neutral
8. Overcome mental obstacles, e.g., develop stronger resilience against the temptation to not exercise	3.49 (1.06)	3.37 to 3.61	3.8	16.0	23.0	41.5	15.7	Neutral
9. Have more physical stamina, e.g., develop a great capacity to maintain physical effort	3.56 (0.97)	3.45 to 3.67	3.5	10.8	25.1	47.4	13.2	Neutral
10. Have more mental stamina, e.g., develop a greater capacity to maintain mental effort	3.49 (0.97)	3.38 to 3.61	2.8	13.6	27.2	44.3	12.2	Neutral
Mean score: psychological capability component (statements: 1,2,4,6,8,10)	3.38 (0.70)	3.30 to 3.46						Neutral
Mean score: physical capability component (statements: 3,5,7,9)	3.35 (0.73)	3.27 to 3.44						Neutral
Opportunity								
11. Have more time to do it, e.g., create dedicated time during the day	4.01 (0.91)	3.91 to 4.12	1.0	6.3	15.3	44.9	32.4	Agree
12. Have more money, e.g., be given or earn funds to support the behaviour	2.99 (1.17)	2.85 to 3.12	7.7	33.1	24.4	22.6	12.2	Disagree
13. Have the necessary materials, e.g., acquire better clothes/shoes/other equipment for the task	3.59 (1.07)	3.47 to 3.72	4.9	10.8	24.0	40.8	19.5	Neutral
14. Have it more easily accessible, e.g., easier access to facilities	3.60 (0.98)	3.49 to 3.71	1.7	12.9	26.5	41.5	17.4	Neutral
15. Have more people around me doing it, e.g., be part of a "crowd" who are doing it	3.26 (1.20)	3.12 to 3.40	9.8	19.2	20.2	36.9	13.9	Neutral
16. Have more triggers to prompt me, e.g., have more reminders at strategic times	3.30 (0.93)	3.20 to 3.41	3.5	15.0	36.2	38.3	7.0	Neutral
17. Have more support from others, e.g., have my friends or classmates behind me	3.42 (1.08)	3.30 to 3.55	4.9	15.3	28.2	35.9	15.7	Neutral
Mean score: physical opportunity component (statements: 11,12,13,14)	3.55 (0.73)	3.46 to 3.63						Neutral
Mean score: social opportunity component (statements: 15,16,17)	3.33 (0.80)	3.24 to 3.42						Neutral
Motivation								
18. Feel that I want to do it enough, e.g., feel more of a sense of pleasure or satisfaction from exercise	3.82 (0.94)	3.71 to 3.93	1.7	7.7	20.6	46.7	23.3	Neutral
19. Feel that I need to do it enough, e.g., care more about the negative consequences of not doing it	3.55 (1.03)	3.43 to 3.67	4.2	10.8	27.9	39.7	17.4	Neutral
20. Believe that it would be a good thing to do, e.g., have a stronger sense that I should do it	3.75 (0.91)	3.64 to 3.86	2.1	7.0	23.7	48.4	18.8	Neutral
21. Develop better plans for doing it, e.g., have a clearer and better developed plan for exercising regularly	3.76 (0.88)	3.66 to 3.86	1.7	5.9	24.7	49.5	18.1	Neutral
22. Develop a habit of doing it, e.g., get into a pattern of exercising regularly without having to think	3.97 (0.88)	3.87 to 4.07	1.0	5.2	18.5	46.3	28.9	Neutral
Mean score: automatic motivation component (statements: 18,19,22)	3.78 (0.76)	3.69 to 3.87						Neutral
Mean score: reflective motivation component (statements: 20,21)	3.76 (0.78)	3.67 to 3.85						Neutral

* participants responded on a scale of 1 (strongly disagree) to 5 (strongly agree)

** mean response to statement categorised as agree ≥4, neutral ≥3 <4, disagree <3

The focus group responses identified six domains in the TDF as factors influencing adolescent females' PA behaviour at school. Using the COM-B model, psychological capability, physical opportunity, social opportunity, reflective motivation and automatic motivation were recognised as potentially important COM-B components to target. A summary of the identified domains and their associated COM-B component is provided in Table 2.

Psychological capability: Behavioural regulation. Many students didn't plan when they'll participate in PA or have a system in place that objectively managed, monitored, encouraged or regulated PA behaviour. *"[We have] no [reminders], unless, you're part of a team and you've training"* (Student B, Senior Cycle).

Physical opportunity: Environmental context and resources. This was the only domain where there was a clear difference in opinion. Barriers were identified by students in the school context that discouraged them to participate in PA, such as a lack of options *"there isn't as many* [sport] *teams for seniors"* (Student C, Senior Cycle) and the changing of uniforms for physical education class. The Steering Committee believed that the students had many choices and opportunities to be active at school, *"We have lots of options"* (Teacher F, Steering Committee), *"There's very little we don't have"* (Teacher B, Steering Committee).

Social opportunity: Social influence. The influence of peers and classmates was identified as both a facilitator to PA participation *"if your friends are there with you, you have more confidence"* (Student B, Junior Cycle) "*I'd probably end up quitting if it weren't for the people on the team"* (Student B, Senior Cycle), and a barrier to PA participation *"you won't do it if there's someone in the group you don't get on with, or if none of your friends are doing it"* [and] *"I don't want to look stupid, or have people laugh at me*" (Student D, Junior Cycle). Steering Committee members also regarded peers' influence as both a barrier, *"they won't play because they're afraid of what their mates would say*" (Teacher F, Steering Committee). *"It's always about how they look, and how they're perceived. That's the number one barrier from what I've seen"* (Teacher C, Steering Committee) and a facilitator to participation in PA, *"I think being in a group of friends is a really positive aspect of them engaging in physical activity because we know with* [Teacher G], *we do our class and its groups of friends that come, and it's a positive influence all the time"* (Teacher A, Steering Committee).

Reflective motivation: Beliefs about capabilities. *"In terms of capabilities, I think there is loads of capabilities, but they don't often see it"* (Teacher F, Steering Commit- tee). Students' lack of confidence deterred them from being active or to try new sports and activities. They felt self-conscious and often compared their own capabilities to that of their classmates, *"you become very aware of yourself when you're surrounded by girls who are very good at it, and you start to close into yourself"* (Student A, Senior Cycle). *Reflective motivation: Goals.* Other commitments, such as homework and exams resulted in students not prioritising PA or setting goals to participate in PA, *"just trying to fit everything in, you're supposed to get 8 h of sleep, then 3 h of study a night, and then be active as well?"* (Student C, Senior Cycle). The Steering Committee also acknowledged this, particularly as students got older, *"their commitment levels just fall off, and their priorities change"* (Teacher C, Steering Committee).

Automatic motivation: Reinforcement. Students identified negative reinforcements, such as getting a note in their school journal if they didn't bring in their correct uniform for physical education class, but needed more positive reinforcements to participate in PA at school. They wanted to feel encouraged to participate and liked having choices. Enjoyment was critical, and a good balance between competition and fun, *"It's important to balance fun and competition, it wouldn't be fun without the competition either, a mix of the two is good"* (Student A, Senior Cycle). Steering Committee members believed that more positive reinforcement could be beneficial, and suggested rewards for students' PA participation, such as 'certificates for attendance'.

Table 2: Summary of behavioural diagnosis using the Theoretical Domain Framework and COM-B components over the three focus groups (n=19)

TDF Domain	Domain Definition	Summary	Participant Quote	COM-B Component
Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions	Adolescent females needed to have systems in place that they could use for monitoring whether they participated in PA. They needed to action-plan, self-monitor and adopt procedures or ways of working that encouraged them to do PA.	"[we have] no [reminders], unless, you're part of a team and you've training" (Student B, Senior Cycle). "I think reminders would work. Like get the teachers to write 'PE tomorrow' on the board. Or get the prefects to remind the class to remind them to bring in the gear for the next day" (Student F, Junior Cycle).	Psychological Capability
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour.	Some of the students felt that time, the changing of uniforms for PE class, not having PE as an option and the lack of sport options available in the school, were barriers to being active. The Steering Committee felt the school offered many opportunities for the students to be active.	"it's a massive effort to change into PE tracksuits, so [students] just say they forgot them and not do PE" (Student D, Junior Cycle). "there isn't as many [sport] teams for seniors" (Student C, Senior Cycle). "if you do honours maths you can't do PE, cause its during that time" (Student B, Senior Cycle). "there's very little we don't have" [and] "there is no day after school that the hall is free, and the lunch times too" (Teacher B, Steering Committee). "we have lots of options" (Teacher F, Steering Committee).	Physical Opportunity
Social influence	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours.	Adolescents needed social support from their friends, family and classmates to exercise, and the opportunity to be part of a group and provide encouragement. Many of the females felt nervous about exercising alone and worried about how they would be perceived by their peers.	"I wanted to join the fitness club, but none of my friends would do it" (Student A, Junior Cycle). "you won't do it if there's someone in the group you don't get on with, or if none of your friends are doing it" [and] "I don't want to look stupid, or have people laugh at me" (Student D, Junior Cycle) "if your friends are there with you, you have more confidence" (Student B, Junior Cycle). "I'd probably end up quitting if it weren't for the people on the team" (Student B, Senior Cycle). "people would rather do other stuff, like hang out with your friends" (Student F, Senior Cycle). "they won't play because they're afraid of what their mates would say" (Teacher F, Steering Committee). "it's always about how they look, and how they're perceived. That's the number one barrier from what I've seen" (Teacher C, Steering Committee). "I think being in a group of friends is a really positive aspect of them engaging in physical activity because we know with [Teacher G], we do our class and its groups of friends that come, and it's a positive influence all the time" (Teacher A, Steering Committee).	Social Opportunity
Beliefs about capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use.	Adolescent females lacked confidence in doing PA, especially alone. They found it difficult to try new sports or activities and became self-conscious when doing so.	"it's difficult when you're trying something new" (Student F, Junior Cycle). "you become very aware of yourself when you're surrounded by girls who are very good at it, and you start to close into yourself" (Student A, Senior Cycle). "I think their confidence levels are on the floor" (Teacher C, Steering Committee).	Reflective Motivation

			“in terms of capabilities, I think there is loads of capabilities, but they don’t often see it” (Teacher F, Steering Committee).	
Goals	Mental representations of outcomes or end states that an individual wants to achieve.	Other priorities, for example homework, exams, family and social life competed for adolescent female’s time. They struggled to balance it all and needed to feel that PA was a priority.	“when teachers give us homework, they give us a lot and like you don’t have the time to do it at home, and you want to do exercise, but you can’t because you’ve stuff at home to do” (Student B, Junior Cycle). “just trying to fit everything in, you’re supposed to get 8 hours of sleep, then 3 hours of study a night, and then be active as well?” (Student C, Senior Cycle). "their commitment levels just fall off, and their priorities change” (Teacher C, Steering Committee).	Reflective Motivation
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus.	Adolescent females needed to feel that they wanted to do PA and for it to be fun/enjoyable. They liked having choice/autonomy and being with friends. There were punishments in place for not partaking in PE at school, but felt that they wanted more positive reinforcement for them to participate in PA.	“stuff with friends. Or even if they did ‘trial classes’, which would introduce new people to a sport” (Student F, Junior Cycle). “they [teachers] don’t change the sport, even if we say we don’t like it” (Student D, Senior Cycle). “it’s important to balance fun and competition – it wouldn’t be fun without the competition either, a mix of the two is good” (Student A, Senior Cycle). “I think in first year, they say you have to join at least one team but that’s it. They tell us to join one team, but we’re not followed up on it” (Student E, Senior Cycle). “you’d get a bad note into your journal if you didn’t bring in your PE gear or if you refuse to take part” (Student C, Senior Cycle).	Automatic Motivation

PA = Physical Activity, PE = Physical Education, TY = Transition Year

4.5 Discussion

Consistent with the literature (Guthold et al., 2020; Inchley et al., 2020; Woods et al., 2018), PA levels of adolescent females in this sample were far below recommended guidelines for optimum health. Moreover, the results indicated an age-related decline in PA participation. This paper identified factors influencing adolescent females' PA behaviour in a single-sex, female-only designated disadvantaged post-primary school using the COM-B model and TDF. Data from two-methods (questionnaires and semi-structured focus groups) with two groups of stakeholders (students and teachers) were complementary; the questionnaire quantified the factors influencing adolescent females' PA behaviour at school and the qualitative data provided in-depth perspectives explaining these factors. Five of six COM-B components were identified as potentially important to change PA behaviour. In this study, physical capability, i.e., having the physical skills, strength or stamina to perform the behaviour, did not emerge from the data as a factor that needed to change to positively influence students' PA behaviour at school. The remaining five components are discussed.

Opportunity

*Physical opportunity***.** Having more time was identified by the students as the strongest predictor to them being more active at school. Previous research indicates time constraints are a major barrier to PA participation for adolescent females (Corr et al., 2018; Slater and Tiggemann, 2010; Woods et al., 2010). Lack of time was cited by post-primary females as the main reason for not taking part in more activities/sport in a national study conducted in 2010 (Woods et al., 2010). Increased schoolwork, part-time jobs and responsibilities at home have been previously cited by females as reasons for their lack of time to regularly participate in PA (Corr et al., 2018). Examples of strategies to overcome time constraints as a barrier to PA includes providing accessible PA opportunities and active breaks throughout the day, encouraging goal-setting and action planning (i.e., prompt detailed planning of performance of PA) and active commuting to school (e.g., walking, cycling or running). Students in this current study identified barriers to PA in the school environment, such as a lack of PA options and the changing into sport uniforms. These barriers have also been cited in previous studies (Cowley et al., 2021b; Martins et al., 2021; Slater and Tiggemann, 2010).

Social opportunity. Consistent with previous research (Corr et al., 2018; Fitzgerald et al., 2012; Martins et al., 2021; Wiltshire et al., 2017) both the Steering Committee and students in

this study acknowledged the substantial influence that peers have on adolescent PA participation. This could present an opportunity to integrate socialising with exercise in a supportive and inclusive environment. Moreover, it was recognised that peers' influence on adolescent females' perceptions of PA had both positive and negative impacts. Likewise, Corr et al. (2018) identified peers as being positive if; they're a motivating factor and make PA more enjoyable, and negative if: they regard participating in PA as a missed opportunity to spend time with friends, or a fear of being judged. Providing social support (practical and emotional) and telling the person that they can successfully perform PA, arguing against self-doubts and asserting that they can and will succeed (verbal persuasion about capability) are examples of behaviour change techniques that can help promote PA.

Motivation

Reflective motivation. Regular PA was not always a 'goal' to achieve among students. Consistent with previous studies, changing and competing priorities (Corr et al., 2018; Cowley et al., 2021b), including increased academic pressures, part-time employment, and responsibilities at home, often got prioritised over PA. Moreover, limiting beliefs about capabilities to do PA was identified as a barrier to PA participation. Indeed, low levels of perceived competence (Corr et al., 2018; Slater and Tiggemann, 2010; Woods et al., 2010), low levels of self-efficacy for being physically active (Graham et al., 2014; Martins et al., 2021) or a lack of confidence in skills (Cowley et al., 2021b), have all been cited by adolescent females as common barriers to PA participation. This finding is particularly important since research indicates adolescent females' perceived competence is positively associated with PA (Biddle et al., 2005; Craike et al., 2014).

*Automatic motivation***.** Lastly, adolescent females in this study identified a lack of positive reinforcements at school that would encourage them to participate in PA. The students were aware of the negative reinforcements for not participating in physical education, but wanted more positive reinforcements and incentives to take part. These included increased choices in PA options and for PA to be both competitive and 'fun'. Enjoyment and perceiving PA as 'being fun' has been identified as a strong facilitator to PA involvement (Belton et al., 2014; Corr et al., 2018; Martins et al., 2021). Providing adolescent females with 'youth agency' and autonomy through choice of PA, more emphasis on fun and involvement, and offering a variety of activities to promote PA are common recommendations across the literature to promote PA during adolescence (Corr et al., 2018; Martins et al., 2021; Rees et al., 2006).

Capability

Psychological capability. The adolescent females that were not part of a sports-team identified a lack of self- behavioural regulation to participate in PA. Self-monitoring, action-planning and breaking habits are the constructs underpinning behavioural regulation (Cane et al., 2012). Research indicates behaviour regulation is correlated with PA in adolescent females (Biddle et al., 2005; Craike et al., 2014). Examples of strategies to increase behavioural regulation include forming new habits (i.e., prompt rehearsal and repetition of PA in the same context repeatedly so that the context elicits the behaviour) and action planning (prompt detailed planning of performance of PA, which must include at least one of context, frequency, duration and intensity).

Strengths and Limitations

This theoretically informed approach, using the COM-B model and the TDF, lent clarity and structure to the behavioural analysis process. Obtaining data via a mixed-methods approach and use of multiple sources strengthened our understanding of adolescent female PA behaviour in this context. A high proportion of the eligible research participants (students attending the school) completed the questionnaire. Research indicates that a contributing factor to a high response rate could be the use of parental/guardian opt-out consent (Junghans et al., 2005; Tigges, 2003).

A limitation of using parental/guardian opt-out consent was that ethically, no personal identifying information could be collected. This included students' home address, often used to identify one's social deprivation status, thus no individual SES data was collected. This study was conducted in one single-sex, female-only, designate disadvantaged post-primary school in Ireland. These findings may not be generalisable to the wider community. Despite efforts to include a mix of perceived PA levels across the year groups, the views and contributions of the twelve students (aged 12-18) that participated in the focus groups may not represent the students in the school. The quantitative data was collected in a day, thus females that were absent that day or were unable to participate due to an exam, did not contribute. Lastly, the PA levels of adolescent females in this sample were self-reported (subjective), which is dependent on students' recall ability (Sylvia et al., 2014).

4.6 Conclusion

The PA levels of adolescent females in this sample were far below recommended guidelines for optimum health. This paper describes how a mixed-method approach using the BCW COM-B model and TDF can be successfully applied through a systematic process to understand the factors influencing adolescent females' PA behaviour in the school setting. The behavioural analysis presented adds detail to the existing literature on the range factors influencing adolescent females' PA behaviour, reinforcing the need for tailored PA interventions for adolescent females. Following the BCW steps, these data will be used to subsequently co-design a school-based PA intervention.

Chapter 5 Study 2: Co-design process

Co-design of a school-based physical activity intervention for adolescent females using the Behaviour Change Wheel and Public and Patient Involvement.

5.1 Abstract

Introduction: There is a critical need to strengthen the development and implementation of effective interventions to increase adolescent females physical activity (PA) levels. Involving young people in research via a Public and Patient Involvement (PPI) approach can help to ensure that interventions reflect their preferences and therefore, improve intervention relevance, acceptability and feasibility. A behavioural analysis was performed to identify the range of factors influencing adolescent females' PA behaviour in the school setting (Stage 1 of the Behaviour Change Wheel (BCW)). This study aimed to use this data to co-design, with adolescent females, an extra-curricular school-based PA intervention, the Girls Active Project (GAP), following the subsequent stages of the BCW. This paper outlines the novel methodological approach taken.

Setting: One single-sex, female-only, designated disadvantaged post-primary school (students aged 12-18) in Dublin, Ireland.

Methods: Five discussion groups with eight PPI contributors (students aged 15-17) were guided by Stage 2 (identify intervention options) and Stage 3 (identify content and implementation options) of the BCW. The APEASE (Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity) criteria was used to select the most appropriate intervention functions, policy categories and behaviour change techniques for the GAP programme. The Template for Intervention Description and Replication (TIDieR) checklist was used to specify details of the intervention.

Results: The BCW co-design process resulted in the identification of seven intervention functions, four policy categories and 21 behaviour change techniques. A multi-component, peer-led, after-school PA programme was proposed. It offers autonomy to students through choice of PA, and a diversified and unstructured opportunity to be active with peers in a supportive and inclusive environment.

Conclusions: This paper describes how the BCW, a comprehensive, evidence-based, theory-driven framework was used in combination with PPI to co-design an after-school intervention aimed to increase adolescent females' PA levels. This approach could be replicated in other settings to develop targeted behavioural interventions in populations with specific demographic characteristics.

5.2 Introduction

There is a clear need for effective targeted interventions to promote and retain females' participation in PA (Guthold et al., 2020; van Sluijs et al., 2021). Evidence continues to accumulate on the health benefits of regular PA for adolescents (Bailey et al., 2012; Chaput et al., 2020; Janssen and LeBlanc, 2010), including cognitive outcomes and a reduced risk of experiencing depression. The prevalence of insufficient PA in females, however, has remained unchanged since 2001 (Guthold et al., 2020). Research indicates PA delivered during extra-curricular periods in school could potentially increase adolescents' PA (Jago and Baranowski, 2004). In general, evidence suggests school-based PA interventions have been minimally successful (Borde et al., 2017; Dobbins et al., 2013; Kriemler et al., 2011; Lai et al., 2014; Love et al., 2019; Owen et al., 2017) which indicates that changing adolescents PA behaviour through school-based interventions can be challenging. The school environment, however, is considered to be an ideal setting for PA promotion based on the significant amount of time adolescents spend at school presenting various opportunities to intervene, and its ability to reach large numbers of adolescents across a range of differing backgrounds (Cale and Harris, 2006; Hills et al., 2015).

Over the years, research has gradually shifted from a practice of consulting young people taking part in a research study, to one of actively involving them in the research process (Bird et al., 2013; Enright and O'Sullivan, 2012; Kellett, 2005; Lundy and McEvoy, 2012; Thompson et al., 2015). PPI is defined "as research being carried out 'with' or 'by' members of the public rather than 'to', 'about' or 'for' them" (INVOLVE, 2012). There is evidence to suggest that PPI in research may facilitate the process of translating research evidence into practice and policy (INVOLVE, 2012; Staley, 2009), contribute to reducing health research waste (Minogue et al., 2018), and can have beneficial impacts for the service users, researchers, and community (Brett et al., 2014b), and on the quality and appropriateness of health research (Brett et al., 2014a). With the aim to capture the contextual input necessary to

represent the unique youth experience, the use of PPI 'youth advisory groups' in health research has increased in recent years (Sellars et al., 2020), expanding across different research fields such as cyberbullying (Dennehy et al., 2018), healthy eating interventions (McSweeney et al., 2019), sexual health (Young et al., 2019), and PA (James et al., 2019). Findings support, however, that more work needs to be done to increase young people's involvement in youth-related research (Jacquez et al., 2013; Sellars et al., 2020) and to enable them to influence the development of interventions that target health and well-being (Larsson et al., 2018). Using a co-design approach to intervention development can harness local and contextualised expertise of the adolescent females using the PA programme, and be a potentially powerful way to help navigate what can be a complex and context-sensitive issue (O'Reilly et al., 2022).

There is compelling evidence to suggest that multi-component interventions (Kriemler et al., 2011; Messing et al., 2019; Owen et al., 2017; Pearson et al., 2015) and interventions underpinned by theory (Lai et al., 2014; Owen et al., 2017; Pearson et al., 2015) are more likely to be effective in changing adolescents' PA behaviour than those targeting single components, or non-theory based interventions. Indeed, targeting ecological domains beyond the individual level has been found to be important in PA interventions for adolescents (Perry et al., 2012), whilst tailoring these interventions to specific target populations is essential (Heath et al., 2012). The BCW is a comprehensive and theory-driven method for developing health behaviour interventions (Michie et al., 2014). It includes three stages (eight steps) in the intervention design process (Figure 6, Chapter 3): understand the behaviour (Stage 1, steps 1-4), identify intervention options (Stage 2, steps 5-6) and identify content and implementation options (Stage 3, steps 7-8). Stage 1 was carried out and reported on in the previous chapter. This study focused on Stage 2 'identify intervention options' and Stage 3 'identify content and implementation options'.

The MRC (Skivington et al., 2021) encourages a 'bolder approach' to intervention research recommending that researchers involve new methods that are not yet widely used, as well as undertaking methodological innovation and development. The aim of this study was to co-design an extra-curricular school-based PA intervention in a single-sex, female-only, designated disadvantaged post-primary school, using the BCW in combination with a PPI approach. To our knowledge, this is the first study that has used this methodological approach.

5.3 Methods

Study design

The step-by-step method for designing behaviour change interventions in the BCW guide was employed (Michie et al., 2014). Discussion groups with a PPI Youth Advisory Group (adolescent females aged 15 to 17) were used to co-design the school-based PA intervention.

Setting

One single-sex, female-only, designated disadvantaged post-primary school in Dublin, Ireland.

PPI contributors

Research and PPI are separate activities, differing in whether the public are involved as 'research participants' or as 'contributors to the research process', i.e., PPI contributors. Using the terms 'focus group' and 'discussion group' to differentiate between research and public involvement methods has contributed to improved clarity in research (Doria et al., 2018). For the purposes of this study, the following definitions by Doria et al. (2018) were used:

'Focus groups' refer to research activities. In focus groups, researchers collect data by speaking with a group of research subjects about their experiences. Researchers use this information to answer research questions and share their findings in academic journals and gatherings.

'Discussion groups' refer to engagement or involvement activities. Discussion groups are a way for the public to help plan research projects. Their contributions are not treated as research data, but instead they help make decisions that shape the research process.

Eight Transition Year students (aged 15 to 17) joined a Girls Active Project 'Youth Advisory Group' and participated in five PPI discussion groups to co-design the school-based PA intervention. In Ireland, Transition Year is a one-year school programme that can be taken in the year after the Junior Cycle and before the two-year Leaving Certificate programme (Department of Education, 2021). It is not a standard academic year. The year is designed around giving students life skills and a more hands-on aspect to learning. Written informed assent and parental/guardian consent was obtained from the eight Youth Advisory Group

members (PPI contributors). The researcher (SMQ) facilitated five discussion groups during school hours, each lasting 80 minutes (a double-class). A guide on how to actively involve young people in research (Kirby, 2004) was adhered to. The school principal and staff designated time and space for the discussion groups and ensured that the students were available.

Discussion groups

The researcher (SMQ) aimed for each discussion group to be encouraging and for the PPI contributors to feel valued and heard. The researcher (SMQ) took notes throughout each discussion group. The Youth Advisory Group played their own music, engaged with each discussion group and shared their thoughts and unique perspectives as both adolescent females, and students attending the school. The first PPI discussion group was set-up with the Youth Advisory Group to introduce the researcher (SMQ), explain the specified target behaviour (increase PA levels), the purpose of the GAP programme and their role as contributors to the research process. Lay (non-academic) language was used and the Youth Advisory Group were briefly taught about research and study design in a fun environment. The researcher (SMQ) intended to build rapport with the PPI contributors. A planned overview of the discussion groups can be found in Appendix C.

The four remaining discussion groups with the Youth Advisory Group (PPI contributors) focused on stage 2, identify intervention options (steps 5 and 6) and stage 3, identify content and implementation options (steps 7 and 8) of the BCW (Figure 6, Chapter 3). The BCW (Michie et al., 2014) APEASE (Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity) were considered to direct the selection of appropriate intervention options, content and implementation options for the GAP programme. Data from study 1 (Chapter 4) were presented to the Youth Advisory Group. The COM-B components relevant to the factors influencing adolescent females participation in PA were linked to intervention functions (BCW step 5). Michie et al. (2014) describes an 'intervention function' as broad categories of means by which an intervention can change behaviour. Afterwards, the intervention functions were linked to policy categories that were likely to be appropriate and effective in supporting each intervention function (BCW step 6) (Michie et al., 2014).

The BCW includes an extensive taxonomy of 93 consensually agreed, distinct behaviour change techniques (BCTs) (Michie et al., 2013). A BCT is "an active component of an

intervention designed to change behaviour" (Michie et al., 2014, p.145). BCTs that did not meet the APEASE criteria within the context of adolescent females PA behaviour at school were excluded, and the most appropriate BCTs were shortlisted and decided on through discussion (step 7). The final step of the BCW (step 8) included applying the APEASE criteria to select the most appropriate modes of delivery for the GAP programme. Intervention dimensions including content, provider, setting, recipient, intensity and duration were also deliberated and decided upon. Intervention recruitment and retention strategies were discussed and GAP posters were designed to display in the school.

Lastly, the Template for Intervention Description and Replication (TIDieR) checklist (Hoffmann et al., 2014) was employed to specify details of the intervention containing the who, what, how and where of proposed intervention delivery (Appendix C). The TIDieR checklist was developed to improve the reporting of interventions, as it provides authors with a systematic guide to clearly describe their interventions and subsequently, allow for future replication. This checklist was discussed with members of the Steering Committee and school principal for feedback and approval.

5.4 Results

The results of this intervention development study are presented below in accordance with Stage 2 'identify intervention options' and Stage 3 'identify content and implementation options' of the BCW intervention design process. Lastly, an outline of the proposed GAP programme is provided.

Stage 2: identify intervention options (steps 5 and 6)

The five COM-B components (psychological capability, physical opportunity, social opportunity, reflective motivation and automatic motivation) that were identified as potentially important (study 1) were mapped directly onto nine intervention functions; 'education' (increasing knowledge or understanding); 'persuasion' (using communication to induce positive or negative feelings or stimulate action); 'incentivisation' (creating an expectation of reward); 'coercion' (creating an expectation of punishment or cost); ' training' (imparting skills); 'restriction' (using rules to reduce the opportunity to engage in the target behaviour, or to increase the target behaviour by reducing the opportunity to engage in competing behaviours; 'environmental restructuring' (changing the physical or social context); 'modelling' (providing an example for people to aspire to or imitate); and

'enablement' (increasing means/reducing barriers to increase capability, beyond education and training, or opportunity beyond environmental restructuring).

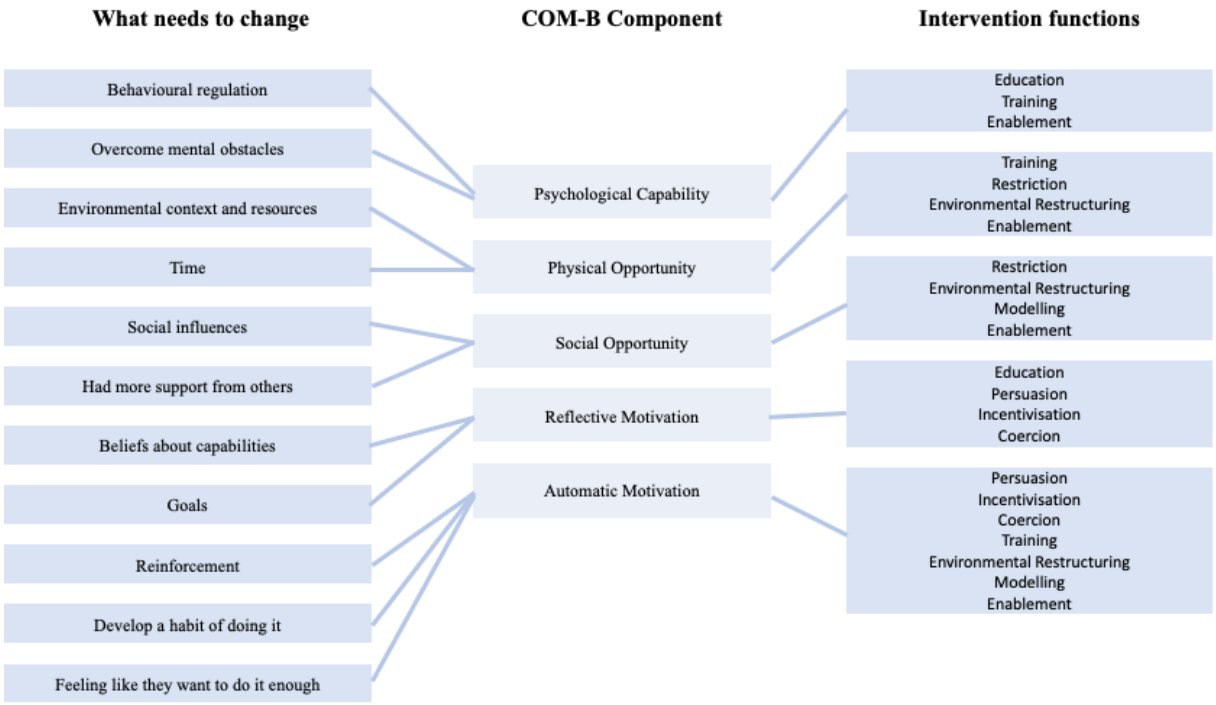


Figure 8: Links between the theoretical domains framework and COM-B model (study 1) and intervention functions (BCW step 5)

Seven intervention functions (education, persuasion, incentivisation, training, environmental restructuring, modelling and enablement) were selected based on consideration of the APEASE criteria. Intervention functions (coercion and restriction) were not considered acceptable or practical in this study context. These seven intervention functions were linked to seven policy categories: 'Communication/marketing' (using print, electronic, telephonic or broadcast media); 'guidelines' (creating documents that recommend or mandate practice, this includes all changes to service provision); 'fiscal' (using the tax system to reduce or increase the financial cost); 'regulation' (establishing rules or principles of behaviour or practice); 'legislation' (making or changing laws); 'environmental/social planning' (designing and/or controlling the physical or social environment); 'service provision' (delivering a service) (Michie et al., 2014, p.135). Four policy categories (communication/marketing, guidelines, environmental/social planning and service provision) were selected. Policy categories (fiscal measures, regulation and legislation) were not considered acceptable or practical in this study context (Table 3).

Table 3: Matrix of links between identified intervention functions and policy categories (BCW Step 6)

Policy Categories	Girls Active Project Intervention functions						
	Education	Persuasion	Incentivisation	Training	Environmental restructuring	Modelling	Enablement
Communication/marketing							
Guidelines							
Fiscal Measures							
Regulation							
Legislation							
Environmental/social planning							
Service provision							

Stage 3: identify content and implementation options (steps 7 and 8)

The majority of the 93 BCTs listed were identified as potentially relevant. After careful deliberation and application of the BCW APEASE criteria, 21 were selected as most fitting to increase adolescent females PA levels in this school setting. The 21 BCTs, their definitions and strategies on how they are operationalised are presented in Table 4.

Table 4: Selected behaviour change techniques for the Girls Active Project intervention and intervention strategy

Selected Behaviour Change Technique (code) *Definition**	**Girls Active Project intervention strategy**
Goal setting (behaviour) (1.1) *set or agree a goal defined in terms of the behaviour to be achieved.*	Intervention recipients set a goal to attend a weekly after-school PA programme where they partake in an exercise class.
Action planning (1.4) *Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive).*	Recipients are asked to plan to attend the weekly after-school PA programme.
Monitoring of behaviour by others without feedback (2.1) *Observe or record behaviour with the person's knowledge as part of a behaviour change strategy.*	Recipients' behaviour is monitored at the weekly after-school PA programme.
Social support (practical) (3.2) *Advise on, arrange, or provide practical help (e.g., from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour.*	Practical help is provided to recipients at the after-school PA programme. Parents/guardians are advised (via written form) to provide practical help to facilitate their daughters participation. School staff are advised (verbally) to provide practical help to facilitate students' participation, such as volunteering to supervise the weekly after-school programme.
Social support (emotional) (3.3) *Advise on, arrange, or provide emotional social support (e.g., from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour.*	Emotional social support is provided to recipients at the after-school programme. School staff and parents/guardians are advised to provide encouragement and emotional support to facilitate PA participation.
Instruction on how to perform a behaviour (4.1) *Advise or agree on how to perform the behaviour.*	Project Leaders (intervention providers) advise on how to perform PA at the after-school programme.
Information about health consequences (5.1) *Provide information (e.g., written, verbal, visual) about health consequences of performing the behaviour.*	Information on the benefits of regular participation in PA are explained to intervention recipients (verbally).
Monitoring of emotional consequences (5.4)	Each week, intervention recipients are asked how they feel after the exercise class.

Prompt assessment of feelings after attempts at performing the behaviour.	
Demonstration of the behaviour (6.1) *Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g., via film, pictures, for the person to aspire to or imitate.*	Project leaders (intervention providers) demonstrate how to perform PA at the after-school programme.
Prompts/cues (7.1) *Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance.*	Intervention recipients receive emails from the school to remind them to participate in the weekly after-school PA programme. School staff and parents/guardians are advised to provide regular verbal reminders. These prompts reinforce other BCTs by reminding recipients of the benefits of PA (5.1) and action planning (1.4).
Behavioural practice/rehearsal (8.1) *Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill.*	Recipients practice PA at each exercise class in the after-school programme.
Habit formation (8.3) *Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour.*	Recipients repeatedly participate in PA on a weekly basis at the after-school programme.
Generalisation of a target behaviour (8.6) *Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation.*	Intervention recipients are advised to be active during the week too. This generalisation of PA also reinforces the BCT (information about health consequences, code 5.1) by reminding recipients of the benefits of PA.
Credible source (9.1) *Present verbal or visual communication from a credible source in favour of or against the behaviour.*	Present verbal communication by the research team explaining key benefits of regular PA for health.
Material incentive (behaviour) (10.1) *Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour.*	Inform intervention recipients that they are entered into a raffle to win prizes (e.g., Vouchers or other valued objects) if and only if there has been progress and/or an effort to participate in the after-school PA programme.
Material reward (behaviour) (10.2) *Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress in performing the behaviour.*	Recipients that have made progress and/or an effort to participate in the after-school PA programme are entered into a raffle to win prizes (e.g., Vouchers or other valued objects). Prizes are delivered to raffle-winners.
Non-specific reward (10.3) *Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour.*	Recipients receive a researcher signed 'girls active project certificate of award' for their participation. Project leaders (intervention providers) also receive a researcher signed 'girls active project certificate of achievement' for their participation in the gap.
Social reward (10.4) *Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour.*	Congratulate intervention recipients after each exercise class that they participate in.
Non-specific incentive (10.6) *Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour.*	Inform intervention recipients that they will receive a (researcher) signed 'girls active project certificate of award' for their participation in the gap.
Restructuring the social environment (12.2) *Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments).*	Implement the girls active project peer-led, after-school programme into the school environment to facilitate PA. Include the girls active project in the school PA policy to serve as the school's commitment to support and encourage their students to participate in PA. The policy is agreed to by the principal and steering committee and signed by the school principal. Advise the school that it is pre-arranged for an adult (e.g., steering committee member, pe teacher, school staff, parent/guardian) to supervise the weekly programme. For the feasibility study, the researcher and pe teacher will supervise the PA programme.
Verbal persuasion about capability (15.1) *Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed.*	Empower, encourage and motivate intervention recipients to be physically active. Tell recipients that they can successfully increase their participation in PA, despite current fitness levels and/or capabilities.

*Based on definitions reported in Michie et al. (2014)

Abbreviations: PA= Physical Activity; PE= Physical Education; GAP= Girls Active Project, BCT= Behaviour Change Technique

The selected mode of delivery was 'face-to-face' at a group-level via peer-delivered 'exercise' classes. This was supported by 'distance' delivery at a population-level by details of the intervention and benefits of participating in PA being communicated to students, parents/guardians and school staff via the school's digital media (social media), newsletter and posters displayed in the school. This aimed to provide information about the GAP programme and also encourage social support from students' families, peers and school staff. The selection process based on consideration of the APEASE criteria is provided below (Table 5).

Table 5: Selected modes of delivery used in the Girls Active Project intervention (Step 8)

Mode of delivery				**Girls Active Project Intervention**
				Is this mode of delivery affordable, practical, effective/cost-effective, acceptable, safe and equitable in the context of increasing adolescent females' physical activity levels in the school setting?
Face-to-face	Individual			Unlikely to be practical
	Group			Yes
Distance	Population-level	Broadcast media	TV	Unlikely to be affordable, practical, or equitable
			Radio	Unlikely to be affordable, practical, or equitable
		Outdoor media	Billboard	Unlikely to be affordable, practical, or equitable
			Poster	Yes
		Print media	Newspaper	Yes (school newsletter)
			Leaflet	Unlikely to be effective/cost-effective
		Digital media	Internet	Yes (school social media platforms)
			Mobile phone app	Unlikely to be affordable or equitable
	Individual-level	Phone	Phone helpline	Unlikely to be affordable, practical, acceptable, or equitable
			Mobile phone text	Unlikely to be practical, acceptable, or equitable
		Individually accessed computer programme		Unlikely to be affordable, practical, or equitable

The proposed intervention is a peer-led after-school PA programme. The Youth Advisory Group chose for the group classes to be peer-delivered face-to-face for 45-minutes on a weekly-basis after-school (rather than before or during breaks) in the school setting. The Youth Advisory Group members preferred the term 'exercise class' than 'PA class'. The exercise classes are delivered by Transition Year students (intervention providers known as 'Project Leaders') to other students (intervention recipients). Classes are supervised by an adult. Project Leaders work as a team to choose what activities they deliver (e.g., dancing, boxing, football) and change it on a weekly-basis to offer variety to the students attending. The classes aim to be fun, inclusive and supportive. Intervention recipients have opportunities

to win prizes (e.g., vouchers or other valued objects) and receive a 'Girls Active Project Certificate' after their participation in the programme. The completed TIDieR checklist is shown in Appendix C. Following discussions with the school principal and physical education teacher, it was agreed that the GAP programme would be trialled the following academic term (January to May 2021) and could be implemented and integrated into the school PA policy. Templates of school PA policies that integrate the GAP programme were provided to the principal (Appendix D). The feasibility trial was registered online: 10.17605/OSF.IO/75HWJ (date of registration: 9th December 2020).

5.5 Discussion

This methodological paper outlines how the BCW, a comprehensive, evidence-based, theory-driven framework was systematically used in combination with a PPI approach to develop a school-based PA intervention in a single-sex, female-only, designated disadvantaged post-primary school in Ireland. Similar to two previous studies that used the BCW to design PA interventions, the process was considered time-consuming (Murtagh et al., 2018; Webb et al., 2016) due to the large volume of choice. Despite this, the research team considered the BCW to be a useful framework to co-design the intervention and would use it again in a future study. Given the scope of options provided, other behaviour change interventions using the BCW in the school-setting may produce different results. The discussion groups allowed the researcher (SMQ) and Youth Advisory Group (PPI contributors) to consider the full range of options and to choose the most appropriate through a systematic evaluation of theory and evidence, whilst ensuring that the range of opportunities being created were matched to the preferences of the students. The experience of capturing the views of adolescent females in the intervention design process and identifying specific strategies that respond to their interests and needs was perceived to be invaluable by the research team.

The proposed peer-led, after-school PA intervention, the GAP programme, contained 21 BCTs. Evidence suggests after-school programmes focused on PA and/or sports can be effective, however, attendance rates are highly important as the effectiveness of a programme strongly depended on attendance (Messing et al., 2019). Similarly, Demetriou et al. (2017) found modest support of the benefits of after-school PA programmes, yet identified better outcomes when conducting the programmes in the school setting, providing sessions on two or more days a week, and ensuring high programme attendance rates (Demetriou et al., 2017). Given that peers influence adolescent's PA behaviour (Fitzgerald et al., 2012; Wiltshire et al., 2017) peer-based interventions could be an effective means of helping

adolescents become more physically active. Study 1 (Chapter 4) identified social influences, particularly peers, as being positive if; they're a motivating factor and make PA more enjoyable, and negative if: they regard participating in PA as a missed opportunity to spend time with friends, or a fear of being judged. The Youth Advisory Group believed that peers' influence would be positive because the Project Leaders, i.e., Transition Year students would (a) demonstrate the exercises, (b) encourage participation, and (c) deliver the class in a fun, inclusive and supportive (non-judgemental) environment. Social support (practical and emotional) and verbal persuasion about capability (telling the students that they can successfully perform PA, arguing against self-doubts and asserting that they can and will succeed) are examples of the chosen BCTs that apply social influences in a positive way. Offering a variety of activities and providing 'youth agency' and autonomy through choice of activity are common recommendations across the literature to promote adolescent females' PA (Martins et al., 2021; Rees et al., 2006). An emphasis on fun and involvement have also been cited by females in previous studies (Corr et al., 2018) as facilitators to PA participation. Notably, the PA promotion strategies proposed in the GAP programme are similar to the evidence-based delivery principles in 'SAAFE' by Lubans et al. (2017) on delivering PA classes in school, i.e., 'Supportive, Active, Autonomous, Fair and Enjoyable'. Lastly, the Youth Advisory Group identified what incentives would be most desired by programme participants, and might be more likely to have an influence on them. There is a limited evidence base on the effectiveness of behavioural incentives for encouraging PA behaviour in adolescents (Corepal et al., 2018). Previous school-based PA interventions have found merit in providing small rewards to facilitate sustained involvement (Jago et al., 2012; Jong et al., 2020), such as sports bags or pens (Jong et al., 2020).

Strengths and Limitations

This paper describes a novel approach to designing a school-based PA intervention using the BCW in combination with a PPI approach. Using the BCW allowed for a systematic, evidence base and theory-driven process to intervention development. Stakeholder buy-in played a significant role in this study. The Youth Advisory Group truly engaged in the research process. Good relationships and ways of working have been recognised as key factors for facilitating high quality PPI (Wilson et al., 2015). Involving adolescent females in the intervention design process ensured that the intervention reflected their unique needs and interests. This led to an intervention which was logical and practical yet still theory-based. The transparent methods allow for future replication. The main limitation to this study was that it was conducted in one single-sex, female-only, designate disadvantaged post-primary

school in Ireland, thus findings may not be generalisable to the wider community. Moreover, the views and contributions of the eight students who voluntarily joined the Youth Advisory Group may not represent the students in the school.

5.6 Conclusion

This methodological paper outlines how the BCW, a comprehensive, evidence-based, theory-driven framework was systematically used in combination with a PPI approach to co-design a school-based intervention aimed to increase adolescent females PA levels. The intervention was tailored to overcome the barriers to adolescent females' PA participation and take account of the preferences of adolescent females. The transparent intervention development process described could facilitate future replication and may be useful for other researchers. This work has had implications by informing practice in the post-primary school setting. The intervention trial is reported on in the next chapter.

Chapter 6 Study 3: Feasibility trial

Feasibility of a peer-led, after-school physical activity intervention for disadvantaged adolescent females during the COVID-19 pandemic: Results from the Girls Active Project (GAP).

6.1 Abstract

Introduction: There is a critical need for interventions that can be feasibly implemented and are effective in successfully engaging adolescent females in physical activity (PA). A theory-based, peer-led, after-school PA intervention, the *Girls Active Project (GAP)* was co-designed with adolescent females. This study aimed to assess the feasibility of implementing and evaluating the GAP programme.

Setting: One single-sex, female-only, designated disadvantaged post-primary school (students aged 12-18) in Dublin, Ireland.

Methods: Mixed-methods were applied with multiple stakeholders over a 12-week trial (March to May 2021). A single-arm study design was used to examine intervention: reach, dose, fidelity, acceptability, compatibility, and context. Feasibility of using proposed self-reported outcome measures (moderate-to-vigorous PA levels, self-rated health, life satisfaction, PA self-efficacy and PA enjoyment) were also explored. Due to school closure resulting from the COVID-19 pandemic, the intervention was delivered both online, and in-person in the school setting.

Results: Eight exercise classes were peer delivered by Project Leaders (n=6, students aged 15-17) to intervention recipients (students aged 13-14). Recruitment was low (n=8, 10% of eligible students, mean age:13.3 SD: .46), yet retention was high (n=7, 88%). Attendance rates were satisfactory (68%) and the intervention was implemented with high fidelity (87%). Data completion rates suggested proposed self-reported outcome measures were deemed appropriate (≥95%), except for weight (50%) and height data (80%). Despite COVID-19 hindering intervention implementation, both quantitative and qualitative data suggested that stakeholders were satisfied and perceived the in-person delivered intervention to be compatible with the school-setting. Recommended refinements included extending class duration, introducing different rewards and boosting programme awareness.

Conclusions: Further thought must be given on how to increase recruitment. Overall, the in-person delivered after-school PA programme was well-received by stakeholders and shows promise as an intervention that can be feasibly implemented and evaluated. Suggested improvements to the GAP intervention programme are recommended, before continuing to a more robust evaluation.

Trial registration: 10.17605/OSF.IO/75HWJ (prospectively registered, date of registration: 9th December 2020)

6.2 Introduction

Despite evidence continuing to accumulate on the health benefits of regular PA for adolescents (Chaput et al., 2020; Janssen and LeBlanc, 2010), globally, 85% of adolescent females (aged 11-17) are insufficiently physically active (Guthold et al., 2020). PA levels are particularly low among females of lower SES (Borraccino et al., 2009; Inchley et al., 2020). The World Health Organisation recommends that adolescents accumulate at least an average of 60 minutes a day of MVPA (Bull et al., 2020). An age-related decline in PA participation during adolescence is a consistent finding in the literature (Corder et al., 2016b; Dumith et al., 2011), with national evidence to suggest (Murphy et al., 2020) that the largest reduction in PA levels for females occur between second (aged 13-14) and third year (aged 14-15) in post-primary school. Efforts made to increase the PA levels of adolescents are of particular importance since PA appears to track reasonably well from adolescence to adulthood (Telama, 2009). Furthermore, there is evidence emerging to suggest that the on-going COVID-19 pandemic has caused a further decrease in PA participation (Ng et al., 2020; Rossi et al., 2021), especially for adolescents of lower SES (Rossi et al., 2021).

There is a critical need to strengthen the development and implementation of effective interventions to increase adolescent female PA levels (Guthold et al., 2020; van Sluijs et al., 2021). The school environment is well-known as a potential setting for targeting adolescent PA behaviour (Hills et al., 2015). Evidence suggests, however, school-based PA interventions have been minimally successful at increasing PA levels (Dobbins et al., 2013; Lai et al., 2014; Love et al., 2019; Messing et al., 2019). This indicates that changing adolescent PA behaviour through school-based interventions can be challenging. Previous reviews suggest that multi-component (Messing et al., 2019; Owen et al., 2017) interventions and interventions that use a theoretical model or framework (Lai et al., 2014; Owen et al., 2017) might be most effective in the promotion of PA for adolescents, with certain intervention strategies, such as after-

school programmes focused on PA and/or sports indicating effectiveness, however, attendance rates were highly important as the effectiveness of a programme strongly depended on attendance (Messing et al., 2019). Similarly, Demetriou et al. (2017) found modest support of the benefits of after-school programmes conducted in the school setting, yet identified better outcomes when conducting the programmes in the school setting, providing sessions on two or more days a week, and ensuring high programme attendance rates (Demetriou et al., 2017).

At post-primary school level in Ireland, traditional team-based and structured sports dominate extra-curricular PA, i.e., PA or sport played before, during or after school, but not part of the curriculum (Woods et al., 2018). Given that participation is higher among males (70%) than females (57%) and in more affluent students (66%) than less affluent students (56%) (Woods et al., 2018), a call for additional extra-curricular PA programmes that appeal to adolescent females of lower SES may be warranted. In Ireland, a classification system known as DEIS (Delivering Equality of opportunity In Schools) is used by the Department of Education to indicate that a school is based in a community at risk of disadvantage and social exclusion (Department of Education, 2017). The Girls Active Project (GAP) programme was co-designed with adolescent females in a designated disadvantaged (DEIS) post-primary school in Ireland using the BCW (Michie et al., 2014) in combination with PPI. This novel approach was applied to systematically co-design a contextually appropriate school-based and theory-based PA intervention that aimed to meet the needs of adolescent females and provide relevant and meaningful opportunities for them to be active. Details of the intervention development process are available elsewhere (McQuinn et al., 2022). The GAP programme is a novel, multi-component school-based PA programme. It offers female adolescents a readily accessible fun and unstructured opportunity to be active with peers in a supportive and inclusive environment. The females who co-designed the GAP programme (study 2) chose for the programme to be peer-delivered after-school in the school setting. The GAP includes strategies that are commonly recommended across the literature to promote adolescent females' PA, such as incorporating social support (Mendonça et al., 2014; Salvy et al., 2012) and providing females with autonomy through choice of activity, alongside offering a diverse range of activities (Martins et al., 2021; Mitchell et al., 2015; Rees et al., 2006). Moreover, given that lack of time has been identified as a key barrier to school PA policy implementation (Nathan et al., 2018), engaging students to deliver intervention components may possibly reduce the burden on teachers (Lubans et al., 2011). Using a peer-led approach (such as that used in the GAP programme) in school-based interventions has become

increasingly popular, and has shown potential in increasing adolescent female PA levels (Carlin et al., 2018; Owen et al., 2018; Sebire et al., 2018) with findings to suggest that peer-led PA interventions may be equally as effective as those delivered by professionals (Ginis et al., 2013). The next step was to assess feasibility of the GAP intervention programme.

There is a growing appreciation of the significant role that feasibility studies play in the development and evaluation of complex interventions, primarily its value of progressing to a larger-scale trial or effectiveness study (Beets et al., 2021; Hallingberg et al., 2018; Skivington et al., 2021). This small-scale real-world testing can provide information for researchers to enhance the thoroughness of a future trial (Bird et al., 2011; Eldridge et al., 2016b) and through publication, may benefit other researchers (El-Kotob and Giangregorio, 2018; Lancaster and Thabane, 2019). Following the MRC framework guidance (Skivington et al., 2021), this study aimed to investigate the feasibility of implementing and evaluating the GAP programme. The research team selected the feasibility measures deemed most appropriate for this study based on the research objectives and available data (Pearson et al., 2020). These included: reach, dose, fidelity, acceptability, compatibility and context. This study also explored the feasibility of measuring the proposed self-reported outcomes (minutes of daily MVPA, height, weight, self-rated health, life satisfaction, self-efficacy related to PA and PA enjoyment) that will be used to evaluate efficacy in a future trial (El-Kotob and Giangregorio, 2018) by assessing their completion rates. These self-reported outcomes were proposed during the co-design process and agreed upon by the research team (study 2). Reporting data completion rates is consistent with previous feasibility studies (Corepal et al., 2019; Iadarola et al., 2020) and proves useful as this information can help inform intervention refinements and provide additional support for the feasibility of using these outcome measures (Pearson et al., 2020).

The specific objectives of this feasibility study were:

1. Capture the recruitment and retention rates of intervention recipients and explore factors influencing participation (Reach).
2. Determine attendance rates and the extent to which intervention providers implemented the intervention as intended (Dose and fidelity).
3. Assess the feasibility of using proposed self-reported outcome measures (Data completion rates).
4. Explore stakeholders' satisfaction with the intervention (Acceptability).

5. Examine the perceived fit and sustainability of the intervention in the school-setting (Compatibility).
6. Understand context, i.e., the external factors that affected intervention implementation (Context).

6.3 Methods

Design and setting

A mixed-methods single-arm feasibility trial was conducted in a female-only, designated disadvantaged post-primary school in Dublin, Ireland. This school had previously participated in the co-design of the GAP programme (McQuinn et al., 2022) and were therefore familiar with the intervention and proposed processes involved. To ensure it reflected the realities of the intervention setting (Hallingberg et al., 2018), this study involved multiple stakeholders (intervention recipients, intervention providers, school staff and parents/guardians). The feasibility measures and their definitions, stakeholders involved, data collection tools and the timeframe of each objective as they relate to the present study are provided in Table 6. The reporting of this study followed the Consolidated Standards of Reporting Trials (CONSORT) 2010 (Eldridge et al., 2016a) statement with extension to randomised pilot and feasibility trials and the Template for Intervention Description and Replication checklist (TIDieR) (Hoffmann et al., 2014) (Appendix C).

Table 6: Data collection procedures and schedule of measures (feasibility study)

Objective	Measure *Definition*	Stakeholder(s)	Data Collection Tool	Data Collection Timeframe				
				Week 1: Phase one Baseline	**Week 8: Mid**	**Week 8: Phase two Baseline**	**Week 12: Post**	**During/ throughout: Week 1-12**
				Online	**Paper-based/ In-person**	**Paper-based/ In-person**	**Online/Paper-based/ In-person**	**Online/ in-person**
1. To capture the recruitment and retention rates of intervention recipients and explore factors influencing participation	**Reach** [a] *Participation rate in the innovation by the intended audience*	Intervention recipients	Recruitment and retention records (i.e., # Who were eligible, # Who consented # Who enrolled, #Who stayed)	X	X	X	X	X
			Demographic section in questionnaire	X		X^		
			Feedback questionnaire & focus group		X		X	
		Parents/Guardians	Questionnaire				X	
2. To determine attendance rates and the extent to which intervention providers implemented the intervention as intended.	**Dose** [b] ***Dose delivered:*** *the number/amount of intended units delivered/provided (i.e., dose is a function of the efforts of intervention providers)* ***Dose received****: Extent to which participants engage or interact with are receptive or use intervention (i.e., dose is a function of the efforts of intervention participants)* **Fidelity** [b] *the extent to which the programme was implemented as planned*	Intervention recipients	Attendance records					X
		Intervention providers	self-reported provider checklist (Project Leader logbooks)					X
3. To assess the feasibility of using proposed self-reported	'Data completion rates' of outcome measures was used as an indicator to the – **Feasibility of future trial design to conduct a full trial** [a]	Intervention recipients	# Outcome measures completed (% data completion)	X	X	X^	X	

	outcome measures	*Measures informing implementation trial methods including the feasibility, acceptability or quality of data collection procedures, survey items, tools, or data management strategies.*							
4.	**To explore stakeholders' satisfaction with the intervention.**	**Acceptability** [a] *Service providers or support system's satisfaction with the innovation*	Intervention recipients	Feedback questionnaire & focus group		X		X	
			Intervention providers	Feedback questionnaire				X	
			Intervention providers	Focus group		X		X	
			Parents/Guardians	Questionnaire & semi-structured interview				X	
			School staff	Semi-structured interview				X	
5.	**To examine the perceived fit and sustainability of the intervention in the school-setting.**	**Compatibility (appropriateness)** [a] *Perceived fit of the innovation with organisation's values, mission, priorities*	Intervention recipients	Feedback questionnaire & focus group		X		X	
			Intervention providers	Feedback questionnaire				X	
			Intervention providers	Focus group		X		X	
			Parents/Guardians	Questionnaire & semi-structured interview				X	
			School staff	Semi-structured interview				X	
6.	**To understand context, i.e., the external factors that affected intervention implementation.**	**Context** [a] *Political, economic, or social influences on implementation of the innovation*	Intervention recipients	Feedback questionnaire & focus group		X		X	
			Intervention providers	Feedback questionnaire				X	
			Intervention providers	Focus group		X		X	
			Parents/Guardians	Questionnaires & semi-structured interviews				X	
			School staff	Semi-structured interviews				X	

[a] Based-on measure and terminology reported in Pearson et al. (2020)
[b] Based on measure and terminology reported in Steckler & Linnan (2002)
^ applicable to newly enrolled intervention recipients
Abbreviations: PA (physical activity); MVPA (moderate-to-vigorous intensity physical activity).

The COVID-19 pandemic implications on this study

In January 2021, there was a nationwide lockdown which involved national school closures. Consequently, although the intervention was originally designed to be delivered in person on school grounds, it was divided into two phases. Both phases were delivered at the same time (4pm) each week on the same day (Tuesday). Phase one involved four classes being delivered via Zoom using the school online platform. When schools fully reopened in April 2021, four classes were delivered in person (phase two) in the school sports hall or playing field. In response to COVID-19-related social restrictions, just one year group was invited to participate as 'intervention recipients'. This was a protective measure to avoid integrating students from different year groups and to accommodate for social distancing (2 metres). Furthermore, school guidelines permitted just one researcher (SMQ) attend the school to collect data during intervention implementation. Figure 9 presents the overall timeline and COVID-19 implications to this research project.

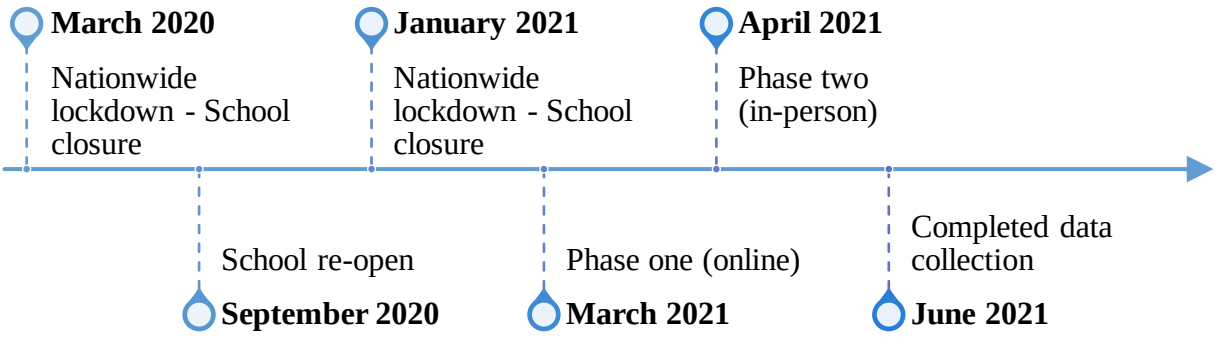


Figure 9: COVID-19 implications to this research project

Recruitment and participants

Intervention providers (who delivered it)

Intervention providers were six Transition Year students (aged 15-17) known as 'Project Leaders' (n=6) who volunteered to take part. In Ireland, Transition Year is a one-year school programme that can be taken in the year after the Junior Cycle (students aged 12-15) and before the two-year Leaving Certificate programme (students aged 15-18) (Department of Education, 2021). It is not a standard academic year. Instead, the year is designed around giving students life skills and a more hands-on aspect to learning. The six Project Leaders who expressed an interest were familiar with the GAP programme from the co-design process (study 2). As a recognition for their time and effort, Project Leaders could use the GAP to

contribute towards ‘Gaisce’, a national self-development programme for young people in Ireland between the age of 15 and 25 (Department of Children, Equality, Disability, Integration and Youth, 2020). At the end of the study, each Project Leader also received a ‘Girls Active Project’ certificate as an expression of appreciation (Appendix D).

Intervention recipients (to whom it was delivered)

Given that national evidence suggests the largest reduction in PA levels for females occur between second (aged 13-14) and third year (aged 14-15) in post-primary school (Murphy et al., 2020), the school principal, physical education teacher, and authors agreed to target the second-year students (n=78, aged 13-14). Intervention recipients were recruited over two rounds, with the second round required due to low recruitment experienced at phase one online (during COVID-19 school closure). The number of intervention recipients who were invited, consented and completed the questionnaires were recorded at week 1 (phase one baseline), week 8 (phase two baseline) and week 12 (post-intervention). The number of recipients who withdrew or were lost to follow up were recorded at mid-intervention (week 8) and post-intervention (week 12). A standard threshold for study attrition (>20%) was employed (Higgins et al., 2011; Pearson et al., 2020).

The GAP intervention programme was pitched to second-year students and their parents/guardians as a fun, free, peer-led exercise programme suitable for all fitness levels that included a variety of activities and provided opportunities to win prizes. Recruitment strategies for both phases included an information email sent from the school to each second-year student and school social media posts on behalf of the research team. ‘Girls Active Project’ posters made by students (McQuinn et al., 2022) were displayed in the school prior to school closure (pre-COVID-19 lockdown, December 2020). In addition, a “word of mouth” campaign (Jago et al., 2011) was employed in phase two (in-person, April 2021). This involved Project Leaders visiting each of the second-year classrooms with the researcher (SMQ) during school hours to encourage them to participate in the intervention. Project Leaders explained the purpose of the GAP intervention programme and answered any questions their peers had.

Adolescent females were eligible to take part in this study if they were (a) a Project Leader or (b) a second-year student. Eligible students received a letter of invitation from the school on behalf of the research team containing information sheets, assent and parental/guardian consent forms and a PA readiness questionnaire for them and their parent/guardian to read

and sign. If the parent/guardian answered 'yes' to any of the questions in the PA readiness questionnaire, they were advised to talk to their general practitioner to discuss if their daughter is able to participate in the physical requirements of the PA programme. Students were excluded from the study if they had not provided assent or parental/guardian consent or they had been advised by their general practitioner not to undertake PA. Participating students were assigned identification codes to protect identity.

Other key stakeholders

At post-intervention, the parent/guardian of each second-year student (n=78) was sent a text message from the school that contained a link to an anonymous online Qualtrics (Qualtrics, 2021) questionnaire (Appendix D). Informed consent was provided online. A reminder text message was sent a week later. Parents/guardians provided their contact details if they were willing to participate in a short, semi-structured, audio-recorded phone call interview. School staff members (two physical education teachers and school principal) were invited to participate in a semi-structured, audio-recorded interview on school grounds at post-intervention. The three school staff members provided written informed consent prior to the interview.

Intervention delivery

As a team, intervention providers (Project Leaders) delivered a 45-minute exercise class after-school once per week to intervention recipients. Key decisions on class time, duration, location and terms used (e.g., exercise class rather than PA class) were discussed and agreed upon in the co-design process (study 2). Project Leaders discussed various activities and mutually decided what was delivered (intervention content) and changed it each week. Due to the COVID-19 pandemic, however, Project Leaders had to consider factors such as adequate space and little to no use of equipment when choosing suitable activities. The activities (listed in Table 7) were a result of these discussions. Of note, class 7 (basketball) and class 8 (dance) were chosen by the Project Leaders based on suggestions provided by intervention recipients during the intervention trial. This current study comprised eight classes over a 12-week period (March to May 2021) to accommodate school holidays (two weeks during April). Training for the Project Leaders consisted of meetings during school hours, either online or in person, with the physical education teacher and researcher (SMQ) to collaboratively discuss and for Project Leaders to decide; what was delivered (for example: boxing) and how (for example: 5 minutes warm-up including skipping, 30 minutes of boxing with intervals of bodyweight

exercises, 5 minutes cool-down and stretches). The researcher (SMQ) and physical education teacher were present to supervise and facilitate discussions, however, the Project Leaders ultimately decided what activities were delivered. If there was not a consensus on what activity would be undertaken, Project Leaders would vote, however, given the number of classes to be delivered, if one activity was chosen over another, the Project Leaders usually agreed to deliver the other activity the following week. Table 7 outlines when the 21 behaviour change techniques were employed during this intervention trial. At the start of each phase (week 1 and week 8), the recipients were encouraged to set a goal to attend each week and were informed of the potential rewards for participation, i.e., a signed 'Girls Active Project' certificate and entries into a raffle to win prizes, including €20 vouchers. The 'class plan' template and certificates can be found in Appendix D. Procedures to standardise delivery were used (Bellg et al., 2004) and a general class structure was followed:

a) welcome and introductions made to intervention recipients and mention the purpose of the GAP programme.
b) intervention recipients given a chance to contribute and ask questions.
c) exercises explained and demonstrated, and intervention recipients given a chance to practise the exercises.
d) intervention recipients congratulated for participating and reminded about next week's class.

It was not mandatory for the students to have their cameras on during online classes (phase one). If Project Leaders preferred not to deliver the class with their cameras on, a suitable YouTube exercise video was chosen instead. A physical education teacher was present to offer any modifications to exercises if required. Researcher (SMQ) attended each class to assist in supervision and if needed, offer encouragement and consultation to Project Leaders.

Table 7: The Behaviour Change Techniques employed during the Girls Active Project intervention trial (Michie et al. 2014)

Behaviour Change Technique	Week 1_Class 1: H.I.I.T.	Week 2_Class 2: Dance	Week 3_Class 3: Boxing	Week 4_Class 4: Dance	Week 8_Class 5: Boxing	Week 9_Class 6: Football	Week 10_Class 7: Basketball	Week 11_Class 8: Dance
Goal setting (behaviour)	X				X			
Action planning	X	X	X	X	X	X	X	
Monitoring of behaviour by others without feedback	X	X	X	X	X	X	X	X
Social support (practical)	X	X	X	X	X	X	X	X
Social support (emotional)	X	X	X	X	X	X	X	X
Instruction on how to perform a behaviour	X	X	X	X	X	X	X	X
Information about health consequences	X	X	X	X	X	X	X	X
Monitoring of emotional consequences	X	X	X	X	X	X	X	X
Demonstration of the behaviour	X	X	X	X	X	X	X	X
Prompts/cues	X	X	X	X	X	X	X	X
Behavioural practice/rehearsal	X	X	X	X	X	X	X	X
Habit formation	X	X	X	X	X	X	X	X
Generalisation of a target behaviour	X	X	X	X	X	X	X	X
Credible source	X				X			
Material incentive (behaviour)	X				X			
Material reward (behaviour)				X				X
Non-specific reward								X
Social reward	X	X	X	X	X	X	X	X
Non-specific incentive	X				X			
Restructuring the social environment	X	X	X	X	X	X	X	X
Verbal persuasion about capability	X	X	X	X	X	X	X	X

Data collection

Quantitative and qualitative data were gathered to assess intervention feasibility. All data collection tools used can be found in Appendix D.

Questionnaires

Recipients were asked to complete a self-reported questionnaire (Appendix D) at every data collection time-point (week 1, week 8 and week 12). The questionnaire was piloted and modified with the students who co-designed the intervention (McQuinn et al., 2022) to ensure there was no ambiguity in the questions and to identify any potential problems the recipients might experience. At baseline, recipients were asked to complete the questionnaire at home online (week 1, phase one), via a link to a Qualtrics (Qualtrics, 2021) questionnaire or on paper (week 8, phase two) administered by the researcher (SMQ) during agreed scheduled school hours. This included a short demographic section capturing date of birth, nationality, disability status and the name of the street they lived on. Street names were mapped against a publicly available 'Deprivation Indices' (Pobal, 2021) for Ireland, that identifies underprivileged areas by estimating deprivation on an 8-point scale (1= extremely affluent to 8= extremely disadvantaged) (Pobal, 2021).

Self-reported outcome measures were captured at every data collection time-point; week 1 (phase one baseline), week 8 (mid-intervention and phase two baseline), and week 12 (post-intervention). MVPA levels were measured using the PACE+ scale (Prochaska et al., 2001). This short two-item PA questionnaire is used to assess the attainment of PA guidelines, i.e., an average of 60 minutes a day of MVPA (Bull et al., 2020). This scale has been previously validated (Hardie Murphy et al., 2015) against accelerometery in a sample of 10-18 year old Irish youth ($r = 0.34$; ≥5 valid days). Validity was higher in females ($r = 0.39$; males $r = 0.27$) and increased with age (post-primary $r = 0.39$; primary $r = 0.24$) using ≥5 valid days. Moreover, this scale has been used with adolescents both nationally (Woods et al., 2018) and internationally (Currie et al., 2014). Clear instructions on how to accurately measure height and weight were obtained from the national Children's Sport Participation and Physical Activity (CSPPA) study (Woods et al., 2018). These instructions were provided in written form to each recipient asking them to accurately measure and take note of their height (to the nearest cm) and weight (to the nearest .1 kg) at home. Self-rated health and life satisfaction instruments were previously used in the WHO Health Behaviour in School-aged Children study (Currie et al., 2014). Recipients rated their health from 1, 'poor' to 4, 'excellent'. Life

satisfaction was measured using a slightly adapted version of the one-item scale, Cantril ladder (Cantril, 1965) to facilitate its use with youth. Recipients rated where on the ladder they felt at that moment, from 0, 'worst possible life' to 10, 'best possible life'. A previously validated standardised measure of PA self-efficacy (Motl et al., 2000) with adolescent females (Dishman et al., 2010, 2002; Motl et al., 2000) was used that consisted of eight statements (e.g., "I can be physically active during my free time on most days") rated on a 5-point Likert scale (1: Disagree a lot, to 5: Agree a lot). A score was computed by calculating the average of the eight items. PA enjoyment was measured using the Physical Activity Enjoyment Scale (PACES) for use with young adolescent females (Motl et al., 2001). This previously validated instrument (Carraro et al., 2008; Dishman et al., 2010; Moore et al., 2009; Motl et al., 2001) includes 16 different (positive or negative) statements, (e.g., "When I am active… I enjoy it.") rated on a 5-point Likert scale (1: Disagree a lot, to 5: Agree a lot). A score can be computed by calculating the average of the 16 items (Moore et al., 2009) or reversing negative item scores and summing them to positive item scores (Carraro et al., 2008) where total enjoyment scores can range from 16 to 80 (maximum enjoyment). Data completion rates are expressed as overall percentages. The mean scores, standard deviations and ranges for each measure are also presented to provide context.

Self-reported feedback questionnaires were developed by the authors to capture stakeholder experiences with various aspects of the intervention. This feedback questionnaire was integrated into the recipients questionnaire at week 8 (mid-intervention) and week 12 (post-intervention). A 5-point Likert scale, (1: Dislike very much, to 5: Like very much) was used to assess recipients' satisfaction with the programme. A predetermined mean score of $\geq$3.5 out of 5 was considered feasible (Corr et al., 2020). Recipients were asked to rate factors influencing participation, such as 'my friends', using a 5-point Likert scale, (1: Not at all, to 5: Extremely). Perceived sustainability was assessed by asking recipients if they would like the programme to remain in the school, and if they would continue to participate if it did. Recipients were also asked to share opinions on how to improve the programme. Project Leaders were asked to complete a similar feedback questionnaire at post-intervention (week 12).

A total of 20 parents/guardians participated in the online questionnaire (n=20, response rate: 26%). It took approximately 6 minutes to complete (Appendix D). Parents/guardians of second-year students were asked to explain why they thought their daughter did or did not participate, if they would like for the programme to remain as an option for students attending the school and provide suggestions on what the school could do to make it easier for them as a

parent/guardian to enable their daughter to participate. Parents/guardians of intervention recipients indicated their daughter's satisfaction with the programme by rating various statements, (e.g., my daughter enjoyed participating in the GAP) using a 5-point Likert scale (1: Disagree a lot, to 5: Agree a lot).

Attendance and delivery self-reported provider checklists

Student attendance was recorded and monitored by the physical education teacher and researcher (SMQ). Project Leaders were asked to complete a short (approximately 3-minutes) self-reported provider checklist ('Project Leader logbook') online using a Qualtrics (Qualtrics, 2021) questionnaire after each class that they attended (Appendix D). Project Leaders received weekly reminder emails to complete the self-reported provider checklist. The delivery self-reported provider checklist contained an implementation checklist that was developed by the authors. The checklist assessed if the class aims, based on the behaviour change techniques (Table 7) were delivered that day. A total of 38 self-reported provider checklists were requested. Intervention fidelity was measured via the degree to which the treatment (exercise classes) were delivered as intended by Project Leaders. Levels of fidelity previously reported in the literature were applied, with 80%–100% interpreted as 'high' fidelity, 51%–79% as 'moderate' and 0%–50% as 'low' fidelity (Borrelli et al., 2005; Garbacz et al., 2014; Perepletchikova and Kazdin, 2005; Toomey et al., 2017). This study aimed for a benchmark of 80% fidelity. Total fidelity is expressed as an average of the class aims being delivered across the eight exercise classes.

Semi-structured focus groups and interviews

Four semi-structured focus groups occurred during school hours, two with intervention recipients and two with Project Leaders (week 8 and week 12) lasting approximately 20 minutes (range: 17-26 minutes). Two parents/guardians participated in a semi-structured phone call interview, lasting on average 9 minutes (range: 7-11 minutes). These interviews were intentionally designed and specifically promoted as being short with the intention of increasing parental/guardian engagement. Despite being short, the questions asked complemented the parent/guardian questionnaire and addressed study objectives. Semi-structured interviews with the three school staff members occurred on school grounds at post-intervention lasting on average 26 minutes (range: 20–33 minutes).

Topic guides (Appendix D) used for the focus groups and interviews were developed by the authors and aimed to explore stakeholders' satisfaction with the GAP programme, its

perceived sustainability in the school and to identify any contextual factors that may have affected implementation. Stakeholders revealed what they liked and disliked about the programme, reasons for participation and provided recommendations for future implementation. Each semi-structured focus group and interview was audio-recorded and hand-written notes were taken by the researcher (SMQ). The audio-recordings were transcribed verbatim and pseudonyms were assigned to protect participant identity.

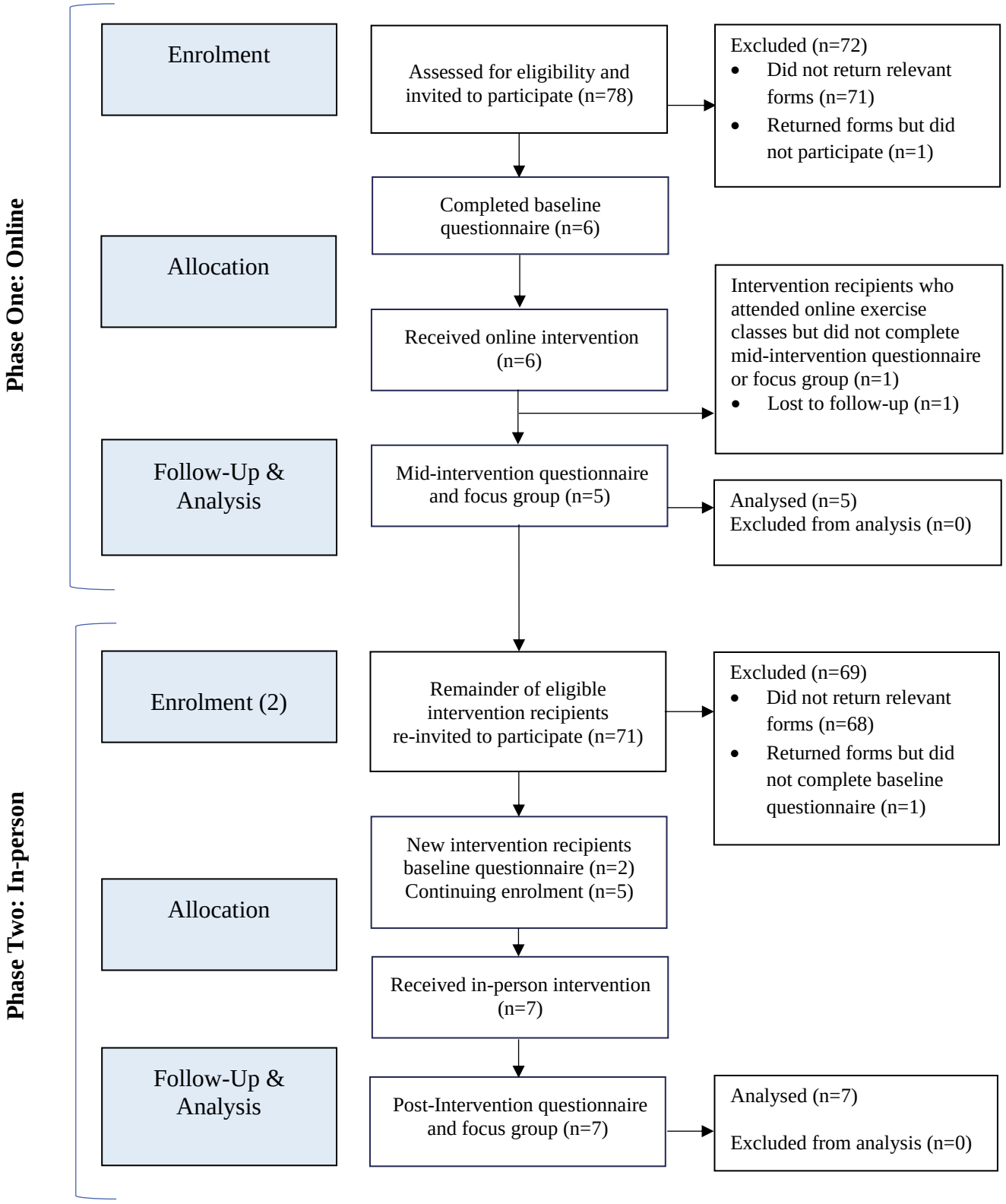
Data analysis

Descriptive analyses were performed using the Statistical Package for Social Sciences (SPSS) version 25. Each proposed outcome measure is represented by a mean score, as well as a rate of completion. Focus group and interview transcripts were analysed using a six-step thematic approach (Braun and Clarke, 2006). Initially, each transcript was read and re-read several times by the researcher (SMQ) who developed a sample coding frame. These coded transcripts were reviewed by the remaining authors (SJB, AS and MRS). The coding frame was refined iteratively by SMQ, SJB, AS and MRS with subsequent discussions. Anonymised illustrative quotes supporting emerging themes were highlighted and agreed by researchers.

6.4 Results

Enrolment, who participated and why? (Objective 1)

Figure 10: Flow chart of intervention recipients through this study based on the CONSORT 2010 flow diagram



A total of ten second-year students returned the relevant documents to take part. Of which, eight completed the baseline questionnaire (six at week 1 and two at week 8) and participated in the intervention (*n=8/78*, 10.3%). One student who consented did attend, but was absent on both days of data collection. Another student did not respond to emails and was eventually lost to follow-up. Seven recipients completed data collection at week 12, post-intervention (*n=7/8*, 87.5%). During the in person delivered classes (phase two), the physical education teacher and researcher (SMQ) observed that additional second-year students attended, yet failed to return the necessary documents to participate in data collection. Of the eight recipients who did complete the baseline questionnaire, the mean age was 13.25 (range: 13-14, SD: .46), all of Irish nationality (*n*=8, 100%) and with no reported disability (*n*=8, 100%). The deprivation indices based on home street addresses, ranged from 'disadvantaged' to 'very disadvantaged' (Mean: 6.4, range: 6 'disadvantaged' to 7 'very disadvantaged', SD: .52).

Facilitating factors that influenced participation shifted between both phases of the intervention. Improving health and well-being and challenging oneself were the highest rated factors in phase one (Mean:4.8, SD: .45), whereas being with others was the number one facilitator (Mean: 4.8, SD:.45) during phase two, followed by wanting to be physically fit (Mean: 4.40, SD:.89). Fun, enjoyment and socialising with peers were identified as key motivators, "*that's why I did it, I just went, and I actually really liked it because it's a nice way to spend time with the girls as well"* (Intervention recipient I, post-intervention focus group). Other facilitators to participation included the desire to feel like they've achieved something and the lack of alternative options during the COVID-19 pandemic. Most parents/guardians believed their daughter participated to improve health and fitness *"she wanted to get more active and to be more involved in after school activities"* (Parent K, post-intervention questionnaire), and to spend time with peers *"I think she participated because she enjoys trying out new things and hanging out with her friends"* (Parent J, post-intervention questionnaire). Of less concern, recipients scored the 'Girls Active Project' certificate (Mean: 1.80, SD: 1.30, phase one) and family (Mean: 2.0, SD: 1.23, phase two) as the lowest motivating factors. Recipients scored the rewards, including vouchers, as a 'slightly' motivating factor in both phases of the intervention (Mean: 2.8, SD:.45, phase one Vs Mean: 2.4, SD: .89, phase two). Despite the Project Leaders deeming the rewards a success, *"I think they were amazing. I think they enjoyed it, and they definitely appreciated it. They were like 'I got a voucher for doing something I actually enjoyed', and then they were like I'm going to keep doing that"* (Project Leader B, post-intervention focus group),

recipients described the rewards as just a *"bonus",* and not a leading factor influencing involvement.

Attendance, and was the intervention implemented as intended? (Objective 2)

Project Leaders delivered eight exercise classes and all planned behaviour change techniques were employed. No adverse events were reported. On average, providers attended 79% of classes (71% phase one Vs 87.5% phase two). Attendance was slightly lower for recipients (68%) with no significant difference found between phase one (67.8%) and phase two (68.7%). A total of 31 delivery self-reported provider checklists (15 at phase one and 16 at phase two) out of a possible 38 were completed (82% completion rate). On average, most of the exercise classes started on time (94%) and were delivered as planned (87%), *"We gave the class the exact plans as we did in our head, it was great, everyone cooperated brilliantly!'* (Project Leader F, written extract from Logbook phase two). Project Leader absence or an unrelated injury were cited as reasons why a class was not delivered as planned. The implementation checklist results are presented in Table 8. On average, 87% of the aims were delivered (89% phase one Vs 86% phase two). During phase one, Project Leaders believed the recipients were practising the exercises (aim 5), although said it was difficult to judge because some recipients had their cameras off, *"I think they were actually doing it, but they were just embarrassed"* (Project Leader A, mid-intervention focus group).

Table 8: Implementation checklist responses based on Project Leaders self-reported provider checklists

Class aim	Phase one: online (15 logbooks)	Phase two: in-person (16 logbooks)	Total intervention (31 logbooks)
1. **Welcome and introductions were made**	100% yes	100% yes	100% yes
2. **Purpose of the girls active project was mentioned**	93% yes	69% yes	80% yes
3. **Recipients were given a chance to contribute to the discussion and ask questions**	93% yes	100% yes	97% yes
4. **Exercises were explained and demonstrated**	93% yes	88% yes	90% yes
5. **Recipients were given a chance to practice the exercises**	50% yes	75% yes	63% yes
6. **Recipients were congratulated for joining the class and encouraged to be active**	100% yes	94% yes	97% yes
7. **Recipients were reminded about next week's class**	93% yes	75% yes	83% yes
Total fidelity	**89%**	**86%**	**87%**

*Options: Yes/No/Unsure

Are the proposed outcome measures feasible? (Objective 3)

On average, the rates of completion for the self-reported outcomes were high at 90%. Table 9 provides a summary of the outcome data and completion rates at the three data collection timepoints. Weight (kg) and height (m) data were completed the least by recipients at 50% and 80%, respectively. Completion of MVPA levels, self-rated health, life satisfaction and PA self-efficacy were 100% at all data collection timepoints.

Table 9: Measure completion and scores for proposed self-reported outcome data

Measure	Week 1: Baseline (phase one), Online			Week 8: Mid-intervention and Baseline (phase two), paper-based			Week 12: Post-intervention, paper-based			Overall
	Mean (SD)	**Range**	**Percent completed**	**Mean (SD)**	**Range**	**Percent completed**	**Mean (SD)**	**Range**	**Percent completed**	**Percent completed**
MVPA (7 days)	3.75 (1.9)	0-5 days	100 (6/6)	4.1 (1.7)	1 – 7 days	100 (7/7)	4.0 (1.6)	1 – 7 days	100 (7/7)	**100 (20/20)**
Height (m)	1.61 (.07)	1.49 – 1.68	100 (6/6)	1.65 (.04)	1.60 – 1.70	57 (4/7)	1.65 (.03)	1.60 – 1.70	86 (6/7)	**80 (16/20)**
Weight (kg)	51.1 (8.5)	44.4 – 66.0	100 (6/6)	55.6 (14.7)	45.2 – 66.0	29 (2/7)	53.0 (2.8)	51.0 – 55.0	29 (2/7)	**50 (10/20)**
Self-rated health	3.5 (.55)	3 – 4	100 (6/6)	3.3 (.76)	2 – 4	100 (7/7)	3.3 (.76)	2 – 4	100 (7/7)	**100 (20/20)**
Life satisfaction	8.0 (1.3)	7-10	100 (6/6)	7.0 (2.3)	3 – 10	100 (7/7)	7.0 (2.3)	3 – 10	100 (7/7)	**100 (20/20)**
PA self-efficacy	4.1 (.42)	3.4 – 4.5	100 (6/6)	4.0 (.70)	2.9 – 4.5	100 (7/7)	4.1 (0.78)	2.9 – 4.9	100 (7/7)	**100 (20/20)**
PA enjoyment	68.2 (13.3)	45 - 79	100 (6/6)	73.5 (7.8)	60 - 80	86 (6/7)	74.6 (4.5)	69 - 80	100 (7/7)	**95 (19/20)**

Abbreviations: SD (Standard Deviation); MVPA (Moderate to Vigorous Physical Activity); M (Metre); Kg (Kilogram); PA (Physical Activity)
Scale scores: MVPA (0-7 days); Height (metre); Weight (Kilogram); Self-rated health (1: 'Poor' to 4: 'Excellent'); Life Satisfaction (0: 'worst possible life' to 10: 'best possible life'); PA self-efficacy (average of 8 items on a 5-point Likert scale, 1: Disagree a lot, to 5: Agree a lot); PA enjoyment (total scores range from 16: lowest, to 80: maximum enjoyment).

Were the stakeholders satisfied with the intervention? (Objective 4)

Satisfaction levels reported by intervention recipients and Project Leaders at mid-intervention (week 8) and post-intervention (week 12) for each aspect of the programme are presented in Table 10. Overall satisfaction rates for both recipients and Project Leaders indicated high acceptability of the intervention. Two aspects of the intervention achieved a mean score of < 3.5 out of 5, and thus considered not feasible. This included the intervention '*being online'* (Mean: 3.4, SD: .55) and Project Leaders *'completing the weekly self-reported provider checklists'* (Mean: 3.3., SD: . 1.0).

Table 10: Satisfaction levels reported by intervention recipients and intervention providers on aspects of the Girls Active Project programme at mid-intervention and post-intervention

Aspect of the Girls Active Project intervention	Intervention recipients (n=5)		Intervention recipients (n=7)		Intervention providers (n=6)		Categorisation*
	Week 8: mid-intervention (phase one)		Week 12: post-intervention (phase two)		Week 12: post-intervention (Overall)		
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	
Organisation	4.6 (.55)	4-5	5.0 (.00)	5-5	4.3 (.82)	3-5	Feasible
Class duration	4.6 (.55)	4-5	5.0 (.00)	5-5	4.2 (.41)	4-5	Feasible
Dates of delivery	4.8 (.45)	4-5	4.7 (.76)	3-5	4.0 (1.1)	2-5	Feasible
Start and end time	4.8 (.45)	4-5	5.0 (.00)	5-5	3.5 (.55)	3-4	Feasible
Variety of activities	4.4 (.89)	3-5	4.9 (.38)	4-5	4.8 (.41)	4-5	Feasible
Delivery of activities (Project Leaders)	4.8 (.45)	4-5	4.9 (.38)	4-5	NA	NA	Feasible
Information provided	4.6 (.55)	4-5	4.6 (.79)	3-5	NA	NA	Feasible
It being online	3.4 (.55)	3-4	NA	NA	NA	NA	Not feasible
It being in-person	NA	NA	5.0 (.00)	5-5	NA	NA	Feasible
Being a leader delivering the classes	NA	NA	NA	NA	4.8 (.41)	4-5	Feasible
Completing the weekly self-reported provider checklists	NA	NA	NA	NA	3.3 (1.0)	2-5	Not feasible
Working as part of a team	NA	NA	NA	NA	4.7 (.52)	4-5	Feasible
Overall satisfaction	5.0 (.00)	5-5	4.7 (.76)	3-5	4.7 (.52)	4-5	Feasible

Abbreviations: SD (Standard Deviation), NA (Not Applicable)
Scale scores: 5-point Likert scale (1: Dislike very much, to 5: Like very much)
*a predetermined mean score of ≥3.5 out of 5 was considered feasible

Seven parents/guardians of second-year students answered 'yes' to their daughter taking part in the intervention (*n*=7/15, 47%). Most agreed that their daughter: enjoyed the programme (Mean: 4.7, SD:.82, range: 3-5); liked that it was peer-led (Mean: 4.4, SD: .89, range: 3-5) and offered variety (Mean: 4.6, SD: . 55, range: 4-5); and liked the timing, dates and duration of the classes (Mean: 4.8, SD: . 50, range: 4-5).

Overall, the qualitative data also suggested that stakeholders were satisfied with the intervention. Both recipients and Project Leaders preferred the intervention delivered in-person, *"it went a lot better than I thought it would online, but I preferred it face-to-face"* (Project Leader B, post-intervention focus group). Project Leaders did not indicate any dissatisfaction with completing the self-reported provider checklists, *"Just the survey? Oh, that was fine, got that done in like 5 minutes"* (Project Leader D, post-intervention focus group). For one Project Leader, the timing and dates coincided with other commitments, however they recognised that *"it's really hard to find a time that suits everyone"* (Project Leader E, post-intervention focus group). Project Leaders enjoyed working with peers, learning new skills *"we learned how to take initiative, like if stuff goes wrong, we adapted and planned different classes and stuff"* (Project Leader A, post-intervention focus group) and their leadership role, *"it gave us a leadership role in the school for sure. It made you feel*

included, and it made you feel like you had a place to go after school where everyone had the same interests, and you were all there for the same reason" (Project Leader D, post-intervention focus group). To improve intervention acceptability, Project Leaders recommended to extend class-duration and provide extra time at the start of the class to setting-up, *"we could try set up everything before second years* [recipients] *arrive so that we are prepared, and it doesn't take up class time"* (Project Leader E, feedback questionnaire). Additional promotional activities from the school to encourage participation was also suggested, *"the school didn't really like promote it that much, like they could have posted it more and put it on the Instagram pages, I think that would have of like helped more people come"* (Project Leader A, post-intervention focus group).

Recipients disliked that not many students enrolled and equally, suggested that the school further promote the GAP programme through weekly reminders, more posters and announcements via the school intercom and social media posts, *"put up a few pictures or a link or if there was a little video put together of what one class is literally like"* (Intervention recipient D, post-intervention focus group). Recipients described how they enjoyed the exercise classes because they got to spend time with friends, relieve stress, didn't feel judged and liked that the Project Leaders were close in age. They also expressed their satisfaction with the variety of activities offered as it introduced them to new activities, *"they're things that like I wouldn't pick myself but then when I done it, it was good"* (Intervention recipient B, mid-intervention focus group) and kept it fun, *"if it was the same every week, it would just get boring like"* (Intervention recipient C, post-intervention focus group). In the phone call interview, one parent/guardian described how it was the variety that attracted her daughter to participate, "*it was because you were doing a bit of something different every week. That's what made her, that's what appealed to her"* (Parent 2, interview). Both parents/guardians suggested additional encouragement from the school would increase participation and improve its acceptability, "*I suppose if they could point out that it was more fun than anything, you know? It wasn't like it was work"* (Parent 2, interview).

School staff members also liked that the programme provided students with an opportunity to try new activities, *"I think when you give those opportunities then of doing a variety of things where they get the opportunity to try them out, it's huge because then that could be their thing that they actually go on to do"* (School staff member A, interview). They believed the students involved enjoyed it, "*you can see them laughing and joking, and that's what I liked about it, it's simple and effective and they come away from it happy"* (School staff member B, interview) and particularly liked that, unlike many other extra-curricular PA programmes, the

emphasis wasn't on competition or performance, *"it was about getting involved and just enjoying physical activity, which I really enjoyed that aspect of it"* (School staff member C, interview). Staff members expressed satisfaction with the intervention being peer-led "*it's great because I think we have students that have a great ability to lead and they obviously look up to each other, especially the younger years to the older years"* (School staff member A, interview) and cited many positive impacts the intervention had on the students involved, alongside being active, such as socialising, gaining a sense of belonging, and particularly for Project Leaders, feeling trusted and developing skills.

To enhance intervention acceptability, staff members recommended extending class duration from 45 minutes to one-hour, creating more reminders and introducing different rewards to maintain student involvement, such as a 'Girls Active Project' t-shirt. Staff members considered the intervention acceptable yet were open to modifications, *"I think as it goes on in the future, we'll see where it can be developed as well when it's more established in the school. And then if there are tweaks and things that need changing, we could do it then"* (School staff member C, interview).

Was the intervention perceived as compatible with this school-setting? (Objective 5)

All Project Leaders (100%, *n*=6/6), most parents/guardians (92%, *n*=12/13) and most recipients (80%, *n*=4/5 phase one Vs 85.7%, *n*=6/7 phase two) wanted the programme to remain in the school. Project Leaders perceived the programme as an appropriate fit, *"I loved it and it would be a great thing to keep in the school"* (Project Leader C, feedback questionnaire) with six of them (100%, *n*=6/6) reporting that they would recommend becoming a Project Leader to other students *"I would definitely recommend it as it is an amazing, fun and rewarding experience and not only does it develop your fitness skills, but your leadership ones also"* (Project Leader E, feedback questionnaire). More recipients reported that they would continue to participate if it were delivered in person than online (85.7%, *n*=6/7 phase two Vs 60%, *n*=3/5 phase one). During the post-intervention focus group, some of the recipients explained how they never participated in other after-school PA programmes because they perceived them to be competitive in nature. If given the chance, however, they would continue to participate in the GAP programme because it was significantly less competitive, *"this was a lot more chill"* (Intervention recipient C, post-intervention focus group). Likewise, staff members acknowledged how the programme attracted students that were not usually engaged with extra-curricular PA programmes, *"it's the same girls all the time doing the same sports, whereas the GAP actually opens up exercise*

to a bigger cohort because you're not attracting the same people, which is good" (School staff member B, interview). They perceived this as important as it offered an opportunity for the 'non-competitive' students to engage with PA, *"the non-competitive people, they need to have something. I mean, those are the people you're trying to keep involved and to get active, so yeah, absolutely, I think it* [the GAP programme] *needs to be as fundamental as the other sports, 100%"* (School staff member A, interview). School staff members were optimistic about the intervention's long-term potential in the school. One staff member believed it was less administratively demanding and required limited involvement in terms of class delivery when compared to other after-school PA programmes, *"it's easier. I think it gets better results for less time. So, why wouldn't you do that?"* (School staff member B, interview). The perceived sustainability of the intervention was also influenced by student enjoyment, *"I think it's also far more likely that they continue doing physical activity if it's enjoyable in the first place. So, as a lifelong learning thing, I think it's far more sustainable, even than playing on the school team, because lots of people do that for a year or two and then they drop off anyway even if they were sporty. So, from the point of view of enjoyment and doing it from a health promoting point of view, I think this was far more sustainable and I think they're likely to go with it"* (School staff member C, interview).

What were the external factors that affected intervention implementation? (Objective 6)

Barriers. There were external barriers to recruitment. Stakeholders acknowledged that employing recruitment strategies was difficult due to the COVID-19 pandemic, especially during school closure, *"it's extremely hard to do in COVID. Besides emailing and telephone calling, and getting them to talk to their friends like, they're not in school"* (School staff member B, interview). Recruiting and engaging students online was identified as a barrier, *"initially it had to be online you know, and that doesn't really work for a lot of our students, as we learned"* (School staff member C, interview). Staff members stated that many students did not attend compulsory academic classes online, therefore anything extra-curricular was considered increasingly challenging. Additionally, Project Leaders suggested that the intervention being online was a barrier to enrolment, *"you're tired from doing online school and then you just want to take a break after it, and then it's hard to go back online to do it"* (Project Leader A, post-intervention focus group). Recipients reported homework and distinct to phase one (online), failing to remember *"quarantine brain got the best of everyone"* (Intervention recipient B, mid-intervention focus group) as barriers to participation.

The COVID-19 pandemic continued to affect intervention implementation during phase two (in-person). Project Leaders felt constrained, *"even now in school we're limited in what we can do because of Corona"* (Project Leader B, mid-intervention focus group). The eight parents/guardians of second-year students whose daughter did not take part in the intervention (*n*=8/15, 53%) listed homework, other commitments such as music, a dislike for after-school activities, and anxiety and fears surrounding the COVID-19 pandemic as barriers to enrolment, *"she is finding it hard to settle back into school since lockdown, with her anxiety of school"* (Parent B, questionnaire).

Facilitators. In contrast to the above, some recipients also considered the COVID-19 pandemic as an external facilitator to enrolment due to the lack of other PA options available, *"like this was definitely a good option like you know what I mean, something to do when everything else was closed"* (Intervention recipient A, mid-intervention focus group). Project Leaders could also recognise COVID-19 as a facilitator to enrolment, *"loads of the places weren't open at the time to go and do your exercises"* (Project Leader D, post-intervention focus group). Staff members identified the school reopening (phase two, April 2021 post-lockdown) as an external factor that positively affected intervention implementation as it allowed for the "word of mouth" recruitment strategy to be implemented, *"the numbers definitely increased over the weeks and when they'd be in class talking, they'd talk to each other and encourage each other to go, which is… that's huge"* (School staff member B, interview). Staff members believed that with time, enrolment into the in-person delivered PA programme would have increased. Other identified facilitators included: stakeholder buy-in, via the schools' steady support and commitment, including use of the online platforms and sport hall facilities; the positive working relationship and regular communication with the research team; and the Project Leaders, *"they're confident students, they're enthusiastic. So, you know, that's a huge strength in a way"* (School staff member A, interview).

6.5 Discussion

This paper presents the reach, dose, fidelity, acceptability and compatibility of the school-based GAP intervention programme, data completion rates of proposed self-reported outcome measures and identifies challenges to implementation. The peer-led, after-school PA programme was trialled for the first time over a 12-week period with disadvantaged adolescent females in a single-sex, female-only, designated disadvantaged post-primary school in Ireland during the COVID-19 pandemic. To date and to our knowledge, no other peer-led after-school adolescent PA intervention trials were reported on or registered online

during this time. This study encountered significant contextual barriers and challenges with recruitment. Results, however, indicated the intervention was implemented as intended and was deemed acceptable and compatible with the school setting. The following paragraphs discuss the strengths and challenges of this trial, and provide recommendations for future research.

Strengths

Retention rates were high, providing support for the feasibility of this trial. Peers, enjoyment, improving health and fitness, and the wide-variety of activities offered were regarded as essential for initiating and maintaining interest. The self-reported provider checklists signified that the exercise classes were delivered with high fidelity (>80%) suggesting that the intervention was delivered as intended. These results, however, must be interpreted with caution since, as often required (Maynard et al., 2013), the fidelity measures used were developed specific to this intervention, making it difficult to use valid and reliable fidelity measures. The average dose received by recipients (68%) compared positively to similar feasibility studies on after-school PA interventions for adolescent females, such as the Girls - Peer Activity (G-PACT) Project (Owen et al., 2018) which recorded an average of 40% and 47% attendance in each 'Class' and 'Choice' school, respectively, and the Bristol Girls Dance Project (Jago et al., 2012) with an average of 13.3 sessions attended out of a maximum of 18 (74%). Previous reviews (Demetriou et al., 2017; Messing et al., 2019) on after-school PA programmes have emphasised the importance of high programme attendance rates as the effectiveness of a programme strongly depended on attendance. In general, completion rates for the proposed self-reported outcome measures were high. This demonstrated recipients' comprehension of the proposed measures and could indicate the feasibility of using these outcome measures in a future study.

Positive stakeholder responses were particularly welcome, given the unprecedented circumstances of the COVID-19 pandemic during intervention implementation. Consistent with previous school-based PA interventions for adolescent females (Gorely et al., 2019; Jenkinson et al., 2012), the stakeholders in this study acknowledged the programme's potential to engage inactive students and provide an alternative option to students who may not be attracted to the competitive and performance-focused nature of traditional extra-curricular PA programmes. The stakeholders also recognised the positive impact the programme had on the students involved, alongside being active, such as skill development, which is likely to have implications for ongoing delivery. The benefits associated with being a

student peer ‘mentor’ or ‘leader’ have been documented in past peer-led PA interventions (Glazzard et al., 2021; Gorely et al., 2019; Jong et al., 2020).

Recent findings support the use of online interventions to encourage adolescents engagement with PA (Goodyear et al., 2021), however, given that the GAP programme was designed and intended to be delivered in-person after-school in the school setting, it was perhaps unsurprising that the in-person delivered programme (phase two) was deemed more acceptable than online (phase one). Nonetheless, the findings from the online delivered intervention, could be used to inform interventions of this kind in future pandemics. Since time and staff availability are recognised barriers to the implementation of PA policies in schools (Nathan et al., 2018), it was promising to discover that this peer-led intervention was considered easier to manage and less administratively demanding than other extra-curricular PA programmes. High intervention compatibility was also likely to be due to the co-design work (McQuinn et al., 2022) previously conducted with students in the school. Importantly, this process enabled the programme to be embedded within the school curriculum and allowed for Project Leaders’ time to contribute towards the already established ‘Gaisce’ award (Department of Children, Equality, Disability, Integration and Youth, 2020). Steady support and commitment from the school, and the enthusiastic Project Leaders were cited as factors that helped intervention implementation. This highlighted the importance of stakeholder buy-in, as found in previous school-based PA initiatives (Belton et al., 2020; Corder et al., 2021). Finally, tailoring interventions to the individual school context is important for scaling up (Corder et al., 2021; Sutherland et al., 2021). Stakeholders’ willingness to modify the intervention suggested that they were engaged and felt empowered to tailor the programme to suit their context. This in itself is a positive finding.

Challenges

Despite two rounds of recruitment, enrolment was low. Recruitment is crucial to the success of research programmes as high enrolment rates demonstrate that the programme reached the population for which it was designed. Adolescent females, particularly from disadvantaged groups (Bonevski et al., 2014; Withall et al., 2011) however, can be a difficult population to reach. The challenges of recruiting adolescent females into PA interventions have been recognised in previous research (Edwards et al., 2016; Jago et al., 2011; Owen et al., 2018). Despite the fact that the rewards used in this study (certificates and vouchers) were selected by students in the co-design process (McQuinn et al., 2022), recipients did not in actuality perceive these rewards as strong motivators influencing participation.

This study encountered additional contextual barriers to recruitment attributable to the COVID-19 pandemic. Employing recruitment strategies during school closure (phase one) was difficult given students were not present in school and the lack of engagement with 'online school'. Another factor which may have proven to impact recruitment is that after-school PA programmes are often available to all students in the school, or split into Junior (first, second and third-year students aged 12-15) and Senior Cycle (fourth, fifth and sixth-year students aged 15-18). As previously discussed, just one year group was invited to take part in this study. This would be unusual school practice, and could have made the recruitment process more difficult. It was observed that additional students attended the in person programme (phase two) yet failed to return the relevant documents to participate in data collection. The perceived burden of returning documents could be a reason for this. Student absenteeism was a barrier to data collection identified in this study. A future trial could encounter similar challenges given that evidence suggests lower SES is associated with higher levels of absenteeism at school among adolescent females (Sosu et al., 2021).

The two proposed self-reported outcome measures least completed by recipients were weight and height data. This could indicate that despite the detailed written instructions provided, requesting recipients to record these measurements at home and complete the questionnaires at school was not feasible. Project Leaders deemed completing weekly self-reported provider checklists as unfeasible in the feedback questionnaires, however they did not indicate any dissatisfaction with the task in the focus groups. The online programme (phase one) was also deemed unacceptable by intervention recipients. Most stakeholders agreed that phase one (online) went better than anticipated, but found phase two (in person on school grounds) more acceptable and sustainable. This unique aspect to the study was necessary due to school closure resulting from the COVID-19 pandemic. Ultimately, similar to O'Kane et al. (2021) who reported challenges with remote data collection during COVID-19 lockdown (O'Kane et al., 2021), phase one of this current study (online) was largely dependent on students' engagement with home learning.

Recommended refinements

Low enrolment rates in this study could suggest current recruitment strategies were ineffective, thus further work is required to develop and test recruitment methods. This could involve co-designing strategies with students, parents and school staff to ensure the revised strategies are relevant, acceptable and practical. The "word of mouth" campaign used in phase two was considered valuable by stakeholders in this study, however, students recommended

to further boost programme awareness via school announcements and additional posts on social media, including short videos. Similar to Jago et al. (2011), stakeholders in this study recommended extra emphasis on enjoyment of classes when pitching the programme to increase participation (Jago et al., 2011). Using a parental/guardian passive (opt-out) approach has allowed for greater recruitment of adolescents in previous low-risk, non-intrusive, school-based PA interventions (Corder et al., 2021; Corepal et al., 2019; Gorely et al., 2019; Owen et al., 2018; Sebire et al., 2018), such as the Girls -Peer Activity (G-PACT) (Owen et al., 2018) (94% using passive consent Vs 26% using active consent) and the GoActive programme (Corder et al., 2016a) (78% using passive consent Vs 23% using active consent). This refinement, however, is dependent on ethical approval from the institutional Research Ethics Board, and agreement from the participating school. Another viable approach to recruitment (Jago et al., 2011) includes providing females the opportunity to sample an exercise class in a 'taster session' before committing to the programme. This could enable students to understand what the GAP programme would involve, without the pressure of signing up.

The motivating factors to participation identified in this study, such as being with others and a desire to improve health and fitness, could also prove useful when revising recruitment strategies for a future trial. Indeed, given that friend involvement can be an important factor affecting PA participation (Mendonça et al., 2014; Salvy et al., 2012), recruiting friend groups could be used as a potential strategy (Edwards et al., 2016; Garcia et al., 2016) to increase recruitment. Other school-based PA interventions have found merit in providing small rewards to facilitate sustained involvement (Jago et al., 2012; Jong et al., 2020), such as sports bags or pens (Jong et al., 2020). One stakeholder in this study suggested using different rewards, such as a 'Girls Active Project' t-shirt. Further work with adolescent females to identify what rewards, if any, are acceptable and desirable is warranted to potentially improve recruitment and retention in a future trial.

As per usual school practice for after-school PA programmes, a future trial, if permitted, should invite additional year groups to take part. Increasing classes to two or more days a week could also improve its effectiveness. Alongside ensuring high programme attendance rates, Demetriou et al. (2017) identified better outcomes for after-school PA programmes when providing sessions on two or more days a week (Demetriou et al., 2017). Proposed strategies to improve research with socially disadvantaged groups, such as using flexible data collection methods (Bonevski et al., 2014) may need to be considered as a means to increase level of participation in data collection. The PA questionnaire used in this study to assess the attainment of PA guidelines had a high completion rate (100%) across all time points, which

could indicate the feasibility of using this self-reported outcome measure in a future study. This approach should be combined with an objective measure, such as accelerometers, to capture PA intensity levels and examine the intervention's potential impact on increasing MVPA levels (Kang et al., 2016; Sylvia et al., 2014).

Given the low completion rate for self-reported weight, a future trial should reconsider using weight and height measures. Body image has been previously cited by adolescent females, especially those with low perceived competence and high weight status, as an internal barrier to PA participation (Corr et al., 2018). In contrast, Demetriou et al. (2017) found that females were more receptive than males to after-school PA interventions that promoted weight control (Demetriou et al., 2017). Further discussions with stakeholders could be beneficial in deciding if to include weight and height (either self-reported and/or objective) measures in a future trial. Additionally, further work with Project Leaders is necessary to revise the delivery self-reported provider checklists to improve acceptability, while future research could assess the feasibility of using direct observation to monitor fidelity. Evidence suggests observational measures (Bellg et al., 2004; Borrelli, 2011; Walton et al., 2017) or using a mixed-methods approach (audio-recordings, direct observation, and self-reported checklists) (Toomey et al., 2017) to assess fidelity of intervention delivery may provide a more insightful understanding of fidelity and its influencing factors. Furthermore, alongside revising recruitment strategies, stakeholders suggested extending class duration from 45 minutes to one-hour, allocating extra time for Project Leaders to set-up at school prior to the exercise class and creating more reminders for recipients to attend class.

Strengths and limitations of this study

There are strengths to this study. This paper contributes to the expanding literature on feasibility studies of school-based PA interventions. Although unintended, the two-phase delivery of the intervention during COVID-19 allowed us to compare feasibility between an online and in-person delivered school-based PA intervention. This feasibility study used a mixed-methods approach and included multiple stakeholders perspectives (i.e., intervention recipients, providers, parents/guardians, physical education teachers and school principal). This allowed us to collect rich meaningful data on feasibility and acceptability of the intervention. Another strength of this study are the learnings and practical recommendations provided for future research.

There are a number of limitations to this study. Although it is acceptable given that this study's primary aim was to evaluate feasibility, this study involved a small sample size and therefore caution in generalisation is warranted. This study did not include an economic evaluation. Assessing the feasibility of using an objective measure (e.g., accelerometers) to capture adolescent MVPA levels was not possible due to school closure and travel restrictions. This study used self-reported PA data, which is dependent on students' recall ability (Kang et al., 2016; Sylvia et al., 2014). While many of the evaluation tools used in this study allowed for specificity, a limitation of this approach is the lack of evidence for the reliability or validity of the scores that such scales generate. This limitation has been acknowledged in similar evaluations of school-based adolescent PA interventions (Corder et al., 2021; Maynard et al., 2013).

6.6 Conclusion

The in-person delivered intervention was well-received by stakeholders involved, and shows promise as an intervention that can be feasibly implemented and evaluated. Despite the COVID-19 pandemic hindering intervention implementation, classes were delivered as intended and retention was high. Enrolment, however, was low, amplifying the need for further work on revising and testing recruitment strategies. There were important lessons to be learned from this study, both with and without the lens of the COVID-19 pandemic. This paper contributes to the growing body of knowledge on feasibility studies of after-school PA interventions, where the sharing of this detailed feasibility work may benefit other researchers in reusing techniques that have proved successful, or in avoiding similar challenges. The novel GAP intervention programme should be revised using the recommendations from this study, before continuing to a more robust evaluation.

Chapter 7 Discussion

7.1 Introduction

This chapter will present a summary of the overall findings of this Ph.D. research in relation to the existing literature and outline its contribution to research, policy, practice and its impact at a societal level. The strengths and limitations of this research are discussed, followed by potential directions for future research. The final section of this chapter will contain overall concluding remarks and a personal reflection.

7.2 Summary of findings

The overarching aim of this thesis was to co-design a school-based behaviour change intervention based on theory to improve adolescent females PA levels and test the intervention in a single-sex, female-only, designated disadvantaged post-primary school. Using mixed-methods and gathering multiple stakeholder perspectives, this research set out to: i) identify the factors influencing adolescent females' PA behaviour at school; ii) use these data to subsequently co-design, with adolescent females, the GAP programme; and iii) assess the feasibility of implementing and evaluating the GAP programme.

This research was a response to the recently documented low levels of adolescent females' PA participation worldwide (Guthold et al., 2020), particularly amongst those of lower SES (Inchley et al., 2020; van Sluijs et al., 2021). In an Irish context, these low levels of PA participation are consistent with the literature, with just 7% of 12 to 18 year-old females reporting to meet the PA guidelines for health (Woods et al., 2018). There are many interventions aimed at promoting PA throughout adolescence (Messing et al., 2019), particularly school-based interventions (Borde et al., 2017; Dobbins et al., 2013; Kriemler et al., 2011; Love et al., 2019) and interventions aimed at adolescent females (Owen et al., 2017; Pearson et al., 2015). These interventions, however, often report varied and minimal effects, indicating that changing adolescents' PA behaviour through school-based interventions can be challenging.

A theoretical framework, the BCW, was used to guide intervention development. Chapter 4, the first study in this thesis, provided an insight into the factors that 'need to change' to positively influence adolescent females' PA behaviour at school. This concurrent mixed-methods study, using the COM-B model and TDF, presented a behavioural analysis of factors

influencing adolescent females' PA behaviour at school to inform intervention development. Consistent with the literature (Guthold et al., 2020; Inchley et al., 2020; Murphy et al., 2020; Woods et al., 2018), PA levels were far below recommended guidelines for optimum health with just 1.4% of the students in this sample (n=287) reported meeting the recommended PA guidelines. Moreover, similar to the literature (Corder et al., 2016b; Dumith et al., 2011; Murphy et al., 2020), there was an age-related decline in MVPA participation. The questionnaire identified that students (n=287) would be more active if they had more time. Additional factors emerging from the qualitative data were social influences, environmental context and resources, behavioural regulation, beliefs about capabilities, goals, and reinforcement. These factors were directly mapped to the COM-B components; psychological capability, physical opportunity, social opportunity, reflective motivation and automatic motivation. This opening study reinforced the need for specifically tailored PA interventions for adolescent females. The following chapter (study 2), used this behavioural analysis to co-design the intervention using the subsequent steps (steps 5 to 8) in the BCW.

Chapter 5, the second study in this thesis, used a novel approach to intervention development that involved four discussion groups with eight Transition Year students (PPI contributors in a Youth Advisory Group). This chapter was a distinctive milestone towards designing a theory-based PA intervention that was tailored to the school context and matched to the preferences of the students. The five COM-B components that were identified as potentially important (study 1) were mapped directly onto nine intervention functions. After application of the BCW APEASE criteria, seven intervention functions, four policy categories and 21 BCTs were selected as most appropriate to increase adolescent females PA levels. By documenting the BCTs associated with the GAP programme, the reader was provided with an overview of this multi-component intervention. The proposed intervention included 'face-to-face' peer-delivered exercise classes at a group level on a weekly basis for 45-minutes after-school. The programme would offer a diversified, fun and unstructured opportunity to be active with friends in a supportive and inclusive environment. This chapter laid the foundations for the final study in this thesis, as described in chapter 6.

Chapter 6 assessed the feasibility of implementing and evaluating the GAP programme over a 12-week trial during the COVID-19 pandemic. This study encountered significant contextual barriers and challenges with recruitment. As is acknowledged and discussed in chapter 6, results of this study specifically highlighted the need to revise recruitment strategies. It was encouraging to observe through our results that the intervention was delivered as intended and well-received by key stakeholders involved who perceived the intervention to be compatible

with the school setting. The intervention being delivered online and Project Leaders' task of completing the weekly delivery self-reported provider checklists were both deemed unfeasible in the feedback questionnaires. Data completion rates suggested proposed self-reported outcome measures were deemed appropriate (≥95%), except for weight (50%) and height data (80%). Lastly, chapter 6 provides recommended refinements to the intervention before continuing to a more robust evaluation.

7.3 Contribution of this research

This research has successfully developed a school-based PA intervention based on theory, and investigated the feasibility of implementing and evaluating this intervention in a single-sex, female-only, designated disadvantaged post-primary school. The validated 'Research Impact Framework' designed by Kuruvilla et al. (2006) is used to help describe the impact of this Ph.D. research. This framework provides four broad potential areas of impact: research-related impacts, policy impacts, service impacts, and societal impacts (Kuruvilla et al., 2006). The contribution made by this Ph.D. thesis is discussed below in relation to these four research impact areas.

7.3.1 Research-related impact

This research generated knowledge about adolescent females' PA behaviour. The low rates of PA participation reported by the students in the sample (n=287, aged 12-18) contributes to the growing body of evidence to suggest that PA participation is particularly low among adolescent females and adolescents attending designated-disadvantaged post-primary schools in Ireland (Woods et al., 2018). The behavioural analysis presented identified and added detail on the range of factors influencing adolescent females' PA behaviour. The intervention co-design process, with adolescent females, provided important insights into this high risk population, and identified specific strategies and BCTs that respond to their interests and needs. This knowledge offered a thorough foundation for development of a multi-component school-based PA intervention based on theory. Furthermore, the feasibility study learnings and practical recommendations provided could inform future research. The sharing of this work through publications may benefit other researchers across disciplines by facilitating future replication or in avoiding similar challenges.

Methodological contributions as part of this Ph.D. research included the application of established methods and a novel approach to intervention development. The application of the

MRC framework contributes to intervention research, while the use of the BCW and TDF adds to behavioural science methodology. This theoretical approach contributes to the existing literature on developing theory-based interventions. Furthermore, working with a 'Youth Advisory Group' as part of the research process contributes to actively involving young people in health research through PPI. This approach led to the development of a school-based PA intervention that was tailored to its local context. The MRC encourages a 'bolder approach' to intervention research, with Skivington et al. (2021) recommending that researchers involve new methods that are not yet widely used, as well as undertaking methodological innovation and development. To our knowledge, this Ph.D. research developed the first school-based PA intervention using the BCW in combination with a PPI approach. The mixed-methods employed to assess the feasibility of implementing and evaluating an intervention contributes to intervention feasibility research and implementation science.

7.3.2 Policy impact

This research had an impact on policy-making at a local level. The BCW process included a step on policy (step 6). The participating school had an existing 'well-being' policy. During implementation, the principal agreed to integrate the GAP programme into the existing policy or create a new school PA policy to support the initiative and commit to its sustainability. Policy templates were provided to the school, alongside the resources required (certificates, exercise class planners) to continue implementing the programme (Appendix D). A recent systematic review by Woods et al. (2021) found evidence of impact for 'sport/extra-curricular PA' to support PA in the school setting (Woods et al., 2021).

On a broader level, this research supports persuasive evidence to back ongoing and proposed policy activities to engage adolescents with PA, while raising awareness and support for new policy-making at a national and international-level. This thesis addresses a topical and timely research area in Irish policy. Health and well-being policies in Ireland recognise the issue of population physical inactivity in policy documents including the 'Healthy Ireland' framework (Department of Health Ireland, 2013) and the 'National Physical Activity Plan' (Department of Health Ireland, 2016). These policies acknowledge the important role that schools play in PA promotion. Aligning with the aims and objectives of the current national PA plan, the GAP programme aimed to teach adolescents the necessary skills for confident engagement with PA and provide opportunities to adopt an active way of life. In the qualitative work with key stakeholders at post-intervention, they discussed how the GAP programme provided an

alternative opportunity for students to engage with PA at school, particularly for students who may not be drawn to the often competitive and performance-focused nature of traditional extra-curricular PA programmes, with implications for the long-term health and well-being of adolescent females. This Ph.D. research adds weight to PA policies specifically targeted at females, such as Sport Irelands 'Women in Sport Policy' (Sport Ireland, 2019). More work is needed, however, to develop and implement international and national policies that focus specifically on promoting PA participation among adolescent females. The gender gap in PA levels is evident across most countries for adults (Guthold et al., 2018) and adolescents (Guthold et al., 2020). Policies that address the PA gender gap could therefore have a substantial impact on overall population health (Health, 2019).

7.3.3 Service impact

The impact of research on health 'service' can include impacts across various categories, such as evidence-based practice (Kuruvilla et al., 2006). The participating school in this programme of research integrated the research-informed GAP programme into school practice. This research contributed to helping schools fulfil their PA promoting role (Hills et al., 2015) by co-designing a tailored and contextually appropriate school-based intervention. In addition, the GAP programme was integrated into school practice through the national 'Gaisce' award (Department of Children, Equality, Disability, Integration and Youth, 2020). Unlike previous feasibility studies on peer-led, school-based PA interventions (Corder et al., 2016a; Jenkinson et al., 2012) who experienced difficulties recruiting 'peer leaders' or 'mentors', the Gaisce award, alongside encouragement from the physical education teacher facilitated the straightforward and successful recruitment of Project Leaders in this research. Findings suggested the GAP programme was compatible with the school-setting and could become part of routine school practice. It was particularly relevant, because unlike the traditional team sports that dominate extra-curricular PA in Irish schools (Woods et al., 2018), the GAP programme offered an opportunity for students to engage in unstructured, fun, and diversified PA after-school. Moreover, our findings suggested the GAP programme was less administratively demanding for teachers and required limited involvement in terms of class delivery when compared to other after-school PA programmes.

7.3.4 Societal impact

This research can be described in terms of its societal impact by promoting healthy behaviour, i.e., PA. PA has direct and indirect benefits to adolescent health and well-being (Chaput et al.,

2020), including enhanced quality of life, increased self-esteem and positive effects on academic performance. Adolescence has been identified as an *"important time for laying the foundations of good health"* (WHO, 2022). This transitional phase between childhood and adulthood presents an opportunity to promote PA for long-term behaviour change and wider public health benefits beyond adolescence.

This Ph.D. research also contributed to health equity outcomes by explicitly focusing on the needs of a disadvantaged and vulnerable population. The current WHO 'Global Action Plan on Physical Activity (2018–2030)' states the need to strengthen the development and implementation of behavioural public health intervention targeted at females and vulnerable or marginalised populations, that engage with and increase PA opportunities (WHO, 2018). As previously discussed, when comparing PA levels with gender and SES, research indicates adolescent females of lower SES are consistently the least active (Borraccino et al., 2009; Inchley et al., 2020). This research focused on adolescent females in a designated disadvantaged post-primary school. Moreover, the individual deprivation indices used in the feasibility study indicated that the students in this sample were disadvantaged. Given that disadvantaged young people in Ireland have previously cited feelings of disempowerment through the belief that no significance was credited to their opinions about PA (McEvoy et al., 2016), this Ph.D. research actively involved female adolescents in the research process as co-designers to ensure that the PA intervention aligned with their unique needs and interests.

7.4 Strengths and limitations of this research

This section provides a summary of the overall strengths and limitations of this thesis. The strengths and limitations of the individual papers have been acknowledged and addressed within the study chapters.

One of the major strengths of this Ph.D. research was the iterative development of the studies through the use of the MRC framework for developing and evaluating complex interventions (Skivington et al., 2021). The overall aim of this Ph.D. research was to develop and evaluate a school-based PA intervention for adolescent females of lower SES, but we did not have a predefined idea of what the intervention would be at the outset. Adhering to the guidance of the MRC, a new intervention was developed for a new context based on research evidence and theory of the problem (phase one) using the BCW in combination with a PPI approach, and the feasibility and acceptability of the intervention and evaluation design was assessed (phase two). In this research, key stakeholders (students, teachers, principal and

parents/guardians) were recruited from the same school, thereby, providing multiple perspectives from within the same context. Research indicates capturing multiple stakeholders' perspectives can ensure it reflects the realities of the intervention setting (Hallingberg et al., 2018). Stakeholder buy-in was indeed a strength of this Ph.D. research. Facilitation from the school and stakeholder engagement was crucial to the success of this programme of research. The final strength of this Ph.D. is that it provides practical recommendations for future research.

As with all research, there are also limitations in this work, many beyond the control of the research team. This programme of research was conducted in one single-sex, female-only, designated disadvantaged post-primary school in Dublin, Ireland, and therefore, caution in generalisation is warranted. This research did not include an economic evaluation. The MRC framework (Skivington et al., 2021) recommends engaging economic expertise at an early stage to help identify the scope of costs and benefits to assess for the purpose of answering the questions most important to decision-makers. This research was reliant on self-reported PA data. This can be interpreted as a limitation due to the possibility of participants' inability to recall activities precisely (Sylvia et al., 2014). Lastly, there was no follow-up data collection. Assessing intervention maintenance was beyond the scope of this Ph.D. thesis.

7.5 Directions for future research

This Ph.D. research reinforced the need for interventions that can be feasibly implemented and are effective in successfully engaging adolescent females in PA. Intervention developers could consider our methodological and theoretical approach taken to intervention development. Based on our experience, using the BCW in combination with a PPI approach was useful for providing a theory-based and systematic method to intervention development, whilst also ensuring that the intervention was logical, practical and reflected the students' interests and needs. This led to a multi-component, school-based intervention that was based on theory. Furthermore, researchers developing similar interventions in the future could apply the learnings from this research in their work by reusing techniques that appeared successful or in avoiding similar challenges.

7.5.1 Next steps for intervention development and evaluation

Following the MRC framework for developing and evaluating complex interventions (Skivington et al., 2021), this Ph.D. research has undertaken the development of an

intervention (MRC phase one), and the assessment of feasibility of the intervention and evaluation design (MRC phase two) phases. The next phase (MRC phase three), involves an evaluation of the intervention. This would include obtaining unbiased estimates of effectiveness of the GAP programme at increasing MVPA levels, for example, in a fully powered randomised controlled trial. The intervention's impact on the secondary outcome measures (e.g., self-rated health, life satisfaction, self-efficacy related to PA, and PA enjoyment) would also be examined. The MRC framework, however defines evaluation as *"going beyond asking whether an intervention works (in the sense of achieving its intended outcome), to a broader range of questions including identifying what other impact it has, theorising how it works, taking account of how it interacts with the context in which it is implemented, how it contributes to system change, and how the evidence can be used to support decision making in the real world"* (Skivington et al., 2021, p. 7). As described in chapter 3, the MRC framework phases do not automatically occur in a linear order. The decision to whether the research should stop, return to a previous phase, repeat a phase, or proceed to the next phase should depend on the answers to six questions (Skivington et al., 2021). The following paragraphs contain our answers to these six questions.

1. How does the intervention interact with its context?

This Ph.D. research involved the co-design of a contextually appropriate school-based adolescent PA intervention for adolescent females. The GAP programme was designed and intended to be delivered in person. The findings from the online delivered intervention, however, could be used to inform interventions of this kind in future pandemics. The feasibility trial results suggested the in-person delivered intervention was well-received by stakeholders involved and was perceived as compatible with the school-setting. Importantly, further work is required to develop and test recruitment strategies in this context. The COVID-19 pandemic was a key contextual barrier that hindered intervention implementation. Although impending guidelines following the on-going COVID-19 pandemic are yet unknown, this contextual barrier may not need to be addressed in a future trial.

2. What is the underpinning programme theory?

The GAP programme was designed using a theoretical framework, the BCW (Michie et al., 2014). It is theory-driven, school-based adolescent PA intervention that includes 21 BCTs.

3. How can diverse stakeholder perspectives be included in the research?

This Ph.D. thesis highlights the importance of research with key stakeholders in both phases of the MRC framework (intervention development and feasibility). Multiple stakeholders perspectives were incorporated in this research, including teachers, students, principal and parents/guardians.

4. What are the key uncertainties?

It is important to identify the uncertainties that exist in the intervention and to explore those that the theory, research team and stakeholders deem most important (Skivington et al., 2021). These judgments, subsequently, inform the framing of research questions. A key uncertainty in this research includes the generalisability of research findings. A future evaluation should include more than one school (including a comparison school), recruit a mixed-sex and/or a non-designated disadvantaged (non-DEIS) post-primary school and expand the age-range (e.g., Junior Cycle students, 12 to 15 years old and/or Senior Cycle years, 15 to 18 years old) to strengthen the generalisability of the GAP programme findings.

Another key uncertainty includes the intervention's efficacy of increasing adolescent females PA levels. A pilot cluster-randomised controlled trial may be used to explore the intervention's preliminary effectiveness to increase MVPA. Data completion rates for the proposed self-reported MVPA measure (Hardie Murphy et al., 2015; Prochaska et al., 2001) was very high (100%) in the feasibility trial. This could demonstrate recipients' comprehension of the measure, indicating the feasibility of collecting this outcome measure in a future trial. For a more objective evaluation of the GAPs potential impact on adolescent females MVPA, accelerometers should be used in a future trial. Combining both approaches may provide a more robust surveillance and comprehensive assessment of PA behaviour (Kang et al., 2016).

Furthermore, uncertainty exists around intervention maintenance, i.e., the extent to which the behaviour is sustained for 6 months or more after the intervention, and the extent to which the programme becomes institutionalised (Glasgow et al., 2019) or part of routine school practice. Indeed, increased time piloting the in-person delivered intervention, with longitudinal follow-up data collection is warranted to assess maintenance and measure sustained improvements in PA.

5. How can the intervention be refined?

Based on data collected, the GAP programme needs to be refined. Ideally, this iterative process would lead to the refined intervention demonstrating greater feasibility and acceptability (Skivington et al., 2021). These recommended refinements have been discussed in detail in chapter 6.

6. What are the comparative resource and outcome consequences of the intervention?

This research did not include an economic evaluation, i.e., *'the* comparative *analysis of alternative courses of action in terms of both costs (resource use) and consequences (outcomes, effects)'* (Skivington et al., 2021). The MRC framework recommends researchers to include an economic evaluation at all phases of intervention research (Skivington et al., 2021). Essentially, an economic evaluation would help to identify and compare the costs and benefits of the intervention. This answers the questions that matter most to decision makers, thus contributing to evidence-based decision making. School-relevant mechanisms should be put in place to collect the necessary data for an economic evaluation in a future trial.

Based on our answers to these six questions, our recommendation would be to build on what we have learned by refining the intervention, revising recruitment strategies and to continue the feasibility phase (phase two) of the investigation into the GAP programme by conducting a pilot cluster-randomised controlled trial. This trial should include an economic evaluation and address key uncertainties. Afterwards, depending on the answers to the six questions, the research may proceed to the evaluation phase (phase three) of the MRC framework.

7.6 Conclusion

This Ph.D. research advances our understanding of developing and evaluating school-based PA interventions aimed at increasing adolescent females PA levels. It has contributed to the body of knowledge on adolescent females' PA behaviour, research methods, local-level PA policy, school practice, PA promotion and health equity. The results indicated that the BCW can be successfully applied in combination with a PPI approach to co-design a contextually appropriate school-based adolescent PA intervention. The in-person delivered peer-led, after-school PA intervention was well-received by stakeholders and shows promise as an intervention that can be feasibly implemented and evaluated. Following the MRC framework, the findings from this Ph.D. research could guide future work in a pilot cluster-randomised controlled trial, before continuing to a more robust evaluation.

7.7 Personal reflection

The overall research process has been challenging and often unpredictable, yet an extremely rewarding experience. I've acquired new skills and gained invaluable experience that has helped me develop as an academic researcher. Data collection from 2019 to 2021 was the most important component in both my understanding and navigation of this research. The PPI co-design process was particularly insightful in terms of building rapport with the girls and developing an intervention that speaks directly to their needs and interests. I also enjoyed observing the peer-delivered exercise classes. Some of the student 'Project Leaders' were nervous at first, but soon became excited, as they gradually took ownership of the project and truly fulfilled their role as 'leaders' who supported and encouraged their fellow peers to exercise. In my opinion, the intervention extended beyond promoting PA, it inspired new friendships, increased students' confidence and fostered skill-development. It was discussed how some of the students who participated would not have usually engaged with physical education or extra-curricular sport clubs at school. To me, seeing these girls get involved, laugh and genuinely enjoy being active was one of the highlights of my Ph.D. experience.

"It is good to have an end to journey towards; but it is the journey that matters, in the end"
(Ursula K. Le Guin in The Left Hand of Darkness, 1969)

Since the trial ended, I have remained in contact with the school that participated in this programme of research. I was pleased to know that the school has continued to implement the GAP programme. Interestingly, their reason to continue with the after-school programme was the same reason they agreed to participate in this research to begin with; because of a desire to encourage student-involvement at school, and provide additional, relevant and meaningful opportunities for them to be active. I believe this attitude and approach to PA promotion that includes tailoring interventions to individual contexts and importantly, a willingness to listen to adolescent females and encourage their involvement, can contribute towards designing and implementing effective interventions that successfully engage adolescent females in PA.

References

Active School Flag, 2020. Active School Flag | More Schools, More Active, More Often. URL //activeschoolflag.ie/ (accessed 1.25.22).

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes, Theories of Cognitive Self-Regulation 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Atkin, A.J., Gorely, T., Biddle, S.J.H., Cavill, N., Foster, C., 2011. Interventions to Promote Physical Activity in Young People Conducted in the Hours Immediately After School: A Systematic Review. Int.J. Behav. Med. 18, 176–187. https://doi.org/10.1007/s12529-010-9111-z

Bailey, D.P., Boddy, L.M., Savory, L.A., Denton, S.J., Kerr, C.J., 2012. Associations between cardiorespiratory fitness, physical activity and clustered cardiometabolic risk in children and adolescents: the HAPPY study. Eur J Pediatr 171, 1317–1323. https://doi.org/10.1007/s00431-012-1719-3

Bandura, A., 1986. Social foundations of thought and action: a social cognitive theory. Prentice-Hall.

Barker, F., Atkins, L., de Lusignan, S., 2016. Applying the COM-B behaviour model and behaviour change wheel to develop an intervention to improve hearing-aid use in adult auditory rehabilitation. International Journal of Audiology 55, S90–S98. https://doi.org/10.3109/14992027.2015.1120894

Beets, M.W., Okely, A., Weaver, R.G., Webster, C., Lubans, D., Brusseau, T., Carson, R., Cliff, D.P., 2016. The theory of expanded, extended, and enhanced opportunities for youth physical activity promotion. International Journal of Behavioral Nutrition and Physical Activity 13, 120. https://doi.org/10.1186/s12966-016-0442-2

Beets, M.W., von Klinggraeff, L., Weaver, R.G., Armstrong, B., Burkart, S., 2021. Small studies, big decisions: the role of pilot/feasibility studies in incremental science and premature scale-up of behavioral interventions. Pilot and Feasibility Studies 7, 173. https://doi.org/10.1186/s40814-021-00909-w

Bellg, A.J., Borrelli, B., Resnick, B., Hecht, J., Minicucci, D.S., Ory, M., Ogedegbe, G., Orwig, D., Ernst, D., Czajkowski, S., Treatment Fidelity Workgroup of the NIH Behavior Change Consortium, 2004. Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH Behavior Change Consortium. Health Psychol 23, 443–451. https://doi.org/10.1037/0278-6133.23.5.443

Belton, S., Britton, Ú., Murtagh, E., Meegan, S., Duff, C., McGann, J., 2020. Ten Years of 'Flying the Flag': An Overview and Retrospective Consideration of the Active School Flag Physical Activity Initiative for Children—Design, Development & Evaluation. Children (Basel) 7. https://doi.org/10.3390/children7120300

Belton, S., O' Brien, W., Meegan, S., Woods, C., Issartel, J., 2014. Youth-Physical Activity Towards Health: evidence and background to the development of the Y-PATH physical activity intervention for adolescents. BMC Public Health 14, 122. https://doi.org/10.1186/1471-2458-14-122

Belton, S., O'Brien, W., McGann, J., Issartel, J., 2019. Bright spots physical activity investments that work: Youth-Physical Activity Towards Health (Y-PATH). Br J Sports Med 53, 208–212. https://doi.org/10.1136/bjsports-2018-099745

Biddle, S.J.H., Nigg, C.R., 2000. Theories of exercise behavior. International Journal of Sport Psychology 31, 290–304.

Biddle, S.J.H., Whitehead, S.H., O'Donovan, T.M., Nevill, M.E., 2005. Correlates of Participation in Physical Activity for Adolescent Girls: A Systematic Review of Recent Literature. Journal of Physical Activity and Health 2, 423–434. https://doi.org/10.1123/jpah.2.4.423

Bird, D., Culley, L., Lakhanpaul, M., 2013. Why collaborate with children in health research: an analysis of the risks and benefits of collaboration with children. Arch Dis Child Educ Pract Ed 98, 42–48. https://doi.org/10.1136/archdischild-2012-303470

Bird, L., Arthur, A., Cox, K., 2011. "Did the trial kill the intervention?" experiences from the development, implementation and evaluation of a complex intervention. BMC Medical Research Methodology 11, 24. https://doi.org/10.1186/1471-2288-11-24

Bonevski, B., Randell, M., Paul, C., Chapman, K., Twyman, L., Bryant, J., Brozek, I., Hughes, C., 2014. Reaching the hard-to-reach: a systematic review of strategies for improving health and medical research with socially disadvantaged groups. BMC Medical Research Methodology 14, 42. https://doi.org/10.1186/1471-2288-14-42

Borde, R., Smith, J.J., Sutherland, R., Nathan, N., Lubans, D.R., 2017. Methodological considerations and impact of school-based interventions on objectively measured physical activity in adolescents: a systematic review and meta-analysis. Obesity Reviews 18, 476–490. https://doi.org/10.1111/obr.12517

Borraccino, A., Lemma, P., Iannotti, R., Zambon, A., Dalmasso, P., Lazzeri, G., Giacchi, M., Cavallo, F., 2009. Socio-economic effects on meeting PA guidelines: comparisons among 32 countries. Med Sci Sports Exerc 41, 749–756. https://doi.org/10.1249/MSS.0b013e3181917722

Borrelli, B., 2011. The assessment, monitoring, and enhancement of treatment fidelity in public health clinical trials. Journal of Public Health Dentistry 71, S52–S63. https://doi.org/10.1111/j.1752-7325.2011.00233.x

Borrelli, B., Sepinwall, D., Ernst, D., Bellg, A.J., Czajkowski, S., Breger, R., DeFrancesco, C., Levesque, C., Sharp, D.L., Ogedegbe, G., Resnick, B., Orwig, D., 2005. A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. J Consult Clin Psychol 73, 852–860. https://doi.org/10.1037/0022-006X.73.5.852

Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3, 77–101. https://doi.org/10.1191/1478088706qp063oa

Brett, J., Staniszewska, S., Mockford, C., Herron-Marx, S., Hughes, J., Tysall, C., Suleman, R., 2014a. Mapping the impact of patient and public involvement on health and social care research: a systematic review. Health Expectations 17, 637–650. https://doi.org/10.1111/j.1369-7625.2012.00795.x

Brett, J., Staniszewska, S., Mockford, C., Herron-Marx, S., Hughes, J., Tysall, C., Suleman, R., 2014b. A Systematic Review of the Impact of Patient and Public Involvement on Service Users, Researchers and Communities. Patient 7, 387–395. https://doi.org/10.1007/s40271-014-0065-0

Brett, J., Staniszewska, S., Mockford, C., Seers, K., Herron-Marx, S., Bayliss, H., 2010. The PIRICOM study : a systematic review of the conceptualisation, measurement, impact and outcomes of patients and public involvement in health and social care research (Report). University of Warwick, Coventry, UK.

Buchan, D.S., Ollis, S., Thomas, N.E., Baker, J.S., 2012. Physical Activity Behaviour: An Overview of Current and Emergent Theoretical Practices. J Obes 2012, 546459. https://doi.org/10.1155/2012/546459

Bull, F.C., Al-Ansari, S.S., Biddle, S., Borodulin, K., Buman, M.P., Cardon, G., Carty, C., Chaput, J.-P., Chastin, S., Chou, R., Dempsey, P.C., DiPietro, L., Ekelund, U., Firth, J., Friedenreich, C.M., Garcia, L., Gichu, M., Jago, R., Katzmarzyk, P.T., Lambert, E., Leitzmann, M., Milton, K., Ortega, F.B., Ranasinghe, C., Stamatakis, E., Tiedemann, A., Troiano, R.P., Ploeg, H.P. van der, Wari, V., Willumsen, J.F., 2020. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med 54, 1451–1462. https://doi.org/10.1136/bjsports-2020-102955

Cale, L., 2000. Physical Activity Promotion in Secondary Schools. European Physical Education Review 6, 71–90. https://doi.org/10.1177/1356336X000061006

Cale, L., Harris, J., 2006. School-based physical activity interventions: effectiveness, trends, issues, implications and recommendations for practice. Sport, Education and Society 11, 401–420. https://doi.org/10.1080/13573320600924890
Camacho-Miñano, M.J., LaVoi, N.M., Barr-Anderson, D.J., 2011. Interventions to promote physical activity among young and adolescent girls: a systematic review. Health Educ Res 26, 1025–1049. https://doi.org/10.1093/her/cyr040
Cane, J., O'Connor, D., Michie, S., 2012. Validation of the theoretical domains framework for use in behaviour change and implementation research. Implement. Sci. 7, 37. https://doi.org/10.1186/1748-5908-7-37
Cantril, H., 1965. The Pattern of Human Concerns. Rutgers University Press.
Carlin, A., Murphy, M.H., Nevill, A., Gallagher, A.M., 2018. Effects of a peer-led Walking In ScHools intervention (the WISH study) on physical activity levels of adolescent girls: a cluster randomised pilot study. Trials 19, 31. https://doi.org/10.1186/s13063-017-2415-4
Carraro, A., Young, M.C., Robazza, C., 2008. A contribution to the validation of the Physical Activity Enjoyment Scale in an Italian sample. Social Behavior and Personality 36, 911. https://doi.org/10.2224/sbp.2008.36.7.911
Caspersen, C.J., Powell, K.E., Christenson, G.M., 1985. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep 100, 126–131.
Central Statistics Office Ireland, 2016. Age Groups - CSO - Central Statistics Office [WWW Document]. Census of Population 2016 - Profile 3 An Age Profile of Ireland. URL https://www.cso.ie/en/releasesandpublications/ep/p-cp3oy/cp3/agr/ (accessed 3.6.22).
Chaput, J.-P., Willumsen, J., Bull, F., Chou, R., Ekelund, U., Firth, J., Jago, R., Ortega, F.B., Katzmarzyk, P.T., 2020. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. International Journal of Behavioral Nutrition and Physical Activity 17, 141. https://doi.org/10.1186/s12966-020-01037-z
Clarke, A.L., Jhamb, M., Bennett, P.N., 2019. Barriers and facilitators for engagement and implementation of exercise in end-stage kidney disease: Future theory-based interventions using the Behavior Change Wheel. Seminars in Dialysis 32, 308–319. https://doi.org/10.1111/sdi.12787
Conroy, D.E., Berry, T.R., 2017. Automatic Affective Evaluations of Physical Activity. Exercise and Sport Sciences Reviews 45, 230–237. https://doi.org/10.1249/JES.0000000000000120
Cooper, A.R., Goodman, A., Page, A.S., Sherar, L.B., Esliger, D.W., van Sluijs, E.M., Andersen, L.B., Anderssen, S., Cardon, G., Davey, R., Froberg, K., Hallal, P., Janz, K.F., Kordas, K., Kreimler, S., Pate, R.R., Puder, J.J., Reilly, J.J., Salmon, J., Sardinha, L.B., Timperio, A., Ekelund, U., 2015. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). International Journal of Behavioral Nutrition and Physical Activity 12, 113. https://doi.org/10.1186/s12966-015-0274-5
Coppinger, T., Lacey, S., O'Neill, C., Burns, C., 2016. 'Project Spraoi': A randomized control trial to improve nutrition and physical activity in school children. Contemporary Clinical Trials Communications 3, 94–101. https://doi.org/10.1016/j.conctc.2016.04.007
Corder, K., Atkin, A.J., Ekelund, U., Sluijs, E.M. van, 2013. What do adolescents want in order to become more active? BMC Public Health 13, 1–10. https://doi.org/10.1186/1471-2458-13-718
Corder, K., Brown, H.E., Schiff, A., Sluijs, E.M.F. van, 2016a. Feasibility study and pilot cluster-randomised controlled trial of the GoActive intervention aiming to promote

physical activity among adolescents: outcomes and lessons learnt. BMJ Open 6, e012335. https://doi.org/10.1136/bmjopen-2016-012335
Corder, K., Schiff, A., Kesten, J.M., van Sluijs, E.M.F., 2015. Development of a universal approach to increase physical activity among adolescents: the GoActive intervention. BMJ Open 5. https://doi.org/10.1136/bmjopen-2015-008610
Corder, K., Sharp, S.J., Atkin, A.J., Andersen, L.B., Cardon, G., Page, A., Davey, R., Grøntved, A., Hallal, P.C., Janz, K.F., Kordas, K., Kriemler, S., Puder, J.J., Sardinha, L.B., Ekelund, U., van Sluijs, E.M.F., 2016b. Age-related patterns of vigorous-intensity physical activity in youth: The International Children's Accelerometry Database. Preventive Medicine Reports 4, 17–22. https://doi.org/10.1016/j.pmedr.2016.05.006
Corder, K., Winpenny, E., Love, R., Brown, H.E., White, M., Sluijs, E. van, 2019. Change in physical activity from adolescence to early adulthood: a systematic review and meta-analysis of longitudinal cohort studies. Br J Sports Med 53, 496–503. https://doi.org/10.1136/bjsports-2016-097330
Corder, K.L., Brown, H.E., Croxson, C.H., Jong, S.T., Sharp, S.J., Vignoles, A., Wilkinson, P.O., Wilson, E.C., van Sluijs, E.M., 2021. A school-based, peer-led programme to increase physical activity among 13- to 14-year-old adolescents: the GoActive cluster RCT. Public Health Research 9, 1–134. https://doi.org/10.3310/phr09060
Corepal, R., Best, P., O'Neill, R., Kee, F., Badham, J., Dunne, L., Miller, S., Connolly, P., Cupples, M.E., van Sluijs, E.M.F., Tully, M.A., Hunter, R.F., 2019. A feasibility study of 'The StepSmart Challenge' to promote physical activity in adolescents. Pilot and Feasibility Studies 5, 132. https://doi.org/10.1186/s40814-019-0523-5
Corepal, R., Tully, M.A., Kee, F., Miller, S.J., Hunter, R.F., 2018. Behavioural incentive interventions for health behaviour change in young people (5–18 years old): A systematic review and meta-analysis. Preventive Medicine 110, 55–66. https://doi.org/10.1016/j.ypmed.2018.02.004
Corr, M., McMullen, J., Morgan, P.J., Barnes, A., Murtagh, E.M., 2020. Supporting Our Lifelong Engagement: Mothers and Teens Exercising (SOLE MATES); a feasibility trial. Women & Health 60, 618–635. https://doi.org/10.1080/03630242.2019.1688446
Corr, M., McSharry, J., Murtagh, E.M., 2018. Adolescent Girls' Perceptions of Physical Activity: A Systematic Review of Qualitative Studies. Am J Health Promot 0890117118818747. https://doi.org/10.1177/0890117118818747
Corr, M., Murtagh, E., 2019. 'No one ever asked us': a feasibility study assessing the co-creation of a physical activity programme with adolescent girls. Glob Health Promot 1757975919853784. https://doi.org/10.1177/1757975919853784
Cowley, E.S., Watson, P.M., Foweather, L., Belton, S., Mansfield, C., Whitcomb-Khan, G., Cacciatore, I., Thompson, A., Thijssen, D., Wagenmakers, A.J.M., 2021a. Formative Evaluation of a Home-Based Physical Activity Intervention for Adolescent Girls—The HERizon Project: A Randomised Controlled Trial. Children 8, 76. https://doi.org/10.3390/children8020076
Cowley, E.S., Watson, P.M., Foweather, L., Belton, S., Thompson, A., Thijssen, D., Wagenmakers, A.J.M., 2021b. "Girls Aren't Meant to Exercise": Perceived Influences on Physical Activity among Adolescent Girls—The HERizon Project. Children 8, 31. https://doi.org/10.3390/children8010031
Craig, P., Dieppe, P., Macintyre, S., Michie, S., Nazareth, I., Petticrew, M., 2008. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ 337, a1655. https://doi.org/10.1136/bmj.a1655
Craike, M.J., Polman, R., Eime, R., Symons, C., Harvey, J., Payne, W., 2014. Associations Between Behavior Regulation, Competence, Physical Activity, and Health for Adolescent Females. Journal of Physical Activity and Health 11, 410–418. https://doi.org/10.1123/jpah.2012-0070

Crocker, J.C., Boylan, A.-M., Bostock, J., Locock, L., 2017. Is it worth it? Patient and public views on the impact of their involvement in health research and its assessment: a UK-based qualitative interview study. Health Expect. 20, 519–528. https://doi.org/10.1111/hex.12479

Currie, C., Inchley, J., Molcho, M., Lenzi, M., Veselska, Z., Wild, F. (Eds.), 2014. Health Behaviour in School-aged Children (HBSC) Study Protocol: Background, Methodology and Mandatory items for the 2013/14 Survey. St Andrews: CAHRU.

Davidoff, F., Dixon-Woods, M., Leviton, L., Michie, S., 2015. Demystifying theory and its use in improvement. BMJ Qual Saf 24, 228–238. https://doi.org/10.1136/bmjqs-2014-003627

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., Michie, S., 2015. Theories of behaviour and behaviour change across the social and behavioural sciences: a scoping review. Health Psychol Rev 9, 323–344. https://doi.org/10.1080/17437199.2014.941722

De Meester, F., van Lenthe, F.J., Spittaels, H., Lien, N., De Bourdeaudhuij, I., 2009. Interventions for promoting physical activity among European teenagers: a systematic review. International Journal of Behavioral Nutrition and Physical Activity 6, 82. https://doi.org/10.1186/1479-5868-6-82

Deci, E.L., Ryan, R.M., 2000. The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. Psychological Inquiry 11, 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Demetriou, Y., Gillison, F., McKenzie, T.L., 2017. After-School Physical Activity Interventions on Child and Adolescent Physical Activity and Health: A Review of Reviews. Advances in Physical Education 7, 191–215. https://doi.org/10.4236/ape.2017.72017

Dennehy, R., Cronin, M., Arensman, E., 2018. Involving young people in cyberbullying research: The implementation and evaluation of a rights-based approach. Health Expectations 0, 1–11. https://doi.org/10.1111/hex.12830

Department of Children, Equality, Disability, Integration and Youth, 2020. Gaisce | Irish President's Award | Get Involved [WWW Document]. Gaisce. URL https://www.gaisce.ie/ (accessed 11.2.21).

Department of Education, 2021. Transition Year [WWW Document]. Department of Education and Skills. URL https://www.education.ie/en/Schools-Colleges/Information/Curriculum-and-Syllabus/Transition-Year-/ (accessed 4.8.21).

Department of Education, 2017. DEIS: Delivering Equality of Opportunity in Schools [WWW Document]. Department of Education and Skills. URL https://www.education.ie/en/schools-colleges/services/deis-delivering-equality-of-opportunity-in-schools-/ (accessed 4.8.21).

Department of Health Ireland, 2016. Get Ireland Active - The National Physical Activity Plan. Department of Health, Dublin, Ireland.

Department of Health Ireland, 2013. Healthy Ireland – A Framework for Improved Health and Wellbeing 2013 – 2025 | Department of Health.

Department of the Taoiseach, 2021. First Report on Well-being Framework for Ireland July 2021 [WWW Document]. URL https://www.gov.ie/en/press-release/fb19a-first-report-on-well-being-framework-for-ireland-july-2021/ (accessed 1.25.22).

Department of Transport, Tourism and Sport, 2019. National Sports Policy 2018 - 2027. Department of Transport, Tourism and Sport.

Dewar, D.L., Plotnikoff, R.C., Morgan, P.J., Okely, A.D., Costigan, S.A., Lubans, D.R., 2013. Testing Social-Cognitive Theory to Explain Physical Activity Change in Adolescent Girls From Low-Income Communities. Research Quarterly for Exercise and Sport 84, 483–491. https://doi.org/10.1080/02701367.2013.842454

Dishman, R.K., Hales, D.P., Sallis, J.F., Saunders, R., Dunn, A.L., Bedimo-Rung, A.L., Ring, K.B., 2010. Validity of Social-Cognitive Measures for Physical Activity in Middle-School Girls. J Pediatr Psychol 35, 72–88. https://doi.org/10.1093/jpepsy/jsp031

Dishman, R.K., Motl, R.W., Saunders, R.P., Dowda, M., Felton, G., Ward, D.S., Pate, R.R., 2002. Factorial Invariance and Latent Mean Structure of Questionnaires Measuring Social-Cognitive Determinants of Physical Activity among Black and White Adolescent Girls. Preventive Medicine 34, 100–108. https://doi.org/10.1006/pmed.2001.0959

Dobbins, M., Husson, H., DeCorby, K., LaRocca, R.L., 2013. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. Cochrane Database Syst Rev CD007651. https://doi.org/10.1002/14651858.CD007651.pub2

Domecq, J.P., Prutsky, G., Elraiyah, T., Wang, Z., Nabhan, M., Shippee, N., Brito, J.P., Boehmer, K., Hasan, R., Firwana, B., Erwin, P., Eton, D., Sloan, J., Montori, V., Asi, N., Abu Dabrh, A.M., Murad, M.H., 2014. Patient engagement in research: a systematic review. BMC Health Services Research 14, 89. https://doi.org/10.1186/1472-6963-14-89

Doria, N., Condran, B., Boulos, L., Curtis Maillet, D.G., Dowling, L., Levy, A., 2018. Sharpening the focus: differentiating between focus groups for patient engagement vs. qualitative research. Research Involvement and Engagement 4, 19. https://doi.org/10.1186/s40900-018-0102-6

Dumith, S.C., Gigante, D.P., Domingues, M.R., Kohl, H.W., 2011. Physical activity change during adolescence: a systematic review and a pooled analysis. Int J Epidemiol 40, 685–698. https://doi.org/10.1093/ije/dyq272

Edwards, M.J., May, T., Kesten, J.M., Banfield, K., Bird, E.L., Powell, J.E., Sebire, S.J., Jago, R., 2016. Lessons learnt from the Bristol Girls Dance Project cluster RCT: implications for designing and implementing after-school physical activity interventions. BMJ Open 6, e010036. https://doi.org/10.1136/bmjopen-2015-010036

Eldridge, S.M., Chan, C.L., Campbell, M.J., Bond, C.M., Hopewell, S., Thabane, L., Lancaster, G.A., 2016a. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ 355, i5239. https://doi.org/10.1136/bmj.i5239

Eldridge, S.M., Lancaster, G.A., Campbell, M.J., Thabane, L., Hopewell, S., Coleman, C.L., Bond, C.M., 2016b. Defining Feasibility and Pilot Studies in Preparation for Randomised Controlled Trials: Development of a Conceptual Framework. PLOS ONE 11, e0150205. https://doi.org/10.1371/journal.pone.0150205

El-Kotob, R., Giangregorio, L.M., 2018. Pilot and feasibility studies in exercise, physical activity, or rehabilitation research. Pilot Feasibility Stud 4. https://doi.org/10.1186/s40814-018-0326-0

Ellis, K., Pears, S., Sutton, S., 2019. Behavioural analysis of postnatal physical activity in the UK according to the COM-B model: a multi-methods study. BMJ Open 9, e028682. https://doi.org/10.1136/bmjopen-2018-028682

Enright, E., O'Sullivan, M., 2012. Listening to young people's voices in physical education and youth sport research, in: Armour, K., Macdonald, D. (Eds.), Research Methods in Physical Education and Youth Sport. Routledge, London, pp. 120–131. https://doi.org/10.4324/9780203807170

Evans, J.St.B.T., Stanovich, K.E., 2013. Dual-Process Theories of Higher Cognition: Advancing the Debate. Perspect Psychol Sci 8, 223–241. https://doi.org/10.1177/1745691612460685

Fitzgerald, A., Fitzgerald, N., Aherne, C., 2012. Do peers matter? A review of peer and/or friends' influence on physical activity among American adolescents. Journal of Adolescence 35, 941–958. https://doi.org/10.1016/j.adolescence.2012.01.002

Flannery, C., McHugh, S., Anaba, A.E., Clifford, E., O'Riordan, M., Kenny, L.C., McAuliffe, F.M., Kearney, P.M., Byrne, M., 2018. Enablers and barriers to physical activity in overweight and obese pregnant women: an analysis informed by the theoretical domains framework and COM-B model. BMC Pregnancy and Childbirth 18, 178. https://doi.org/10.1186/s12884-018-1816-z

French, S.D., Green, S.E., O'Connor, D.A., McKenzie, J.E., Francis, J.J., Michie, S., Buchbinder, R., Schattner, P., Spike, N., Grimshaw, J.M., 2012. Developing theory-informed behaviour change interventions to implement evidence into practice: a systematic approach using the Theoretical Domains Framework. Implementation Science 7, 38. https://doi.org/10.1186/1748-5908-7-38

Gale, N.K., Heath, G., Cameron, E., Rashid, S., Redwood, S., 2013. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC Medical Research Methodology 13, 117. https://doi.org/10.1186/1471-2288-13-117

Garbacz, L.L., Brown, D.M., Spee, G.A., Polo, A.J., Budd, K.S., 2014. Establishing Treatment Fidelity in Evidence-Based Parent Training Programs for Externalizing Disorders in Children and Adolescents. Clin Child Fam Psychol Rev 17, 230–247. https://doi.org/10.1007/s10567-014-0166-2

Garcia, J.M., Sirard, J.R., Deutsch, N.L., Weltman, A., 2016. The influence of friends and psychosocial factors on physical activity and screen time behavior in adolescents: a mixed-methods analysis. J Behav Med 39, 610–623. https://doi.org/10.1007/s10865-016-9738-6

Ginis, K.A.M., Nigg, C.R., Smith, A.L., 2013. Peer-delivered physical activity interventions: an overlooked opportunity for physical activity promotion. Transl Behav Med 3, 434–443. https://doi.org/10.1007/s13142-013-0215-2

Glasgow, R.E., Harden, S.M., Gaglio, B., Rabin, B., Smith, M.L., Porter, G.C., Ory, M.G., Estabrooks, P.A., 2019. RE-AIM Planning and Evaluation Framework: Adapting to New Science and Practice With a 20-Year Review. Frontiers in Public Health 7, 64. https://doi.org/10.3389/fpubh.2019.00064

Glazzard, J., Rose, A., Ogilvie, P., 2021. The impact of peer mentoring on students' physical activity and mental health. Journal of Public Mental Health 20, 122–131. https://doi.org/10.1108/JPMH-10-2018-0073

Goodyear, V.A., Skinner, B., McKeever, J., Griffiths, M., 2021. The influence of online physical activity interventions on children and young people's engagement with physical activity: a systematic review. Physical Education and Sport Pedagogy 0, 1–15. https://doi.org/10.1080/17408989.2021.1953459

Gorely, T., Harrington, D.M., Bodicoat, D.H., Davies, M.J., Khunti, K., Sherar, L.B., Tudor-Edwards, R., Yates, T., Edwardson, C.L., 2019. Process evaluation of the school-based Girls Active programme. BMC Public Health 19, 1187. https://doi.org/10.1186/s12889-019-7493-7

Gourlan, M., Bernard, P., Bortolon, C., Romain, A.J., Lareyre, O., Carayol, M., Ninot, G., Boiché, J., 2016. Efficacy of theory-based interventions to promote physical activity. A meta-analysis of randomised controlled trials. Health Psychology Review 10, 50–66. https://doi.org/10.1080/17437199.2014.981777

Graham, D.J., Bauer, K.W., Friend, S., Barr-Anderson, D.J., Nuemark-Sztainer, D., 2014. Personal, Behavioral, and Socioenvironmental Correlates of Physical Activity Among Adolescent Girls: Cross-Sectional and Longitudinal Associations. J Phys Act Health 11, 51–61. https://doi.org/10.1123/jpah.2011-0239

Guthold, R., Stevens, G.A., Riley, L.M., Bull, F.C., 2020. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Health 4, 23–35. https://doi.org/10.1016/S2352-4642(19)30323-2

Guthold, R., Stevens, G.A., Riley, L.M., Bull, F.C., 2018. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. The Lancet Global Health 6, e1077–e1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hagger, M.S., Chatzisarantis, N., Biddle, S.J.H., Orbell, S., 2001. Antecedents of children's physical activity intentions and behaviour: Predictive validity and longitudinal effects. Psychology & Health 16, 391–407. https://doi.org/10.1080/08870440108405515

Hallal, P.C., Andersen, L.B., Bull, F.C., Guthold, R., Haskell, W., Ekelund, U., 2012. Global physical activity levels: surveillance progress, pitfalls, and prospects. The Lancet 380, 247–257. https://doi.org/10.1016/S0140-6736(12)60646-1

Hallal, P.C., Victora, C.G., Azevedo, M.R., Wells, J.C.K., 2006. Adolescent Physical Activity and Health. Sports Med 36, 1019–1030. https://doi.org/10.2165/00007256-200636120-00003

Hallingberg, B., Turley, R., Segrott, J., Wight, D., Craig, P., Moore, L., Murphy, S., Robling, M., Simpson, S.A., Moore, G., 2018. Exploratory studies to decide whether and how to proceed with full-scale evaluations of public health interventions: a systematic review of guidance. Pilot and Feasibility Studies 4, 104. https://doi.org/10.1186/s40814-018-0290-8

Hardie Murphy, M., Rowe, D.A., Belton, S., Woods, C.B., 2015. Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. BMC Public Health 15, 1080. https://doi.org/10.1186/s12889-015-2418-6

Haskell, W.L., 2012. Physical activity by self-report: a brief history and future issues. J Phys Act Health 9 Suppl 1, S5-10. https://doi.org/10.1123/jpah.9.s1.s5

Health Research Board, 2021. Strategy 2021-2025: Health research – making an impact (No. ISBN: 978-1903669-27-3.). Health Research Board, Grattan House, 67-72 Lower Mount Street, Dublin 2, D02 H638, Ireland., Dublin.

Health, T.L.P., 2019. Time to tackle the physical activity gender gap. The Lancet Public Health 4, e360. https://doi.org/10.1016/S2468-2667(19)30135-5

Heath, G.W., Brownson, R.C., Kruger, J., Miles, R., Powell, K.E., Ramsey, L.T., Task Force on Community Preventive Services, 2006. The Effectiveness of Urban Design and Land Use and Transport Policies and Practices to Increase Physical Activity: A Systematic Review. J Phys Act Health 3, S55–S76. https://doi.org/10.1123/jpah.3.s1.s55

Heath, G.W., Parra, D.C., Sarmiento, O.L., Andersen, L.B., Owen, N., Goenka, S., Montes, F., Brownson, R.C., 2012. Evidence-based intervention in physical activity: lessons from around the world. Lancet 380, 272–281. https://doi.org/10.1016/S0140-6736(12)60816-2

Higgins, J.P.T., Altman, D.G., Gøtzsche, P.C., Jüni, P., Moher, D., Oxman, A.D., Savović, J., Schulz, K.F., Weeks, L., Sterne, J.A.C., 2011. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 343, d5928. https://doi.org/10.1136/bmj.d5928

Hills, A.P., Dengel, D.R., Lubans, D.R., 2015. Supporting Public Health Priorities: Recommendations for Physical Education and Physical Activity Promotion in Schools. Progress in Cardiovascular Diseases, 2013 Global Congress on Physical Activity - All Hearts Need Exercise: A Global Call to Action by the AHA 57, 368–374. https://doi.org/10.1016/j.pcad.2014.09.010

Hoffmann, T.C., Glasziou, P.P., Boutron, I., Milne, R., Perera, R., Moher, D., Altman, D.G., Barbour, V., Macdonald, H., Johnston, M., Lamb, S.E., Dixon-Woods, M., McCulloch, P., Wyatt, J.C., Chan, A.-W., Michie, S., 2014. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ 348, g1687. https://doi.org/10.1136/bmj.g1687

Hollis, J.L., Sutherland, R., Williams, A.J., Campbell, E., Nathan, N., Wolfenden, L., Morgan, P.J., Lubans, D.R., Gillham, K., Wiggers, J., 2017. A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons. Int J Behav Nutr Phys Act 14. https://doi.org/10.1186/s12966-017-0504-0

Humbert, M.L., Chad, K.E., Spink, K.S., Muhajarine, N., Anderson, K.D., Bruner, M.W., Girolami, T.M., Odnokon, P., Gryba, C.R., 2006. Factors That Influence Physical Activity Participation Among High- and Low-SES Youth. Qual Health Res 16, 467–483. https://doi.org/10.1177/1049732305286051

Huotari, P., Nupponen, H., Mikkelsson, L., Laakso, L., Kujala, U., 2011. Adolescent physical fitness and activity as predictors of adulthood activity. J Sports Sci 29, 1135–1141. https://doi.org/10.1080/02640414.2011.585166

Iadarola, S., Pellecchia, M., Stahmer, A., Lee, H.S., Hauptman, L., Hassrick, E.M., Crabbe, S., Vejnoska, S., Morgan, E., Nuske, H., Luelmo, P., Friedman, C., Kasari, C., Gulsrud, A., Mandell, D., Smith, T., 2020. Mind the gap: an intervention to support caregivers with a new autism spectrum disorder diagnosis is feasible and acceptable. Pilot and Feasibility Studies 6, 124. https://doi.org/10.1186/s40814-020-00662-6

Inchley, J., Currie, D., Budisavljevic, S., Torsheim, T., Jåstad, A., Cosma, A., 2020. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-Aged Children (HBSC) Survey in Europe and Canada. International Report. Volume 1. Key Findings. WHO Regional Office for Europe, Copenhagen.

INVOLVE, 2012. Briefing notes for researchers: involving the public in NHS, public health and social care research. INVOLVE, Eastleigh.

Jacquez, F., Vaughn, L.M., Wagner, E., 2013. Youth as Partners, Participants or Passive Recipients: A Review of Children and Adolescents in Community-Based Participatory Research (CBPR). American Journal of Community Psychology 51, 176–189. https://doi.org/10.1007/s10464-012-9533-7

Jago, R., Baranowski, T., 2004. Non-curricular approaches for increasing physical activity in youth: a review. Prev Med 39, 157–163. https://doi.org/10.1016/j.ypmed.2004.01.014

Jago, R., Davis, L., McNeill, J., Sebire, S.J., Haase, A., Powell, J., Cooper, A.R., 2011. Adolescent girls' and parents' views on recruiting and retaining girls into an after-school dance intervention: implications for extra-curricular physical activity provision. International Journal of Behavioral Nutrition and Physical Activity 8, 91. https://doi.org/10.1186/1479-5868-8-91

Jago, R., Edwards, M.J., Sebire, S.J., Tomkinson, K., Bird, E.L., Banfield, K., May, T., Kesten, J.M., Cooper, A.R., Powell, J.E., Blair, P.S., 2015. Effect and cost of an after-school dance programme on the physical activity of 11–12 year old girls: The Bristol Girls Dance Project, a school-based cluster randomised controlled trial. International Journal of Behavioral Nutrition and Physical Activity 12, 128. https://doi.org/10.1186/s12966-015-0289-y

Jago, R., Sebire, S.J., Cooper, A.R., Haase, A.M., Powell, J., Davis, L., McNeill, J., Montgomery, A.A., 2012. Bristol Girls Dance Project Feasibility Trial: outcome and process evaluation results. International Journal of Behavioral Nutrition and Physical Activity 9, 83. https://doi.org/10.1186/1479-5868-9-83

James, M., Christian, D., Scott, S., Todd, C., Stratton, G., Demmler, J., McCoubrey, S., Halcox, J., Audrey, S., Ellins, E.A., Irvine, E., Brophy, S., 2019. What works best when implementing a physical activity intervention for teenagers? Reflections from the ACTIVE Project: a qualitative study. BMJ Open 9, e025618. https://doi.org/10.1136/bmjopen-2018-025618

James, M., Todd, C., Scott, S., Stratton, G., McCoubrey, S., Christian, D., Halcox, J., Audrey, S., Ellins, E., Anderson, S., Copp, I., Brophy, S., 2018. Teenage recommendations to

improve physical activity for their age group: a qualitative study. BMC Public Health 18, 1–9. https://doi.org/10.1186/s12889-018-5274-3
Janssen, I., LeBlanc, A.G., 2010. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. International Journal of Behavioral Nutrition and Physical Activity 7, 40. https://doi.org/10.1186/1479-5868-7-40
Jenkinson, K.A., Naughton, G., Benson, A.C., 2012. The GLAMA (Girls! Lead! Achieve! Mentor! Activate!) physical activity and peer leadership intervention pilot project: A process evaluation using the RE-AIM framework. BMC Public Health 12, 55. https://doi.org/10.1186/1471-2458-12-55
Jong, S.T., Croxson, C.H.D., Foubister, C., Brown, H.E., Guell, C., Lawlor, E.R., Wells, E.K., Wilkinson, P.O., Wilson, E.C.F., van Sluijs, E.M.F., Corder, K., 2020. Reach, Recruitment, Dose, and Intervention Fidelity of the GoActive School-Based Physical Activity Intervention in the UK: A Mixed-Methods Process Evaluation. Children 7, 231. https://doi.org/10.3390/children7110231
Junghans, C., Feder, G., Hemingway, H., Timmis, A., Jones, M., 2005. Recruiting patients to medical research: double blind randomised trial of "opt-in" versus "opt-out" strategies. BMJ bmj;bmj.38583.625613.AEv1. https://doi.org/10.1136/bmj.38583.625613.AE
Kaiser, K., 2009. Protecting Respondent Confidentiality in Qualitative Research. Qual Health Res 19, 1632–1641. https://doi.org/10.1177/1049732309350879
Kang, M., Mahar, M.T., Morrow, J.R., 2016. Issues in the Assessment of Physical Activity in Children. Journal of Physical Education, Recreation & Dance 87, 35–43. https://doi.org/10.1080/07303084.2016.1192943
Kellett, M., 2005. Children as active researchers: a new research paradigm for the 21st century? ESRC, UK.
Kirby, P., 2004. A Guide to Actively Involving Young People in Research: For researchers, research commissioners, and managers. INVOLVE Support Unit, Eastleigh.
Kriemler, S., Meyer, U., Martin, E., Sluijs, E.M.F. van, Andersen, L.B., Martin, B.W., 2011. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. British Journal of Sports Medicine 45, 923–930. https://doi.org/10.1136/bjsports-2011-090186
Kuruvilla, S., Mays, N., Pleasant, A., Walt, G., 2006. Describing the impact of health research: a Research Impact Framework. BMC Health Serv Res 6, 134. https://doi.org/10.1186/1472-6963-6-134
Lai, S.K., Costigan, S.A., Morgan, P.J., Lubans, D.R., Stodden, D.F., Salmon, J., Barnett, L.M., 2014. Do School-Based Interventions Focusing on Physical Activity, Fitness, or Fundamental Movement Skill Competency Produce a Sustained Impact in These Outcomes in Children and Adolescents? A Systematic Review of Follow-Up Studies. Sports Med 44, 67–79. https://doi.org/10.1007/s40279-013-0099-9
Lancaster, G.A., 2015. Pilot and feasibility studies come of age! Pilot and Feasibility Studies 1, 1. https://doi.org/10.1186/2055-5784-1-1
Lancaster, G.A., Thabane, L., 2019. Guidelines for reporting non-randomised pilot and feasibility studies. Pilot and Feasibility Studies 5, 114. https://doi.org/10.1186/s40814-019-0499-1
Lane, C., McCrabb, S., Nathan, N., Naylor, P.-J., Bauman, A., Milat, A., Lum, M., Sutherland, R., Byaruhanga, J., Wolfenden, L., 2021. How effective are physical activity interventions when they are scaled-up: a systematic review. International Journal of Behavioral Nutrition and Physical Activity 18, 16. https://doi.org/10.1186/s12966-021-01080-4
Langford, R., Bonell, C., Jones, H., Pouliou, T., Murphy, S., Waters, E., Komro, K., Gibbs, L., Magnus, D., Campbell, R., 2015. The World Health Organization's Health

Promoting Schools framework: a Cochrane systematic review and meta-analysis. BMC Public Health 15, 130. https://doi.org/10.1186/s12889-015-1360-y
Larsson, I., Staland-Nyman, C., Svedberg, P., Nygren, J.M., Carlsson, I.-M., 2018. Children and young people's participation in developing interventions in health and well-being: a scoping review. BMC Health Serv Res 18. https://doi.org/10.1186/s12913-018-3219-2
Lee, I.-M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., Katzmarzyk, P.T., Lancet Physical Activity Series Working Group, 2012. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. Lancet 380, 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9
Love, R., Adams, J., Sluijs, E.M.F. van, 2019. Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. Obesity Reviews 20, 859–870. https://doi.org/10.1111/obr.12823
Lubans, D.R., Morgan, P.J., Aguiar, E.J., Callister, R., 2011. Randomized controlled trial of the Physical Activity Leaders (PALs) program for adolescent boys from disadvantaged secondary schools. Preventive Medicine 52, 239–246. https://doi.org/10.1016/j.ypmed.2011.01.009
Lundy, L., McEvoy, L., 2012. Children's rights and research processes: Assisting children to (in)formed views. Childhood 19, 129–144. https://doi.org/10.1177/0907568211409078
Macdonald-Wallis, K., Jago, R., Sterne, J.A.C., 2012. Social Network Analysis of Childhood and Youth Physical Activity: A Systematic Review. American Journal of Preventive Medicine 43, 636–642. https://doi.org/10.1016/j.amepre.2012.08.021
Martins, J., Costa, J., Sarmento, H., Marques, A., Farias, C., Onofre, M., Valeiro, M.G., 2021. Adolescents' Perspectives on the Barriers and Facilitators of Physical Activity: An Updated Systematic Review of Qualitative Studies. International Journal of Environmental Research and Public Health 18, 4954. https://doi.org/10.3390/ijerph18094954
Martins, J., Marques, A., Peralta, M., Palmeira, A., Costa, F.C. da, 2017. Correlates of physical activity in young people: A narrative review of reviews. Implications for physical education based on a socio-ecological approach (Correlatos de actividad física en jóvenes: Una revisión narrativa de revisiones. Implicaciones para. Retos 31, 292–299. https://doi.org/10.47197/retos.v0i31.53505
Maynard, B.R., Peters, K.E., Vaughn, M.G., Sarteschi, C.M., 2013. Fidelity in After-School Program Intervention Research: A Systematic Review. Research on Social Work Practice 23, 613–623. https://doi.org/10.1177/1049731513491150
McEvoy, E., MacPhail, A., Enright, E., 2016. Physical activity experiences of young people in an area of disadvantage: 'there's nothing there for big kids, like us.' Sport, Education and Society 21, 1161–1175. https://doi.org/10.1080/13573322.2014.994176
McQuinn, S., Belton, S., Staines, A., Sweeney, M.R., 2022. Co-design of a school-based physical activity intervention for adolescent females in a disadvantaged community: insights from the Girls Active Project (GAP). BMC Public Health 22, 615. https://doi.org/10.1186/s12889-022-12635-w
McSweeney, L., Bradley, J., Adamson, A.J., Spence, S., 2019. The 'Voice' of Key Stakeholders in a School Food and Drink Intervention in Two Secondary Schools in NE England: Findings from a Feasibility Study. Nutrients 11, 2746. https://doi.org/10.3390/nu11112746
Mendonça, G., Cheng, L.A., Mélo, E.N., de Farias Júnior, J.C., 2014. Physical activity and social support in adolescents: a systematic review. Health Educ Res 29, 822–839. https://doi.org/10.1093/her/cyu017

Messing, S., Rütten, A., Abu-Omar, K., Ungerer-Röhrich, U., Goodwin, L., Burlacu, I., Gediga, G., 2019. How Can Physical Activity Be Promoted Among Children and Adolescents? A Systematic Review of Reviews Across Settings. Front. Public Health 7. https://doi.org/10.3389/fpubh.2019.00055

Michie, S., Abraham, C., Whittington, C., McAteer, J., Gupta, S., 2009. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol 28, 690–701. https://doi.org/10.1037/a0016136

Michie, S., Atkins, L., West, R., 2014. The Behaviour Change Wheel. A guide to designing interventions. Silverback Publishing, London.

Michie, S., Johnston, M., Francis, J., Hardeman, W., Eccles, M., 2008. From Theory to Intervention: Mapping Theoretically Derived Behavioural Determinants to Behaviour Change Techniques. Applied Psychology 57, 660–680. https://doi.org/10.1111/j.1464-0597.2008.00341.x

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M.P., Cane, J., Wood, C.E., 2013. The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. Ann Behav Med 46, 81–95. https://doi.org/10.1007/s12160-013-9486-6

Michie, S., van Stralen, M.M., West, R., 2011. The behaviour change wheel: A new method for characterising and designing behaviour change interventions. Implementation Science 6, 42. https://doi.org/10.1186/1748-5908-6-42

Milton, K., Cavill, N., Chalkley, A., Foster, C., Gomersall, S., Hagstromer, M., Kelly, P., Kolbe-Alexander, T., Mair, J., McLaughlin, M., Nobles, J., Reece, L., Shilton, T., Smith, B.J., Schipperijn, J., 2021. Eight Investments That Work for Physical Activity. Journal of Physical Activity and Health 18, 625–630. https://doi.org/10.1123/jpah.2021-0112

Minogue, V., Cooke, M., Donskoy, A.-L., Vicary, P., Wells, B., 2018. Patient and public involvement in reducing health and care research waste. Research Involvement and Engagement 4, 5. https://doi.org/10.1186/s40900-018-0087-1

Mitchell, F., Gray, S., Inchley, J., 2015. 'This choice thing really works … ' Changes in experiences and engagement of adolescent girls in physical education classes, during a school-based physical activity programme. Physical Education and Sport Pedagogy 20, 593–611. https://doi.org/10.1080/17408989.2013.837433

Mitchell, S.J., Slowther, A.-M., Coad, J., Akhtar, S., Hyde, E., Khan, D., Dale, J., 2019. Ethics and patient and public involvement with children and young people. Archives of Disease in Childhood - Education and Practice 104, 195–200. https://doi.org/10.1136/archdischild-2017-313480

Mockford, C., Staniszewska, S., Griffiths, F., Herron-Marx, S., 2012. The impact of patient and public involvement on UK NHS health care: a systematic review. Int J Qual Health Care 24, 28–38. https://doi.org/10.1093/intqhc/mzr066

Moore, J., Yin, Z., Hanes, J., Duda, J., Gutin, B., Barbeau, P., Zenong, Y., 2009. Measuring Enjoyment of Physical Activity in Children: Validation of the Physical Activity Enjoyment Scale. Journal of Applied Sport Psychology 21, S116–S129. https://doi.org/10.1080/10413200802593612

Motl, R.W., Dishman, R.K., Saunders, R., Dowda, M., Felton, G., Pate, R.R., 2001. Measuring enjoyment of physical activity in adolescent girls. American Journal of Preventive Medicine 21, 110–117. https://doi.org/10.1016/S0749-3797(01)00326-9

Motl, R.W., Dishman, R.K., Trost, S.G., Saunders, R.P., Dowda, M., Felton, G., Ward, D.S., Pate, R.R., 2000. Factorial Validity and Invariance of Questionnaires Measuring Social-Cognitive Determinants of Physical Activity among Adolescent Girls. Preventive Medicine 31, 584–594. https://doi.org/10.1006/pmed.2000.0735

Muellmann, S., Steenbock, B., De Cocker, K., De Craemer, M., Hayes, C., O'Shea, M.P., Horodyska, K., Bell, J., Luszczynska, A., Roos, G., Langøien, L.J., Rugseth, G., Terragni, L., De Bourdeaudhuij, I., Brug, J., Pischke, C.R., 2017. Views of policy makers and health promotion professionals on factors facilitating implementation and maintenance of interventions and policies promoting physical activity and healthy eating: results of the DEDIPAC project. BMC Public Health 17, 932. https://doi.org/10.1186/s12889-017-4929-9

Munir, F., Biddle, S.J.H., Davies, M.J., Dunstan, D., Esliger, D., Gray, L.J., Jackson, B.R., O'Connell, S.E., Yates, T., Edwardson, C.L., 2018. Stand More AT Work (SMArT Work): using the behaviour change wheel to develop an intervention to reduce sitting time in the workplace. BMC Public Health 18, 319. https://doi.org/10.1186/s12889-018-5187-1

Murillo Pardo, B., Camacho-Miñano, M., Lanaspa, E., Julián, J., Novais, C., Santos, M., 2014. Data for action: the use of formative research to design a school-based intervention programme to increase physical activity in adolescents. Global Health Promotion. https://doi.org/10.1177/1757975914547202

Murillo Pardo, B., García Bengoechea, E., Generelo Lanaspa, E., Bush, P.L., Zaragoza Casterad, J., Clemente, J., A, J., García González, L., 2013. Promising school-based strategies and intervention guidelines to increase physical activity of adolescents. Health Educ Res 28, 523–538. https://doi.org/10.1093/her/cyt040

Murphy, J., Sweeney, M.R., McGrane, B., 2020. Physical Activity and Sports Participation in Irish Adolescents and Associations with Anxiety, Depression and Mental Wellbeing. Findings from the Physical Activity and Wellbeing (Paws) Study. Physical Activity and Health 4, 107–119. https://doi.org/10.5334/paah.58

Murtagh, E.M., Barnes, A.T., McMullen, J., Morgan, P.J., 2018. Mothers and teenage daughters walking to health: using the behaviour change wheel to develop an intervention to improve adolescent girls' physical activity. Public Health, Special issue on Migration: A global public health issue. 158, 37–46. https://doi.org/10.1016/j.puhe.2018.01.012

Nader, P.R., Bradley, R.H., Houts, R.M., McRitchie, S.L., O'Brien, M., 2008. Moderate-to-vigorous physical activity from ages 9 to 15 years. JAMA 300, 295–305. https://doi.org/10.1001/jama.300.3.295

Nathan, N., Elton, B., Babic, M., McCarthy, N., Sutherland, R., Presseau, J., Seward, K., Hodder, R., Booth, D., Yoong, S.L., Wolfenden, L., 2018. Barriers and facilitators to the implementation of physical activity policies in schools: A systematic review. Preventive Medicine 107, 45–53. https://doi.org/10.1016/j.ypmed.2017.11.012

Naylor, P.-J., Nettlefold, L., Race, D., Hoy, C., Ashe, M.C., Wharf Higgins, J., McKay, H.A., 2015. Implementation of school based physical activity interventions: A systematic review. Preventive Medicine 72, 95–115. https://doi.org/10.1016/j.ypmed.2014.12.034

Ng, K., Cooper, J., McHale, F., Clifford, J., Woods, C., 2020. Barriers and facilitators to changes in adolescent physical activity during COVID-19. BMJ Open Sport & Exercise Medicine 6, e000919. https://doi.org/10.1136/bmjsem-2020-000919

Nigg, C.R., Courneya, K.S., 1998. Transtheoretical Model: examining adolescent exercise behavior. J Adolesc Health 22, 214–224. https://doi.org/10.1016/S1054-139X(97)00141-9

Nigg, C.R., Geller, K.S., Motl, R.W., Horwath, C.C., Wertin, K.K., Dishman, R.K., 2011. A research agenda to examine the efficacy and relevance of the Transtheoretical Model for physical activity behavior. Psychology of Sport and Exercise 12, 7–12. https://doi.org/10.1016/j.psychsport.2010.04.004

O'Brien, W., Issartel, J., Belton, S., 2013. Evidence for the Efficacy of the Youth-Physical Activity towards Health (Y-PATH) Intervention [WWW Document]. URL

http://www.scirp.org/jouRNAl/PaperInformation.aspx?PaperID=38470 (accessed 2.4.18).
Ojo, S.O., Bailey, D.P., Brierley, M.L., Hewson, D.J., Chater, A.M., 2019. Breaking barriers: using the behavior change wheel to develop a tailored intervention to overcome workplace inhibitors to breaking up sitting time. BMC Public Health 19, 1–17. https://doi.org/10.1186/s12889-019-7468-8
O'Kane, S.M., Lahart, I.M., Gallagher, A.M., Carlin, A., Faulkner, M., Jago, R., Murphy, M.H., 2021. Changes in Physical Activity, Sleep, Mental Health, and Social Media Use During COVID-19 Lockdown Among Adolescent Girls: A Mixed-Methods Study. J Phys Act Health 18, 677–685. https://doi.org/10.1123/jpah.2020-0649
O'Leary, M., Rush, E., Lacey, S., Burns, C., Coppinger, T., 2019. Project Spraoi: two year outcomes of a whole school physical activity and nutrition intervention using the RE-AIM framework. Irish Educational Studies 38, 219–243. https://doi.org/10.1080/03323315.2019.1567368
O'Reilly, M., Wiltshire, G., Kiyimba, N., Harrington, D., 2022. "Is Everybody Comfortable?" Thinking Through Co-design Approaches to Better Support Girls' Physical Activity in Schools. Qualitative Research in Sport, Exercise and Health 0, 1–16. https://doi.org/10.1080/2159676X.2022.2083663
Orsmond, G.I., Cohn, E.S., 2015. The Distinctive Features of a Feasibility Study: Objectives and Guiding Questions. OTJR (Thorofare N J) 35, 169–177. https://doi.org/10.1177/1539449215578649
Owen, M.B., Curry, W.B., Kerner, C., Newson, L., Fairclough, S.J., 2017. The effectiveness of school-based physical activity interventions for adolescent girls: A systematic review and meta-analysis. Prev Med 105, 237–249. https://doi.org/10.1016/j.ypmed.2017.09.018
Owen, M.B., Kerner, C., Taylor, S.L., Noonan, R.J., Newson, L., Kosteli, M.-C., Curry, W.B., Fairclough, S.J., 2018. The Feasibility of a Novel School Peer-Led Mentoring Model to Improve the Physical Activity Levels and Sedentary Time of Adolescent Girls: The Girls Peer Activity (G-PACT) Project. Children 5, 67. https://doi.org/10.3390/children5060067
Pandya-Wood, R., Barron, D.S., Elliott, J., 2017. A framework for public involvement at the design stage of NHS health and social care research: time to develop ethically conscious standards. Research Involvement and Engagement 3, 6. https://doi.org/10.1186/s40900-017-0058-y
Pearson, N., Braithwaite, R., Biddle, S.J.H., 2015. The Effectiveness of Interventions to Increase Physical Activity Among Adolescent Girls: A Meta-analysis. Academic Pediatrics 15, 9–18. https://doi.org/10.1016/j.acap.2014.08.009
Pearson, N., Naylor, P.-J., Ashe, M.C., Fernandez, M., Yoong, S.L., Wolfenden, L., 2020. Guidance for conducting feasibility and pilot studies for implementation trials. Pilot and Feasibility Studies 6, 167. https://doi.org/10.1186/s40814-020-00634-w
Perepletchikova, F., Kazdin, A.E., 2005. Treatment Integrity and Therapeutic Change: Issues and Research Recommendations. Clinical Psychology: Science and Practice 12, 365–383. https://doi.org/10.1093/clipsy.bpi045
Perry, C.K., Garside, H., Morones, S., Hayman, L.L., 2012. Physical Activity Interventions for Adolescents: An Ecological Perspective. J Primary Prevent 33, 111–135. https://doi.org/10.1007/s10935-012-0270-3
Pobal, 2021. Deprivation Indices [WWW Document]. Pobal - government supporting communities. URL https://maps.pobal.ie/WebApps/DeprivationIndices/index.html (accessed 11.2.21).
Popay, J., Collins, M., PiiAF Study Group, 2014. The Public Involvement Impact Assessment Framework Guidance. Universities of Lancaster, Liverpool and Exeter.

Prestwich, A., Webb, T.L., Conner, M., 2015. Using theory to develop and test interventions to promote changes in health behaviour: evidence, issues, and recommendations. Curr. Opin. Psychol. 5, 1–5. https://doi.org/10.1016/j.copsyc.2015.02.011
Prochaska, J.J., Sallis, J.F., Long, B., 2001. A Physical Activity Screening Measure for Use With Adolescents in Primary Care. Arch Pediatr Adolesc Med 155, 554–559. https://doi.org/10.1001/archpedi.155.5.554
Prochaska, J.O., Velicer, W.F., 1997. The transtheoretical model of health behavior change. Am J Health Promot 12, 38–48. https://doi.org/10.4278/0890-1171-12.1.38
Qualtrics, 2021. Qualtrics XM // The Leading Experience Management Software [WWW Document]. Qualtrics. URL https://www.qualtrics.com/uk/ (accessed 11.2.21).
Raihan, N., Cogburn, M., 2021. Stages of Change Theory, StatPearls [Internet]. StatPearls Publishing.
Rees, R., Kavanagh, J., Harden, A., Shepherd, J., Brunton, G., Oliver, S., Oakley, A., 2006. Young people and physical activity: a systematic review matching their views to effective interventions. Health Educ Res 21, 806–825. https://doi.org/10.1093/her/cyl120
Rhodes, R.E., McEwan, D., Rebar, A.L., 2019. Theories of physical activity behaviour change: A history and synthesis of approaches. Psychology of Sport and Exercise, 50 years of FEPSAC: Current and future directions to sport and exercise Psychology research 42, 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010
Rhodes, R.E., Nigg, C.R., 2011. Advancing Physical Activity Theory: A Review and Future Directions. Exercise and Sport Sciences Reviews 39, 113–119. https://doi.org/10.1097/JES.0b013e31821b94c8
Riddoch, C.J., Bo Andersen, L., Wedderkopp, N., Harro, M., Klasson-Heggebø, L., Sardinha, L.B., Cooper, A.R., Ekelund, U., 2004. Physical activity levels and patterns of 9- and 15-yr-old European children. Med Sci Sports Exerc 36, 86–92. https://doi.org/10.1249/01.MSS.0000106174.43932.92
Rossi, L., Behme, N., Breuer, C., 2021. Physical Activity of Children and Adolescents during the COVID-19 Pandemic—A Scoping Review. International Journal of Environmental Research and Public Health 18, 11440. https://doi.org/10.3390/ijerph182111440
Rothman, A.J., 2004. "Is there nothing more practical than a good theory?": Why innovations and advances in health behavior change will arise if interventions are used to test and refine theory. International Journal of Behavioral Nutrition and Physical Activity 1, 11. https://doi.org/10.1186/1479-5868-1-11
Rutter, H., Cavill, N., Bauman, A., Bull, F., 2019. Systems approaches to global and national physical activity plans. Bull World Health Organ 97, 162–165. https://doi.org/10.2471/BLT.18.220533
Sallis, J.F., 2010. Measuring Physical Activity: Practical Approaches for Program Evaluation in Native American Communities. J Public Health Manag Pract 16, 404–410. https://doi.org/10.1097/PHH.0b013e3181d52804
Sallis, J.F., Bull, F., Guthold, R., Heath, G.W., Inoue, S., Kelly, P., Oyeyemi, A.L., Perez, L.G., Richards, J., Hallal, P.C., 2016. Progress in physical activity over the Olympic quadrennium. The Lancet 388, 1325–1336. https://doi.org/10.1016/S0140-6736(16)30581-5
Sallis, J.F., Owen, N., 2015. Ecological Models of Health Behavior (Chapter 3), in: Glanz, K., Rimer, B.K., Viswanath, K. (Eds.), Health Behavior: Theory, Research, and Practice. Jossey-Bass, A Wiley Brand, San Francisco, CA, pp. 43–64.
Sallis, J.F., Prochaska, J.J., Taylor, W.C., 2000. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc 32, 963–975.
Salvy, S.-J., de la Haye, K., Bowker, J.C., Hermans, R.C.J., 2012. Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiology &

Behavior, Proceedings from the 2011 meeting of the Society for the Study of Ingestive Behavior (SSIB) 106, 369–378. https://doi.org/10.1016/j.physbeh.2012.03.022
Scarborough, P., Bhatnagar, P., Wickramasinghe, K.K., Allender, S., Foster, C., Rayner, M., 2011. The economic burden of ill health due to diet, physical inactivity, smoking, alcohol and obesity in the UK: an update to 2006-07 NHS costs. J Public Health (Oxf) 33, 527–535. https://doi.org/10.1093/pubmed/fdr033
Schoeppe, S., Alley, S., Rebar, A.L., Hayman, M., Bray, N.A., Van Lippevelde, W., Gnam, J.-P., Bachert, P., Direito, A., Vandelanotte, C., 2017. Apps to improve diet, physical activity and sedentary behaviour in children and adolescents: a review of quality, features and behaviour change techniques. Int J Behav Nutr Phys Act 14, 83. https://doi.org/10.1186/s12966-017-0538-3
Schoonenboom, J., Johnson, R.B., 2017. How to Construct a Mixed Methods Research Design. Köln Z Soziol 69, 107–131. https://doi.org/10.1007/s11577-017-0454-1
Sebire, S.J., Banfield, K., Jago, R., Edwards, M.J., Campbell, R., Kipping, R., Blair, P.S., Kadir, B., Garfield, K., Matthews, J., Lyons, R.A., Hollingworth, W., 2019. A process evaluation of the PLAN-A intervention (Peer-Led physical Activity iNtervention for Adolescent girls). BMC Public Health 19, 1203. https://doi.org/10.1186/s12889-019-7545-z
Sebire, S.J., Edwards, M.J., Campbell, R., Jago, R., Kipping, R., Banfield, K., Tomkinson, K., Garfield, K., Lyons, R.A., Simon, J., Blair, P.S., Hollingworth, W., 2016. Protocol for a feasibility cluster randomised controlled trial of a peer-led school-based intervention to increase the physical activity of adolescent girls (PLAN-A). Pilot and Feasibility Studies 2, 2. https://doi.org/10.1186/s40814-015-0045-8
Sebire, S.J., Jago, R., Banfield, K., Edwards, M.J., Campbell, R., Kipping, R., Blair, P.S., Kadir, B., Garfield, K., Matthews, J., Lyons, R.A., Hollingworth, W., 2018. Results of a feasibility cluster randomised controlled trial of a peer-led school-based intervention to increase the physical activity of adolescent girls (PLAN-A). International Journal of Behavioral Nutrition and Physical Activity 15, 50. https://doi.org/10.1186/s12966-018-0682-4
Sellars, E., Pavarini, G., Michelson, D., Creswell, C., Fazel, M., 2020. Young people's advisory groups in health research: scoping review and mapping of practices. Arch Dis Child 106, 698–704. https://doi.org/10.1136/archdischild-2020-320452
Sharry, J.M., Murphy, P.J., Byrne, M., 2016. Implementing international sexual counselling guidelines in hospital cardiac rehabilitation: development of the CHARMS intervention using the Behaviour Change Wheel. Implementation Sci 11, 1–11. https://doi.org/10.1186/s13012-016-0493-4
Shippee, N.D., Garces, J.P.D., Lopez, G.J.P., Wang, Z., Elraiyah, T.A., Nabhan, M., Brito, J.P., Boehmer, K., Hasan, R., Firwana, B., Erwin, P.J., Montori, V.M., Murad, M.H., 2015. Patient and service user engagement in research: a systematic review and synthesized framework. Health Expectations 18, 1151–1166. https://doi.org/10.1111/hex.12090
Shrestha, R., Copenhaver, M., 2015. Long-Term Effects of Childhood Risk Factors on Cardiovascular Health During Adulthood. Clinical Medicine Reviews in Vascular Health 2015, 1–5. https://doi.org/10.4137/CMRVH.S29964
Sinnott, C., Mercer, S.W., Payne, R.A., Duerden, M., Bradley, C.P., Byrne, M., 2015. Improving medication management in multimorbidity: development of the MultimorbiditY COllaborative Medication Review And DEcision Making (MY COMRADE) intervention using the Behaviour Change Wheel. Implementation Science 10, 132. https://doi.org/10.1186/s13012-015-0322-1
Sirard, J.R., Pate, R.R., 2001. Physical activity assessment in children and adolescents. Sports Med 31, 439–454. https://doi.org/10.2165/00007256-200131060-00004

Skivington, K., Matthews, L., Simpson, S.A., Craig, P., Baird, J., Blazeby, J.M., Boyd, K.A., Craig, N., French, D.P., McIntosh, E., Petticrew, M., Rycroft-Malone, J., White, M., Moore, L., 2021. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ 374, n2061. https://doi.org/10.1136/bmj.n2061

Slater, A., Tiggemann, M., 2010. "Uncool to do sport": A focus group study of adolescent girls' reasons for withdrawing from physical activity. Psychology of Sport and Exercise 11, 619–626. https://doi.org/10.1016/j.psychsport.2010.07.006

Sniehotta, F.F., Araújo-Soares, V., Brown, J., Kelly, M.P., Michie, S., West, R., 2017. Complex systems and individual-level approaches to population health: a false dichotomy? The Lancet Public Health 2, e396–e397. https://doi.org/10.1016/S2468-2667(17)30167-6

Sosu, E.M., Dare, S., Goodfellow, C., Klein, M., 2021. Socioeconomic status and school absenteeism: A systematic review and narrative synthesis. Review of Education 9, e3291. https://doi.org/10.1002/rev3.3291

Sport Ireland, 2021. Adolescent Girls Get Active (This research was carried out by Women in Sport. Registered charity number 1060267.). Sport Ireland, Dublin, Ireland.

Sport Ireland, 2019. Women in Sport Policy (Policy). Sport Ireland, Dublin, Ireland.

Staley, K., 2009. Exploring impact: public involvement in NHS, public health and social care research. INVOLVE, Eastleigh.

Stalsberg, R., Pedersen, A.V., 2010. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of the evidence. Scandinavian Journal of Medicine & Science in Sports 20, 368–383. https://doi.org/10.1111/j.1600-0838.2009.01047.x

Staniszewska, S., Brett, J., Mockford, C., Barber, R., 2011. The GRIPP checklist: Strengthening the quality of patient and public involvement reporting in research. International Journal of Technology Assessment in Health Care 27, 391–399. https://doi.org/10.1017/S0266462311000481

Staniszewska, S., Brett, J., Simera, I., Seers, K., Mockford, C., Goodlad, S., Altman, D.G., Moher, D., Barber, R., Denegri, S., Entwistle, A., Littlejohns, P., Morris, C., Suleman, R., Thomas, V., Tysall, C., 2017. GRIPP2 reporting checklists: tools to improve reporting of patient and public involvement in research. Research Involvement and Engagement 3, 13. https://doi.org/10.1186/s40900-017-0062-2

Steckler, A., Linnan, L., 2002. Process Evaluation for Public Health Interventions and Research. Wiley.

Story, M., Nanney, M.S., Schwartz, M.B., 2009. Schools and Obesity Prevention: Creating School Environments and Policies to Promote Healthy Eating and Physical Activity. The Milbank Quarterly 87, 71–100. https://doi.org/10.1111/j.1468-0009.2009.00548.x

Strain, T., Brage, S., Sharp, S.J., Richards, J., Tainio, M., Ding, D., Benichou, J., Kelly, P., 2020. Use of the prevented fraction for the population to determine deaths averted by existing prevalence of physical activity: a descriptive study. Lancet Glob Health 8, e920–e930. https://doi.org/10.1016/S2214-109X(20)30211-4

Strath, S.J., Kaminsky, L.A., Ainsworth, B.E., Ekelund, U., Freedson, P.S., Gary, R.A., Richardson, C.R., Smith, D.T., Swartz, A.M., 2013. Guide to the Assessment of Physical Activity: Clinical and Research Applications. Circulation 128, 2259–2279. https://doi.org/10.1161/01.cir.0000435708.67487.da

Sutherland, R., Campbell, E., McLaughlin, M., Nathan, N., Wolfenden, L., Lubans, D.R., Morgan, P.J., Gillham, K., Oldmeadow, C., Searles, A., Reeves, P., Williams, M., Evans, N., Bailey, A., Boyer, J., Lecathelinais, C., Davies, L., McKenzie, T., Robertson, K., Wiggers, J., 2021. Scale-up of the Physical Activity 4 Everyone (PA4E1) intervention in secondary schools: 24-month implementation and cost outcomes from a cluster randomised controlled trial. International Journal of

Behavioral Nutrition and Physical Activity 18, 137. https://doi.org/10.1186/s12966-021-01206-8
Sutherland, R., Campbell, E., Nathan, N., Wolfenden, L., Lubans, D.R., Morgan, P.J., Gillham, K., Oldmeadow, C., Searles, A., Reeves, P., Williams, M., Evans, N., Bailey, A., Morrison, R., McLaughlin, M., Wiggers, J., 2019. A cluster randomised trial of an intervention to increase the implementation of physical activity practices in secondary schools: study protocol for scaling up the Physical Activity 4 Everyone (PA4E1) program. BMC Public Health 19, 883. https://doi.org/10.1186/s12889-019-6965-0
Sylvia, L.G., Bernstein, E.E., Hubbard, J.L., Keating, L., Anderson, E.J., 2014. A Practical Guide to Measuring Physical Activity. J Acad Nutr Diet 114, 199–208. https://doi.org/10.1016/j.jand.2013.09.018
Teddlie, C., Tashakkori, A., 2009. Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioral Sciences. SAGE.
Teixeira, P.J., Carraça, E.V., Markland, D., Silva, M.N., Ryan, R.M., 2012. Exercise, physical activity, and self-determination theory: A systematic review. International Journal of Behavioral Nutrition and Physical Activity 9, 78. https://doi.org/10.1186/1479-5868-9-78
Telama, R., 2009. Tracking of Physical Activity from Childhood to Adulthood: A Review. OFA 2, 187–195. https://doi.org/10.1159/000222244
Telama, R., Yang, X., Leskinen, E., Kankaanpää, A., Hirvensalo, M., Tammelin, T., Viikari, J.S.A., Raitakari, O.T., 2014. Tracking of physical activity from early childhood through youth into adulthood. Medicine and Science in Sports and Exercise 46, 955–962. https://doi.org/10.1249/MSS.0000000000000181
Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., Raitakari, O., 2005. Physical activity from childhood to adulthood: A 21-year tracking study. American Journal of Preventive Medicine 28, 267–273. https://doi.org/10.1016/j.amepre.2004.12.003
The Lancet Public Health, 2019. Time to tackle the physical activity gender gap. The Lancet Public Health 4, e360. https://doi.org/10.1016/S2468-2667(19)30135-5
Thompson, H., Frederico, N., Smith, S.R., Chowdhury, M., Dicks, P., Preston, J., Thompson, C., 2015. iCAN: Providing a Voice for Children and Families in Pediatric Research. Ther Innov Regul Sci 49, 673–679. https://doi.org/10.1177/2168479015601344
Tigges, B.B., 2003. Parental Consent and Adolescent Risk Behavior Research. Journal of Nursing Scholarship 35, 283–289. https://doi.org/10.1111/j.1547-5069.2003.00283.x
Toomey, E., Matthews, J., Hurley, D.A., 2017. Using mixed methods to assess fidelity of delivery and its influencing factors in a complex self-management intervention for people with osteoarthritis and low back pain. BMJ Open 7, e015452. https://doi.org/10.1136/bmjopen-2016-015452
van Sluijs, E.M.F., Ekelund, U., Crochemore-Silva, I., Guthold, R., Ha, A., Lubans, D., Oyeyemi, A.L., Ding, D., Katzmarzyk, P.T., 2021. Physical activity behaviours in adolescence: current evidence and opportunities for intervention. The Lancet 398, 429–442. https://doi.org/10.1016/S0140-6736(21)01259-9
van Sluijs, E.M.F., Kriemler, S., 2016. Reflections on physical activity intervention research in young people – dos, don'ts, and critical thoughts. International Journal of Behavioral Nutrition and Physical Activity 13, 25. https://doi.org/10.1186/s12966-016-0348-z
Walton, H., Spector, A., Tombor, I., Michie, S., 2017. Measures of fidelity of delivery of, and engagement with, complex, face-to-face health behaviour change interventions: A systematic review of measure quality. British Journal of Health Psychology 22, 872–903. https://doi.org/10.1111/bjhp.12260

Webb, J., Foster, J., Poulter, E., 2016. Increasing the frequency of physical activity very brief advice for cancer patients. Development of an intervention using the behaviour change wheel. Public Health 133, 45–56. https://doi.org/10.1016/j.puhe.2015.12.009
Webber, L.S., Catellier, D.J., Lytle, L.A., Murray, D.M., Pratt, C.A., Young, D.R., Elder, J.P., Lohman, T.G., Stevens, J., Jobe, J.B., Pate, R.R., 2008. Promoting Physical Activity in Middle School Girls: Trial of Activity for Adolescent Girls. American Journal of Preventive Medicine 34, 173–184. https://doi.org/10.1016/j.amepre.2007.11.018
Whitehead, S., Biddle, S., 2008. Adolescent girls' perceptions of physical activity: A focus group study. European Physical Education Review 14, 243–262. https://doi.org/10.1177/1356336X08090708
Wilson, P., Mathie, E., Keenan, J., McNeilly, E., Goodman, C., Howe, A., Poland, F., Staniszewska, S., Kendall, S., Munday, D., Cowe, M., Peckham, S., 2015. ReseArch with Patient and Public invOlvement: a RealisT evaluation the RAPPORT study. Health Services and Delivery Research 3, 1–176. https://doi.org/10.3310/hsdr03380
Wiltshire, G., Lee, J., Evans, J., 2017. 'You don't want to stand out as the bigger one': exploring how PE and school sport participation is influenced by pupils and their peers. Physical Education and Sport Pedagogy 22, 548–561. https://doi.org/10.1080/17408989.2017.1294673
Withall, J., Jago, R., Fox, K.R., 2011. Why some do but most don't. Barriers and enablers to engaging low-income groups in physical activity programmes: a mixed methods study. BMC Public Health 11, 507. https://doi.org/10.1186/1471-2458-11-507
Woods, C., Moyna, N., Quinlan, A., Tannehill, D., Walsh, J., 2010. The Children's Sport Participation and Physical Activity Study 2010 (CSPPA 2010) (Monograph). School of Health and Human Performance, Dublin City University, and The Irish Sports Council, Dublin, Ireland.
Woods, C., Powell, C., Saunders, J., O'Brien, W., Murphy, M., Duff, C., Farmer, O., Johnston, A., Connolly, S., Belton, S., 2018. The Children's Sport Participation and Physical Activity Study 2018 (CSPPA 2018). Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland, Sport Ireland, and Healthy Ireland, Dublin, Ireland and Sport Northern Ireland, Belfast, Northern Ireland.
Woods, C.B., Volf, K., Kelly, L., Casey, B., Gelius, P., Messing, S., Forberger, S., Lakerveld, J., Zukowska, J., Bengoechea, E.G., PEN consortium, 2021. The evidence for the impact of policy on physical activity outcomes within the school setting: A systematic review. J Sport Health Sci. https://doi.org/10.1016/j.jshs.2021.01.006
World Health Organization, 2022. Adolescent health [WWW Document]. URL https://www.who.int/westernpacific/health-topics/adolescent-health (accessed 1.23.22).
World Health Organization, 2018. Global action plan on physical activity 2018-2030: more active people for a healthier world. World Health Organization, Geneva.
World Health Organization, 2010. Global recommendations on physical activity for health. World Health Organization, Geneva.
World Health Organization, 2009. Global health risks : mortality and burden of disease attributable to selected major risks. Geneva : World Health Organization.
World Health Organization Europe, 2008. Behaviour change strategies and health: the role of health systems (No. EUR/RC58/R8). Tbilisi, Georgia.
World Health Organization, Regional Office for Europe, 2016. Physical activity strategy for the WHO European Region 2016-2025. World Health Organisation Regional Office for Europe, Copenhagen.
World Health Organization, United Nations Educational Scientific and Cultural Organization, 2021. Making every school a health-promoting school: implementation guidance. (No. Licence: CC BY-NC-SA 3.0 IGO.). World Health Organization and the United Nations Educational, Scientific and Cultural Organization, Geneva.

Young, H., Turney, C., White, J., Lewis, R., Bonell, C., 2019. Formative mixed-method multicase study research to inform the development of a safer sex and healthy relationships intervention in further education (FE) settings: the SaFE Project. BMJ Open 9, e024692. https://doi.org/10.1136/bmjopen-2018-024692

Young, M.D., Plotnikoff, R.C., Collins, C.E., Callister, R., Morgan, P.J., 2014. Social cognitive theory and physical activity: a systematic review and meta-analysis. Obes Rev 15, 983–995. https://doi.org/10.1111/obr.12225

Appendices

Appendix A: Ethical approval

Ollscoil Chathair Bhaile Átha Cliath
Dublin City University

DCU

Ms Sarah McQuinn

School of Nursing and Human Science

22nd February 2019

REC Reference: **DCUREC/2019/005**

Proposal Title: **Girls Active Project (GAP)**

Applicant(s): **Ms Sarah McQuinn, Dr Mary Rose Sweeney, Dr Sarah Jane Belton, Prof. Anthony Staines**

Dear Colleagues,

Further to full committee review, the DCU Research Ethics Committee approves this research proposal.
Materials used to recruit participants should note 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,

Donal O' Gorman

Dr Dónal O'Gorman
Chairperson
DCU Research Ethics Committee

DCU
Research & Innovation

Taighde & Nuálaíocht Tacaíocht
Ollscoil Chathair Bhaile Átha Cliath,
Baile Átha Cliath, Éire

Research & Innovation Support
Dublin City University,
Dublin 9, Ireland

T +353 1 700 8000
F +353 1 700 8002
E research@dcu.ie
www.dcu.ie

Student Questionnaire

Age: _____ **Class/Year: _____**

School: _____ **Date: _____**

Part A: Self-Evaluation

Please read the below statements and tick the answer you feel is most appropriate to you, on a scale from 1 (strongly disagree) to 5 (strongly agree). Some of the items may look strange, but that is just because we need to include anything that might possibly apply for some people. **Please only select one answer per statement.**

Remember:

1. There are no right and wrong answers – this is not a test.
2. Please answer all the questions as honestly and accurately as you can – this is very important.

Q1. Capability

"For me to do physical activity at school, I would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Know more about why it is important, e.g., have a better understanding of the benefits of exercising more	○	○	○	○	○
Know more about how to do it, e.g., have a better understanding of effective ways of exercising or being physically active	○	○	○	○	○
Have better physical skills, e.g., learn different exercises or movements to help me be physically active	○	○	○	○	○
Have better mental skills, e.g., learn how to reason more effectively	○	○	○	○	○
Have more physical strength, e.g., build up muscles for demanding physical work	○	○	○	○	○
Have more mental strength, e.g., develop stronger resilience against barriers to being more active	○	○	○	○	○
Overcome physical limitations, e.g., to get around problems of stature of disability	○	○	○	○	○
Overcome mental obstacles, e.g., develop stronger resilience against the temptation to not exercise	○	○	○	○	○
Have more physical stamina, e.g., develop a great capacity to maintain physical effort	○	○	○	○	○
Have more mental stamina, e.g., develop a greater capacity to maintain mental effort	○	○	○	○	○

Q2. Opportunity

"For me to do physical activity at school, I would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Have more time to do it, e.g., create dedicated time during the day	○	○	○	○	○
Have more money, e.g., be given or earn funds to support the behaviour	○	○	○	○	○
Have the necessary materials, e.g., acquire better clothes/shoes/other equipment for the task	○	○	○	○	○
Have it more easily accessible, e.g., easier access to facilities	○	○	○	○	○
Have more people around me doing it, e.g., be part of a "crowd" who are doing it	○	○	○	○	○
Have more triggers to prompt me, e.g., have more reminders at strategic times	○	○	○	○	○
Have more support from others, e.g., have my friends or classmates behind me	○	○	○	○	○

Q3. Motivation

"For me to do physical activity at school, I would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Feel that I want to do it enough, e.g., feel more of a sense of pleasure or satisfaction from exercise	○	○	○	○	○
Feel that I need to do it enough, e.g., care more about the negative consequences of not doing it	○	○	○	○	○
Believe that it would be a good thing to do, e.g., have a stronger sense that I should do it	○	○	○	○	○
Develop better plans for doing it, e.g., have a clearer and better developed plan for exercising regularly	○	○	○	○	○
Develop a habit of doing it, e.g., get into a pattern of exercising regularly without having to think	○	○	○	○	○

Part B: Physical Activity

Read the following four statements before answering the two questions below.

Physical activity is any bodily movement. It can be done at different levels of effort:

Moderate Effort makes your heart rate and breathing rate faster than normal. You may also sweat a little. Brisk walking and jogging are good examples.

Vigorous Effort makes your heart rate much faster, and you have to breathe deeper and faster than normal. You will probably sweat. Playing football or tennis are good examples.

Physical activity includes: Exercises - Weight training, aerobics, jogging, dancing, etc. Sports - Hurling, football, athletics, swimming, etc. General - Brisk walking, washing the car, walking or cycling to school, etc.

Please try to think carefully and be as accurate as possible with your answers. For these next two questions, add up all the time you spend in physical activity each day. Only include activities of either MODERATE or VIGOROUS effort (as described above).

Q5. Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

Q6. Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day? Only include activities of either MODERATE or VIGOROUS effort. Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

Thank you

Students Focus Group Topic Guide

School:	Group/Year:
Date:	Facilitator:
Total number of participants:	

Consent forms received. Focus groups will be audio-recorded and transcribed. There are no right or wrong answers, this will be an informal discussion.

These questions have been developed for this target group, and behaviour (i.e., physical activity), using the Behaviour Change Wheel guidance (Michie et al., 2014). This approach incorporates all the COM-B (Capabilities, Opportunities, Motivation - Behaviour) components, and TDF (Theoretical Domain Framework) domains.

1. ***Knowledge.*** Do you know what physical activity is?
2. ***Skills.*** Can you physically do it? Do you know how to do physical activity?
3. ***Memory, attention, and decision processes****.* Do you remember to do it? Is physical activity something you usually do? (Memory, attention control – the ability to retain information, selective focus)
4. ***Behavioural regulation****.* Do you have systems that you could use for monitoring whether or not you have carried out physical activity? Are there procedures or ways of working that encourages you to do it? (self-monitoring, breaking habit, action planning – anything aimed at managing or changing objectively observed or measured actions)
5. ***Environmental context and resources****.* What aspects of the school environment (physical or resource factors – i.e., material resources, school culture, weather) influence whether or not you do physical activity? To what extent do these factors facilitate or hinder you doing physical activity?
6. ***Social influence****.* How might views/opinions of others (fellow students, teachers, friends, family) influence your decision to do physical activity? To what extent do social influences facilitate or hinder physical activity? (interpersonal processes that can cause individuals to change their thoughts, feelings or PA behaviours, e.g., social norms, social pressure, group conformity, social support)
7. ***Social role and identity.*** Do you think it is part of your 'role' to do physical activity? Is doing physical activity compatible or in conflict with your identity as a person/student/teenage girl? (a coherent set of behaviours and displayed personalities of an individual in a social or school setting, e.g., social identity, group identity, leadership)
8. ***Beliefs about capabilities****.* Are you confident in doing it? How difficult or easy is it for you to do physical activity? (acceptance of the truth about PA ability, e.g., perceived competence, self-efficacy, self-esteem)

9. ***Optimism.*** Do you think increasing PA levels is something that can be done? How confident are you that increasing physical activity levels is possible? (confidence it will happen, desired goals will be achieved – optimism).
10. ***Beliefs about consequences.*** Do you think there are any benefits/harms of doing or not doing physical activity? What do you think will happen if you do physical activity? What do you think will happen if you don't do physical activity? (acceptance of the truth about outcomes of PA - outcome expectations, beliefs).
11. ***Intentions.*** Have you made a decision to do physical activity? (conscious decisions to perform PA, stability of intentions)
12. ***Goals.*** Is there anything else that you might want to do or achieve that might interfere with you doing PA? How much do you want to do physical activity? (end states that you want to achieve, i.e., target setting, action planning)
13. ***Reinforcement.*** Is there anything that might be reinforcing you to do physical activity? Are there any incentives for you to do physical activity? (relationship between the response and a given stimulus, e.g., rewards, punishments)
14. ***Emotion.*** Does doing physical activity provoke an emotional response for you? (i.e., fear, stress, anxiety, positive affect – complex reaction pattern involving experiential, behavioural and physiological elements).

The following questions may be asked during the focus groups for the researchers to develop a further understanding of physical activity in the school:

- What kinds of activities do you play in physical education (PE) that are fun and make you to want to participate?
- What do you like or dislike about physical education (PE) that determines if you will participate?
- What prevents you from participating in physical activity in school? i.e., Relevant to the school context, what are the barriers to physical activity?
- And relevant to the school context, what are the facilitators to physical activity? ○ What could teachers or others do to help you enjoy physical activity more? ○ Do you participate in sport to win or to be with your friends?
- Is too much of a focus on winning hard for you? Do coaches, parents and teachers think winning is more important than you do?

Recruitment and retention

- If we were to design a programme to get teenage girls more active in your school, what would increase your/their interest in taking part? For e.g., social supports, timing, content?

- What strategies could be used to attract girls who have little or no previous experience in exercise or sports participation?

Steering Committee Questionnaire

School: _____

Role: _____ **Date: _____**

<u>Please read the below statements and tick the answer you feel is most appropriate to you, on a scale</u> <u>from 1 (strongly disagree) to 5 (strongly agree).</u> Some of the items may look strange, but that is just because we need to include anything that might possibly apply for some people. **Please only select one answer per statement.**

Remember:

1. There are no right and wrong answers – this is not a test.
2. Please answer all the questions as honestly and accurately as you can – this is very important.

Q1. Capability

"When it comes to the girls doing physical activity at school, they would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Know more about why it is important, e.g., have a better understanding of the benefits of exercising more	○	○	○	○	○
Know more about how to do it, e.g., have a better understanding of effective ways of exercising or being physically active	○	○	○	○	○
Have better physical skills, e.g., learn different exercises or movements to help me be physically active	○	○	○	○	○
Have better mental skills, e.g., learn how to reason more effectively	○	○	○	○	○
Have more physical strength, e.g., build up muscles for demanding physical work	○	○	○	○	○
Have more mental strength, e.g., develop stronger resilience against barriers to being more active	○	○	○	○	○
Overcome physical limitations, e.g., to get around problems of stature of disability	○	○	○	○	○
Overcome mental obstacles, e.g., develop stronger resilience against the temptation to not exercise	○	○	○	○	○
Have more physical stamina, e.g., develop a great capacity to maintain physical effort	○	○	○	○	○
Have more mental stamina, e.g., develop a greater capacity to maintain mental effort	○	○	○	○	○

Q2. Opportunity

"When it comes to the girls doing physical activity at school, they would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Have more time to do it, e.g., create dedicated time during the day	○	○	○	○	○
Have more money, e.g., be given or earn funds to support the behaviour	○	○	○	○	○
Have the necessary materials, e.g., acquire better clothes/shoes/other equipment for the task	○	○	○	○	○
Have it more easily accessible, e.g., easier access to facilities	○	○	○	○	○
Have more people around them doing it, e.g., be part of a "crowd" who are doing it	○	○	○	○	○
Have more triggers to prompt them, e.g., have more reminders at strategic times	○	○	○	○	○
Have more support from others, e.g., have their friends or classmates behind them	○	○	○	○	○

Q3. Motivation

"When it comes to the girls doing physical activity at school, they would have to... "

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Feel that they want to do it enough, e.g., feel more of a sense of pleasure or satisfaction from exercise	○	○	○	○	○
Feel that they need to do it enough, e.g., care more about the negative consequences of not doing it	○	○	○	○	○
Believe that it would be a good thing to do, e.g., have a stronger sense that they should do it	○	○	○	○	○
Develop better plans for doing it, e.g., have a clearer and better developed plan for exercising regularly	○	○	○	○	○
Develop a habit of doing it, e.g., get into a pattern of exercising regularly without having to think	○	○	○	○	○

Thank You

Steering Committee Focus Group Topic Guide

School:	Group/Year:
Date:	Facilitator:
Total number of participants:	

Consent forms received. Focus groups will be audio-recorded and transcribed. There are no right or wrong answers, this will be an informal discussion.

These questions have been developed for this target group, and behaviour (i.e., physical activity), using the Behaviour Change Wheel guidance (Michie et al., 2014). This approach incorporates all the COMB (Capabilities, Opportunities, Motivation - Behaviour) components, and TDF (Theoretical Domain Framework) domains. Similar to the questionnaire, there may be some questions that come across strange or obvious, but that is just because we need to include anything that might possibly apply for some people.

For each question, I'm asking for your personal opinion.

1. ***Knowledge.*** Do the girls know what physical activity is?
2. ***Skills.*** Can they physically do it? Do they know how to do physical activity?
3. ***Memory, attention and decision processes****.* Do they remember to do it? Is physical activity something they usually do? (Memory, attention control – the ability to retain information, selective focus)
4. ***Behavioural regulation****.* Do they have systems that they could use for monitoring whether or not they have carried out physical activity? Are there procedures or ways of working that encourages them to do it? (self-monitoring, breaking habit, action planning – anything aimed at managing or changing objectively observed or measured actions)
5. ***Environmental context and resources****.* What aspects of the school environment (physical or resource factors – i.e., material resources, school culture, weather) influence whether or not they do physical activity? To what extent do these factors facilitate or hinder them doing physical activity?
6. ***Social influence****.* How might views/opinions of others (fellow students, teachers, friends, family) influence their decision to do physical activity? To what extent do social influences facilitate or hinder physical activity? (interpersonal processes that can cause individuals to change their thoughts, feelings or PA behaviours, e.g., social norms, social pressure, group conformity, social support)
7. ***Social role and identity.*** Do they think it is part of their 'role' to do physical activity? Is doing physical activity compatible or in conflict with their identity as a person/student/teenage girl? (a coherent set of behaviours and displayed personalities of an individual in a social or school setting, e.g., social identity, group identity, leadership)

8. ***Beliefs about capabilities***. Are they confident in doing it? How difficult or easy is it for them to do physical activity? (acceptance of the truth about PA ability, e.g., perceived competence, self-efficacy, self-esteem)
9. ***Optimism.*** Do you think they think increasing PA levels is something that can be done? How confident are they that increasing physical activity levels is possible? (confidence it will happen, desired goals will be achieved – optimism).
10. ***Beliefs about consequences.*** Do you think they think there are any benefits/harms of doing or not doing physical activity? (acceptance of the truth about outcomes of PA – outcome expectations, beliefs).
11. ***Intentions.*** Have they made a decision to do physical activity? (conscious decisions to perform PA, stability of intentions)
12. ***Goals.*** Is there anything else that they might want to do or achieve that might interfere with them doing PA? (end states that you want to achieve, i.e., target setting, action planning)
13. ***Reinforcement.*** Is there anything that might be reinforcing them to do physical activity? Are there any incentives for them to do it? (relationship between the response and a given stimulus, e.g., rewards, punishments)
14. ***Emotion.*** Do you think doing physical activity provokes an emotional response for some students? (i.e., fear, stress, anxiety, positive affect – complex reaction pattern involving experiential, behavioural and physiological elements).

The following questions may be asked during the focus groups for the researchers to develop a further understanding of physical activity in the school:

- In your opinion, what prevents the girls from participating in physical activity in school? i.e., Relevant to the school context, what are the barriers to physical activity?
- And relevant to the school context, what are the facilitators to physical activity?

Recruitment and retention

- If we were to design a programme to get teenage girls more active in your school, what do you think would increase their interest in taking part? For e.g., time, social supports, content?

- Do you know of any strategies that could be used to attract girls who have little or no previous experience in exercise or sports participation?

Thank You

Opt-out (passive) consent invite letter to parents for daughter to participate in the questionnaire (only).

Information Sheet for Student and Parent/Guardian

Researcher:	Sara McQuinn
Researcher title:	PhD Scholar
Telephone number:	087 6121709/ (01) 700 5393
Data Controller:	Dublin City University
DCU Data Protection Officer:	Mr. Martin Ward
DCU Data Protection Officer details:	data.protection@dcu.ie Ph: 7005118 / 7008257

The principal investigators of this research project are Dr. Mary Rose Sweeney and Dr. Sarahjane Belton. Dr. Mary Rose Sweeney can be contacted by email: Maryrose.sweeney@dcu.ie and Sarahjane.belton@dcu.ie

You are being invited to take part in a research study to be carried out at your school by Dublin City University. Please read the information provided below carefully with your parent/guardian. You don't have to take part in this research. You should clearly understand the risks and benefits of taking part so that you can make a decision that is right for you.

If you have any questions, please contact the researcher. You can change your mind about taking part in the study any time you like. Even if the study has started, you can still opt out. You don't have to give us a reason.

Why is this study being done?

Most adolescent girls in Ireland do not meet public health guidelines for physical activity. It is widely acknowledged by health agencies that the school setting presents opportunities for intervention. This study aims to work with students to design a school-based intervention to increase physical activity levels of students in your school. This is your opportunity to get involved and make a positive impact in your school!

What will happen to me if I agree to take part?

You will complete a short questionnaire about physical activity on a tablet device.

What are the benefits?

Potentially a more active school.

What are the risks?

We do not anticipate any risks to taking part in this research. You will complete the questionnaire during school hours where standard school protocols are in place.

Is the study confidential?

We place a high priority on protecting and managing data, especially that of personal data, including information on your health. We will be using your personal health information in our research to help us study physical activity levels and well-being. We will comply with applicable regulations, including the processing of your data under legitimate interest and for scientific purposes (Article 6 and 9 of the General Data Protection Regulation (GDPR) 2016.
No identifying information about any participants will ever be shared or published. All information gathered will be stored in Dublin City University, and only accessible by the research team. It will be disposed of after the project is completed and published. We will share the results of the study, in anonymous form, with your school after the study is complete. We are committed to protecting people involved in our research. Confidentiality cannot be promised with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family, or another source.

Where can I get further information?

If you want to opt out of the study, or if you need any further information now or at any time in the future, please contact:

Name: Sara McQuinn

Phone No: 087- 6121709 / (01) 700 5393 *Email* sara.mcquinn2@mail.dcu.ie

If participants have concerns about this study and wish to contact an independent person, please contact:
The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Consent Form

Dear Parent/Guardian,

Please find overleaf an informed consent form for your child's participation in the Girls Active project (GAP) study. This study is being carried out by Dublin City University.

Please read the Information Sheet attached. No identifying information about any participants will ever be shared or published. We are committed to protecting people involved in our research. Confidentiality cannot be promised with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family, or another source.

Your child will be asked to complete a physical activity questionnaire.

In order for your child to **participate** in this study, please read and explain the study to your child. If you would like them to participate, please read and explain the study to your child, but **NO further action is necessary**.

If you would prefer that your child did **not take part** in the study, please **sign the attached form and return to the teacher**.

Thank you for your time. Yours sincerely,

Signature Sara McQuinn

Sara McQuinn
Principal Investigator – Girls Active Project

Informed Consent Form – Girls Active Project

Investigators: Sara McQuinn, Dr. Mary Rose Sweeney, Dr. Sarahjane Belton and Prof. Anthony Staines

Introduction to the study:

Physical activity has been shown to be extremely beneficial to youth, however in order to develop effective physical activity programmes for young people, it is important that researchers understand what influences them to become and remain active.

During the research project:

• Your child will be asked to complete a physical activity questionnaire. This will take place during normal school hours, and will take about 10 minutes to complete. The questionnaire will ask them about their physical activity levels, and their behaviour around physical activity. These questions have been used with other young people.

All information gathered will be treated in the strictest of confidence. To ensure this, your child's name will be removed from all data and replaced with an ID number. Only the researcher will know their ID number.

Please read Option 1 and Option 2 below and complete as appropriate

Option 1: Child to be included in the study

I have read and understood the information in this form. I have read and explained the information in the form to my child. The researchers have answered my questions and concerns, and I have a copy of this consent form. I understand that all children, including my child, are included in this study.

ACTION: No further action necessary. Please file this consent form for future reference.

Option 2: Child to be removed from the study

I have read and understood the information in this form. I have read and explained the information in the form to my child. The researchers have answered my questions and concerns, and I have a copy of this consent form. I request that my child is **not** included in the study. I understand that my child will not be penalised in any way for doing this.

Parent/Guardian Signature:_____
Name in Block Capitals:_____
Childs Name in Block Capitals: _____
Witness:_____ **Date:**_____

Appendix C: Supplementary material study 2

Youth Advisory Group (YAG) Discussion Groups Guide

- **Build rapport and capacity**: ice breakers will be used to ease inhibitions, build trust and create an open atmosphere. The group will be informed of their roles in the project, and the project aims, objectives and purpose will be discussed. This session will focus on building the group's capacity to engage with the research and issues surrounding physical inactivity. . Influences (i.e., barriers and facilitators) to partaking in physical activity will be discussed. Terminology will be explained. The questionnaires and focus group topic guide will be piloted among the group. The aim will be to enable the group to express their existing views or form new ones based on the interaction with the information generated.
- **Study design**: Brief training on public health research will be delivered to enable the YAG to make informed contributions to the study design. The Behaviour Change Wheel (BCW) and COM-B model will be used to as a guide to intervention design. The group will debate the merits of various school-based interventions, develop strategies and work on refining an intervention they believe would be best suited, including whom would be best suited as 'project leaders'. Research methods used to evaluate interventions will be discussed, such as a mixed-methods, qualitative, or quantitative approaches.
- **Planning for recruitment and data collection**: Questionnaires and appropriate measurement tools will be trialled among the group. Recruitment strategies within the school will be developed, e.g., posters. A suitable platform of communication will be decided upon to share updates about the project, e.g., a twitter page.
- **Final intervention details, evaluation and meeting with Steering Committee:** The intervention will be finalised, and a complete protocol developed (TIDieR checklist). The intervention will be presented to the Steering Committee for review.

The TIDieR (Template for Intervention Description and Replication) Checklist

Information to include when describing an intervention and the location of the information

Item number	Item	
	BRIEF NAME	
1.	Provide the name or a phrase that describes the intervention.	The Girls Active Project: a peer-led, after-school physical activity intervention
	WHY	
2.	Describe any rationale, theory, or goal of the elements essential to the intervention.	The Girls Active Project intervention was developed using the Behaviour Change Wheel, in combination with Public and Patient Involvement and aims to increase adolescent females' physical activity levels.
	WHAT	
3.	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (e.g., online appendix, URL).	The Girls Active Project intervention includes intervention providers (Transition Year students, adolescent females aged 15 to 17, known as 'Project Leaders') delivering exercise classes to other students (intervention recipients) on a weekly basis for 45-minutes after-school. The Project Leaders work as a team to choose what activities (content) they deliver (e.g., dancing, boxing, football) and change it on a weekly-basis to offer variety.
4.	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.	The Girls Active Project intervention consists of the delivery of 21 Behaviour Change Techniques. The school staff will support Project Leaders to deliver the school-based intervention. Details of the Girls Active Project intervention and benefits of participating in PA will be communicated to the students, parents/guardians and school staff via the school's digital media (social media), newsletter and posters. This aims to provide information about the Girls Active Project intervention, and also encourage social support from students' families, peers and school staff. Class attendance will be monitored. Project Leaders will be required to complete a self-reported provider checklist 'Project Leader logbook' after each exercise class. Intervention recipients would have opportunities to win prizes (e.g., vouchers) and a Girls Active Project 'Certificate of Award' will be rewarded to intervention recipients after their participation in the after-school PA programme. Project Leaders (intervention providers) also receive a Girls Active Project 'Certificate of Achievement' for their involvement in the Girls Active Project intervention.
	WHO PROVIDED	
5.	For each category of intervention provider (e.g., psychologist, nursing assistant), describe their expertise, background and any specific training given.	Intervention providers are Transition Year students (adolescent females aged 15 to 17) attending the school. They would voluntarily become a Girls Active Project 'Project Leader'. If applicable, their time as Project Leaders will contribute towards their 'Gaisce Award' (a national award part of a self-directed personal development programme). The Project Leaders will be briefed by the researcher and physical education teacher of their role in the intervention. Training for the intervention providers (Project Leaders) consists of workshops organised with the physical education teacher and researcher. Project Leaders are informed about the class structure and Project Leaders decide what activities they will deliver each week.

		Each 45-minute class will follow a similar structure: a) welcome and introductions made to intervention recipients and mention the purpose of the Girls Active Project, b) intervention recipients given a chance to contribute and ask questions; c) exercises explained and demonstrated, and intervention recipients given a chance to practise the exercises; d) intervention recipients congratulated for participating and reminded about next week's class. All Project Leaders will work as team to deliver the intervention. The researcher and physical education teacher will be present at each exercise class to supervise and provide additional support if required.
	HOW	
6.	Describe the modes of delivery (e.g., face-to-face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a group.	The Girls Active Project intervention will be delivered to intervention recipients via a face to face group exercise class by the Project Leaders (intervention providers). The intervention will be supported by 'distance' delivery at a population-level via the school's digital media (social media), newsletter and posters displayed in the school.
	WHERE	
7.	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.	The Girls Active Project intervention will be delivered after school in the school setting (sports hall and playing field).
	WHEN and HOW MUCH	
8.	Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity, or dose.	The Girls Active Project intervention will be delivered for 45-minutes once a week, after school. It will be delivered every Tuesday starting at 4pm, during the academic term, January to May 2021, excluding holidays.
	TAILORING	N/A (intervention not yet delivered).
9.	If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how.	
	MODIFICATIONS	
10.‡	If the intervention was modified during the course of the study, describe the changes (what, why, when, and how).	N/A (intervention not yet delivered).
	HOW WELL	
11.	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.	Fidelity of intervention delivery will be assessed using the self-reported provider checklist (Project Leader logbooks). Further details will be provided in the Girls Active Project feasibility study paper.
12.‡	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.	N/A (intervention not yet delivered).

** **Authors** - use N/A if an item is not applicable for the intervention being described. **Reviewers** – use '?' if information about the element is not reported/not sufficiently reported.

† If the information is not provided in the primary paper, give details of where this information is available. This may include locations such as a published protocol or other published papers (provide citation details) or a website (provide the URL).

‡ If completing the TIDieR checklist for a protocol, these items are not relevant to the protocol and cannot be described until the study is complete.

* We strongly recommend using this checklist in conjunction with the TIDieR guide which contains an explanation and elaboration for each item.

* The focus of TIDieR is on reporting details of the intervention elements (and where relevant, comparison elements) of a study. Other elements and methodological features of studies are covered by other reporting statements and checklists and have not been duplicated as part of the TIDieR checklist. When a **randomised trial** is being reported, the TIDieR checklist should be used in conjunction with the CONSORT statement (see www.consort-statement.org) as an extension of **Item 5 of the CONSORT 2010 Statement.** When a **clinical trial protocol** is being reported, the TIDieR checklist should be used in conjunction with the SPIRIT statement as an extension of **Item 11 of the SPIRIT 2013 Statement** (see www.spirit-statement.org**)**. For alternate study designs, TIDieR can be used in conjunction with the appropriate checklist for that study design (see www.equator-network.org).

Appendix D: Supplementary material study 3

Girls Active Project: Project Leaders Logbook – Online

Hi GAP Project Leader!

Thanks again for being a leader and playing a key role in making your school more active.

Please answer the following questions about today's exercise class. It won't take too long.

Remember there are no right or wrong answers and please be as honest as you can.

Q1 Todays Date (dd/mm/yyyy):

_____

Q2 Your Name

_____

Q3 Did the exercise class start on time? (4pm Tuesday)

- ○ Yes (1)
- ○ No (2)

Q4 Was the exercise class delivered as planned?

- ○ Yes (1)
- ○ No (2)

Display This Question:
If Q4 = Yes

Q5 If yes, give details:

_____

_____

_____

_____

_____

Display This Question:
If Q4 = No

Q6 If no, why not?

_____

_____

_____

_____

Q7 Please indicate whether or not the following factors were addressed or completed during today's class:

	Yes (1)	No (2)	Unsure (3)
Welcome and Introductions were made (1)	○	○	○
Purpose of the Girls Active Project was mentioned (2)	○	○	○
Second years were given a chance to contribute to the discussion and ask questions (3)	○	○	○
Exercises were explained and demonstrated (4)	○	○	○
Second years were given a chance to practice the exercises (5)	○	○	○
Second years were congratulated for joining the class and encouraged to be active (6)	○	○	○
Second years were reminded about next week's class (7)	○	○	○

Q8 Thank you for completing the logbook.

Any further comments, recommendations or observations you'd like to add, please write them here:

_____

_____

_____

_____

_____

End of Block: Evaluation

Intervention Recipients Attendance

ID	Record of Attendance (mark with □) Exercise Class									Notes
	1	2	3	4	5	6	7	8	Total	
	Date	Date	Date	Date	Date	Date	Date	Date		
A										
B										
C										
D										
E										
F										
G										
H										
I										
J										
Total										

Project Leaders Attendance

ID	Record of Attendance (mark with □) Exercise Class								Total
	1	2	3	4	5	6	7	8	
A									
B									
C									
D									
E									
F									
Total									

Intervention Recipients: Instructions for Physical Measures

Height Protocol

Record in Centimetres (cm) please

Equipment: Measuring tape

1. Remove shoes
2. If the hairstyle affects your height, adjust it for the test
3. Stand with heels and toes together
4. Arms loosely by your side and back straight
5. Look straight ahead
6. Take a deep breath and stand as straight as possible without your heels lifting off the ground.

Weight Protocol

Record in Kilograms (kg) please (to the nearest .1kg)

Equipment: Scales

1. Wear only light garments
2. Remove items such as your phone and keys from pockets
3. Remove shoes.
4. Stand on the scales, with both feet fully on the weighing platform, heels towards the back edge, and arms loosely by your side.
5. Remain as still as possible with your head facing forward.
6. Step down from the scale.

Please record your height (cm) and weight (to the nearest .1kg). You will be asked to answer this in the questionnaire. Thank you very much for taking part.

Researchers contact details: Sara McQuinn, sara.mcquinn2@mail.dcu.ie, 087-XXX XXXX

Intervention Recipients: Baseline Questionnaire

Girls Active Project

Welcome to the Girls Active Project

Remember:

1. There are no right or wrong answers - this is not a test.
2. Please answer all the questions as honestly and accurately as you can - this is very important.

The information gathered will be kept strictly confidential. No identifying information about you will ever be published or shared.

You can play 2 or 3 of your favourite songs, drink a cup of tea and complete the questionnaire (it will take approximately 10 minutes to complete).

Today's Date: (dd/mm/yyyy)

_____

Q1.1 Full Name:
(this will be replaced with an I.D. Code)

_____

Q1.2 Date of Birth: (dd/mm/yyyy)

_____

Q1.3 Nationality (drop down list)

_____

Q1.3.1 (Other) Nationality. Please Specify:

_____

Q1.4 Do you have a disability?

O Yes O No O Rather not say

Q1.5 What is the name of the Street you live on?

Do not give your house number. For example, XXX etc.

_____

You were provided with instructions and asked to measure your height (in centimetres) and weight (in kilograms) at home. Please note your measurements below:

Q2.1 Height (cm): *(leave blank if you'd rather not say)*

_____

Q2.2 Weight (kg), to the nearest .1kg: *(leave blank if you'd rather not say)*

_____

Read the following statements before answering the two questions below.
Physical activity is any bodily movement.

Physical activity includes: Exercises - Weight training, aerobics, jogging, dancing, etc. Sports - Hurling, football, athletics, swimming, etc. General - Brisk walking, washing the car, walking, or cycling to school, etc. It can be done at different levels of effort:

Moderate Effort makes your heart rate and breathing rate faster than normal. You may also sweat a little. Brisk walking and jogging are good examples.

Vigorous Effort makes your heart rate much faster, and you have to breathe deeper and faster than normal. You will probably sweat. Playing football or tennis are good examples.

Please try to think carefully and be as accurate as possible with your answers.
For these next two questions, add up all the time you spend in physical activity each day. Only include activities of either MODERATE or VIGOROUS effort (as described above).

Q3.1 Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

Q3.2. Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day? Only include activities of either MODERATE or VIGOROUS effort. Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

The following questions will ask you about your health and well-being.

Q4.1 Would you say your health is..?

o Excellent (4) o Good (3) o Fair (2) o Poor (1)

Q4.2 Here is a ladder. The top of the ladder "10" is the best possible life for you and the bottom "0" is the worst possible life for you.
In general, where on the ladder do you feel you stand at the moment?

- 10 Best possible life
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- 0 Worst possible life

Q5.1 On a scale of 1 (Disagree a lot) to 5 (Agree a lot), please read the below statements

	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
I can be physically active during my free time on most days. (1)	○	○	○	○	○
I can ask my parent or other adult to do physically active things with me. (2)	○	○	○	○	○
I can be physically active during my free time on most days even if I could watch TV or play video games instead. (3)	○	○	○	○	○
I can be physically active during my free time on most days even if it is very hot or cold outside. (4)	○	○	○	○	○
I can ask my best friend to be physically active with me during my free time on most days. (5)	○	○	○	○	○
I can be physically active during my free time on most days even if I have to stay at home. (6)	○	○	○	○	○
I have the coordination I need to be physically active during my free time on most days. (7)	○	○	○	○	○
I can still be physically active during my free time on most days no matter how busy my day is. (8)	○	○	○	○	○

Q5.2 When I am active...

	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
... I enjoy it (1)	○	○	○	○	○
... I feel bored. (2)	○	○	○	○	○
... I dislike it. (3)	○	○	○	○	○
... I find it pleasurable (4)	○	○	○	○	○
... it's no fun at all. (5)	○	○	○	○	○
... it gives me energy (6)	○	○	○	○	○
... it makes me depressed (7)	○	○	○	○	○
... it's very pleasant (8)	○	○	○	○	○
...my body feels good (9)	○	○	○	○	○
... I get something out of it (10)	○	○	○	○	○
... it's very exciting (11)	○	○	○	○	○
... it frustrates me. (12)	○	○	○	○	○
... it's not at all interesting. (13)	○	○	○	○	○
... it gives me a strong feeling of success (14)	○	○	○	○	○
... it feels good (15)	○	○	○	○	○
... I feel as though I would rather be doing something else. (16)	○	○	○	○	○

Thank you for taking the time to complete this questionnaire.
Your response has been recorded.

We hope you enjoy the Girls Active Project!

Girls Active Project

Girls Active Project

Intervention Recipients: Mid-Questionnaire

Remember:

1. There are no right or wrong answers - this is not a test.
2. Please answer all of the questions as honestly and accurately as you can - this is very important.

The information gathered will be kept strictly confidential. No identifying information about you will ever be published or shared.

You can play 2 or 3 of your favourite songs, drink a cup of tea and complete the questionnaire (it will take approximately 10 minutes to complete).

Today's Date (dd/mm/yyyy):

_____

Q1.1 Name:
(this will be replaced with an I.D. Code)

_____

You were provided with instructions and asked to measure your height (in centimetres) and weight (in kilograms) at home. Please note your measurements below:

Q2.1 Height (cm): _____ *(leave blank if you'd rather not say)*

Q2.2 Weight (kg) to the nearest .1kg: _____ *(leave blank if you'd rather not say)*

Read the following statements before answering the two questions below.
Physical activity is any bodily movement.

Physical activity includes: Exercises - Weight training, aerobics, jogging, dancing, etc. Sports - Hurling, football, athletics, swimming, etc. General - Brisk walking, washing the car, walking or cycling to school, etc. It can be done at different levels of effort:

Moderate Effort makes your heart rate and breathing rate faster than normal. You may also sweat a little. Brisk walking and jogging are good examples.

Vigorous Effort makes your heart rate much faster, and you have to breathe deeper and faster than normal. You will probably sweat. Playing football or tennis are good examples.

Please try to think carefully and be as accurate as possible with your answers. For these next two questions, add up all the time you spend in physical activity each day. Only include activities of either MODERATE or VIGOROUS effort (as described above).

Q3.1 Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
○	○	○	○	○	○	○	○

Q3.2 Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day? Only include activities of either MODERATE or VIGOROUS effort. Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
○	○	○	○	○	○	○	○

The following questions will ask you about your health and well-being.

Q4.1 Would you say your health is..?

o Excellent (4) o Good (3) o Fair (2) o Poor (1)

Q4.2 Here is a ladder. The top of the ladder "10" is the best possible life for you and the bottom "0" is the worst possible life for you.
In general, where on the ladder do you feel you stand at the moment?

- 10 Best possible life
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- 0 Worst possible life

Q5.1 On a scale of 1 (Disagree a lot) to 5 (Agree a lot), please read the below statements

	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
I can be physically active during my free time on most days. (1)	○	○	○	○	○
I can ask my parent or other adult to do physically active things with me. (2)	○	○	○	○	○
I can be physically active during my free time on most days even if I could watch TV or play video games instead. (3)	○	○	○	○	○
I can be physically active during my free time on most days even if it is very hot or cold outside. (4)	○	○	○	○	○
I can ask my best friend to be physically active with me during my free time on most days. (5)	○	○	○	○	○
I can be physically active during my free time on most days even if I have to stay at home. (6)	○	○	○	○	○
I have the coordination I need to be physically active during my free time on most days. (7)	○	○	○	○	○
I can still be physically active during my free time on most days no matter how busy my day is. (8)	○	○	○	○	○

Q5.2 When I am active...

	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
... I enjoy it (1)	○	○	○	○	○
... I feel bored. (2)	○	○	○	○	○
... I dislike it. (3)	○	○	○	○	○
... I find it pleasurable (4)	○	○	○	○	○
... it's no fun at all. (5)	○	○	○	○	○
... it gives me energy (6)	○	○	○	○	○
... it makes me depressed (7)	○	○	○	○	○
... it's very pleasant (8)	○	○	○	○	○
...my body feels good (9)	○	○	○	○	○
... I get something out of it (10)	○	○	○	○	○
... it's very exciting (11)	○	○	○	○	○
... it frustrates me. (12)	○	○	○	○	○
... it's not at all interesting. (13)	○	○	○	○	○
... it gives me a strong feeling of success (14)	○	○	○	○	○
... it feels good (15)	○	○	○	○	○
... I feel as though I would rather be doing something else. (16)	○	○	○	○	○

Q6.1 On a scale of 1 (dislike very much) to 5 (like very much), please tell us how much you liked the following aspects of the Online Girls Active Project

	Dislike very much (1)	Dislike somewhat	Neither like nor dislike	Like somewhat	Like very much (5)
Organisation	○	○	○	○	○
Length of delivery (duration of classes)	○	○	○	○	○
Date(s) of delivery	○	○	○	○	○
Start and end time	○	○	○	○	○
It being online	○	○	○	○	○
Variety of activities each week	○	○	○	○	○
Information provided	○	○	○	○	○
Delivery of activity: Project leaders (Transition Years) delivering the classes	○	○	○	○	○
Overall satisfaction	○	○	○	○	○

Q7.1 On a scale of 1 (not at all) to 5 (extremely), please tell us how much the following aspects of the Online Girls Active Project encouraged or motivated you to participate:

	Not at all (1)	**Slightly (2)**	**Moderately (3)**	**Very (4)**	**Extremely (5)**
The Girls Active Project Certificate	○	○	○	○	○
Prizes (vouchers, etc.)	○	○	○	○	○
My friends	○	○	○	○	○
My family	○	○	○	○	○
Being with others	○	○	○	○	○
Meeting new people	○	○	○	○	○
Wanting to be physically fit	○	○	○	○	○
Improving my health and well-being	○	○	○	○	○
Improving my cardiovascular fitness	○	○	○	○	○
Learning new skills	○	○	○	○	○
Challenging myself	○	○	○	○	○

Q8.1 Would you like for this online Girls Active Project to stay in the school?

Yes	No	Unsure

Q8.2 Would you continue to participate in the online Girls Active Project if it stayed in the school permanently?

Yes	No	Unsure

Q9. Do you have any other comments you would like to share about the Girls Active Project?

Please feel free to make any additional observations here:

_____

_____

_____

_____

Thank you for taking the time to complete this questionnaire.
Your response has been recorded.

We hope you enjoy the Girls Active Project!

Girls Active Project

Intervention Recipients: Post-Questionnaire

Remember:

1. There are no right or wrong answers - this is not a test.
2. Please answer all of the questions as honestly and accurately as you can - this is very important.

The information gathered will be kept strictly confidential. No identifying information about you will ever be published or shared.

You can play 2 or 3 of your favourite songs, drink a cup of tea and complete the questionnaire (it will take approximately 10 minutes to complete).

Today's Date (dd/mm/yyyy):

_____

Q1.1 Name:
(this will be replaced with an I.D. Code)

_____

You were provided with instructions and asked to measure your height (in centimetres) and weight (in kilograms) at home. Please note your measurements below:

Q2.1 Height (cm): _____ *(leave blank if you'd rather not say)*

Q2.2 Weight (kg) to the nearest .1kg: _____ *(leave blank if you'd rather not say)*

Read the following statements before answering the two questions below.
Physical activity is any bodily movement.
Physical activity includes: Exercises - Weight training, aerobics, jogging, dancing, etc. Sports - Hurling, football, athletics, swimming, etc. General - Brisk walking, washing the car, walking or cycling to school, etc. It can be done at different levels of effort:

Moderate Effort makes your heart rate and breathing rate faster than normal. You may also sweat a little. Brisk walking and jogging are good examples.
Vigorous Effort makes your heart rate much faster, and you have to breathe deeper and faster than normal. You will probably sweat. Playing football or tennis are good examples.

Please try to think carefully and be as accurate as possible with your answers.
For these next two questions, add up all the time you spend in physical activity each day. Only include activities of either MODERATE or VIGOROUS effort (as described above).

Q3.1 Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

Q3.2. Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day? Only include activities of either MODERATE or VIGOROUS effort. Please tick one number.

0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
◯	◯	◯	◯	◯	◯	◯	◯

The following questions will ask you about your health and well-being.

Q4.1 Would you say your health is..?

o Excellent (4) o Good (3) o Fair (2) o Poor (1)

Q4.2 Here is a ladder. The top of the ladder "10" is the best possible life for you and the bottom "0" is the worst possible life for you.
In general, where on the ladder do you feel you stand at the moment?

- 10 Best possible life
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- 0 Worst possible life

Q5.1 On a scale of 1 (Disagree a lot) to 5 (Agree a lot), please read the below statements

	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
I can be physically active during my free time on most days. (1)	○	○	○	○	○
I can ask my parent or other adult to do physically active things with me. (2)	○	○	○	○	○
I can be physically active during my free time on most days even if I could watch TV or play video games instead. (3)	○	○	○	○	○
I can be physically active during my free time on most days even if it is very hot or cold outside. (4)	○	○	○	○	○
I can ask my best friend to be physically active with me during my free time on most days. (5)	○	○	○	○	○
I can be physically active during my free time on most days even if I have to stay at home. (6)	○	○	○	○	○
I have the coordination I need to be physically active during my free time on most days. (7)	○	○	○	○	○
I can still be physically active during my free time on most days no matter how busy my day is. (8)	○	○	○	○	○

Q5.2 When I am active...	Disagree a lot (1)	Disagree a little (2)	Neither Agree nor Disagree (3)	Agree a little (4)	Agree a lot (5)
... I enjoy it (1)	○	○	○	○	○
... I feel bored. (2)	○	○	○	○	○
... I dislike it. (3)	○	○	○	○	○
... I find it pleasurable (4)	○	○	○	○	○
... it's no fun at all. (5)	○	○	○	○	○
... it gives me energy (6)	○	○	○	○	○
... it makes me depressed (7)	○	○	○	○	○
... it's very pleasant (8)	○	○	○	○	○
...my body feels good (9)	○	○	○	○	○
... I get something out of it (10)	○	○	○	○	○
... it's very exciting (11)	○	○	○	○	○
... it frustrates me. (12)	○	○	○	○	○
... it's not at all interesting. (13)	○	○	○	○	○
... it gives me a strong feeling of success (14)	○	○	○	○	○
... it feels good (15)	○	○	○	○	○
... I feel as though I would rather be doing something else. (16)	○	○	○	○	○

Q6.1 On a scale of 1 (dislike very much) to 5 (like very much), please tell us how much you liked the following aspects of the in-person Girls Active Project

	Dislike very much (1)	Dislike somewhat	Neither like nor dislike	Like somewhat	Like very much (5)
Organisation	○	○	○	○	○
Length of delivery (duration of classes)	○	○	○	○	○
Date(s) of delivery	○	○	○	○	○
Start and end time	○	○	○	○	○
It being in-person	○	○	○	○	○
Variety of activities each week	○	○	○	○	○
Information provided	○	○	○	○	○
Delivery of activity: Project leaders (Transition Years) delivering the classes	○	○	○	○	○
Overall satisfaction	○	○	○	○	○

Q6.2 Did you prefer participating in the Girls Active Project online or in-person?

Online	In-Person	Unsure	Liked both equally

Q7.1 On a scale of 1 (not at all) to 5 (extremely), please tell us how much the following aspects of the in-person Girls Active Project encouraged or motivated you to participate:

	Not at all (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)
The Girls Active Project Certificate	○	○	○	○	○
Prizes (vouchers, etc.)	○	○	○	○	○
My friends	○	○	○	○	○
My family	○	○	○	○	○
Being with others	○	○	○	○	○
Meeting new people	○	○	○	○	○
Wanting to be physically fit	○	○	○	○	○
Improving my health and well-being	○	○	○	○	○
Improving my cardiovascular fitness	○	○	○	○	○
Learning new skills	○	○	○	○	○
Challenging myself	○	○	○	○	○

Q8.1 Would you like for the in-person Girls Active Project to stay in the school?

Yes	No	Unsure

Q8.2 Would you continue to participate in the in-person Girls Active Project if it stayed in the school permanently?

Yes	No	Unsure

Q8.3 Is there anything the school can do to encourage or support you to take part in the Girls Active Project?

_____

_____

_____

_____

Q9.1 List the top three things you liked most about the Girls Active Project (online and/or in-person):

_____1._____

_____2._____

_____3._____

Q9.2 List the top three things you liked least (or things that need improving) about the Girls Active Project (online and/or in-person):

_____1._____

_____2._____

_____3._____

Q10.1 Were there any barriers to you maintaining involvement in the Girls Active Project?

Yes	No	Unsure

Q10.2 If you answered 'yes' to the above, what were the barriers to you maintaining involvement?

_____

_____

_____

Q11.1 Did you understand the relevance of the Girls Active Project?

Yes	No	Unsure

Q11.2 Do you think the current pandemic (COVID-19) impacted your participation in the Girls Active Project?

Yes	No	Unsure

Q11.3 Please explain how the current pandemic did/did not impact your participation in the Girls Active Project:

_____

_____

_____

Q11.4 Do you think the questionnaires and focus group(s) with the researcher (Sara) as part of this study were acceptable?

Yes	No	Unsure

Q12.1 Do you have any other comments you would like to share about the Girls Active Project?

Please feel free to make any additional comments here:

_____

_____

_____

Thank you for taking the time to complete this questionnaire.
We hope you enjoyed the Girls Active Project!

Mid-intervention: Focus Group Topic Guide
Intervention Recipients

Acceptability – Satisfaction

1. Were you happy with the GAP online?
2. Were you engaged with the GAP online?
3. Were there any exercise classes online that you particularly liked/disliked?
4. Did you like the dates, times, length/duration, variety (exercises) of the classes?
5. Did you like that the TYs (Project Leaders) delivered the classes?
6. Is there anything (more) the school could do to support or encourage you to participate in the GAP?

Retention

7. What aspects of the GAP encouraged/motivated you to participate? (i.e., what motivated you to participate in the GAP?) E.g., seeing friends, improve health, learn new skills, win prizes

Implementation + Context

8. Could you understand the relevance/purpose of the GAP?
9. What helped and/or hindered you attending online? [barriers/facilitators]

Compatibility – perceived sustainability

10. Will you continue to participate in the GAP when it's delivered in-person?
11. Would you continue if it were delivered online?

12. Would you continue to participate in the GAP if it stayed permanently in the school?

13. How can we get more second years to participate?

Additional

14. Any further comments you'd like to make about the Girls Active Project – Online and/or in-person?

Post-intervention: Focus Group Topic Guide

Intervention Recipients

Retention

1. Why did you participate in the GAP? What aspects of the GAP encouraged/motivated you to participate? (i.e., what motivated you to participate in the GAP after school?) e.g., seeing friends, improve health, learn new skills, win prizes

Acceptability – Satisfaction

2. Overall, what did you like most about the GAP? And what did you like least about the GAP? Did you prefer it online or face-to-face?

3. Were you happy with the GAP at school (in-person delivery)?

4. Did you like the dates, times, length/duration, variety (exercises) of the classes?

5. Did you like that the TYs (Project Leaders) delivered the classes?

6. Were the questionnaires and focus groups as part of this study okay?

7. Is there anything (more) the school could do to support or encourage you to participate in the GAP?

Implementation + Context

8. Could you understand the relevance/purpose of the GAP?

9. What factors helped or hindered you to attend the GAP after school? (Maintain involvement – motivators/barriers)

a. Do you think the current pandemic (COVID-19) impacted (positively and/or negatively to) your participation in the GAP? (and if so, how?)

Compatibility – perceived sustainability

10. Moving forward, would you like for the in-person delivered GAP to remain as an option in the school?
11. Would you continue to participate in the GAP if it stayed permanently in the school?
12. Would you recommend your classmate/friends to participate in the GAP?
13. Do you think it could work as a whole-school programme? i.e., all students (year one to six) would be invited to join and TYs deliver the classes. Why/why not?

Additional

14. Any further comments you'd like to make about the Girls Active Project – Online and/or in-person?

Mid-intervention: Focus Group Topic Guide
Project Leaders

Role: Project Leaders delivered the intervention (intervention providers)

Acceptability – Satisfaction

1. Did you enjoy being a project leader? Why/why not?
2. How happy were you with the GAP online?
3. In your opinion, how happy were the second years [intervention recipients] with the GAP online?
4. In your opinion, were the second years [intervention recipients] engaged in the GAP online? (Even with their cameras off)
5. Did you like the dates, times, length/duration, variety (content) of the classes?

Implementation + Context

6. Was the intervention implemented as planned?
7. What factors helped and/or hindered you to deliver the GAP online?

   [barriers and/or facilitators that affected GAP online implementation]

8. Was there (and if so, what) strategies/structures (were) built by the school to support the GAP?
9. Is there anything more the school can do to support or encourage you (and other students) to participate in the GAP?

Compatibility – sustainability

10. Do you think (and if so, to what extent) would the online GAP be sustainable/used long-term in the school?
11. Will you continue to deliver the GAP when it's in-person?
12. How can we get more second years (intervention recipients) to participate?

Additional

13. Any further comments you'd like to make about the Girls Active Project intervention?

Post-intervention: Focus Group Topic Guide
Project Leaders

Role: Project Leaders delivered the intervention (intervention providers)

Acceptability – Satisfaction

1. Did you enjoy being a project leader? Why/why not?
2. Did you enjoy working as part of a team? Do you think you all worked well as a team?
3. Were you happy with the GAP?
4. In your opinion, were the second years (intervention recipients) engaged and/or happy with the GAP?
5. Did you like the dates, times, length/duration, variety (content) of the classes?
6. How did you find the focus groups and feedback questionnaire as part of this study?

Implementation + Context

7. As a project leader, how was it completing the weekly logbooks?
8. Were there any barriers to you being a Project Leader? If so, what were they?
9. Could you understand the relevance/purpose of the GAP?
10. Do you think the GAP was implemented as planned?
11. What factors helped and/or hindered delivering the GAP?
    - Do you think the current pandemic (COVID-19) impacted (positively and/or negatively) participation in the GAP? (and if so, how?)
12. Were there strategies/structures built by the school to support the GAP? (and if so, what were they?)
13. Is there anything more the school can do to support or encourage you (and other students) to participate in the GAP?

Compatibility + Retention

14. Why did you become a project leader? [What aspects of the GAP encouraged/motivated you to participate?] e.g., seeing friends, improve health, learn new skills, win prizes
15. What did you gain from being a project leader? What are the advantages/disadvantages of being a GAP project Leader? For example, would you recommend other students to become a project leader? And why/why not?
16. Do you think (and if so, to what extent) would the GAP be sustainable/used long-term in the school?
17. Would you continue to participate in the GAP if it stayed permanently in the school?
18. Moving forward, do you think it could work as a whole-school programme? Where all students (year one to six) are invited to join after school and Project Leaders deliver the programme. Why/why not?

Additional

19. Any further comments you'd like to make about the Girls Active Project intervention?

Girls Active Project

Welcome to the Girls Active Project
Project Leaders Feedback Questionnaire (Post-Intervention)

Remember:

1. There are no right or wrong answers - this is not a test.
2. Please answer all the questions as honestly and accurately as you can - this is very important.

It is anonymous. The information gathered will be kept strictly confidential. No identifying information about you will ever be published or shared. It will take approximately 10-15 minutes to complete.

Today's Date (dd/mm/yyyy):

_____

Q1.1 List the top three things you liked most about being a Project Leader in the Girls Active Project:

1. _____
2. _____
3. _____

Q1.2 List the top three things you liked least (or things that need improving) about being a Project Leader in the Girls Active Project:

1. _____
2. _____
3. _____

Q1.3 On a scale of 1 (not at all) to 5 (extremely), please tell us how much the following aspects of the Girls Active Project <u>encouraged or motivated you</u> to be a Leader:

	Not at all (1)	Slightly (2)	Moderately (3)	Very (4)	Extremely (5)
The Girls Active Project Certificate	○	○	○	○	○
Prizes (vouchers, etc.)	○	○	○	○	○
My friends	○	○	○	○	○
My family	○	○	○	○	○
Being with others	○	○	○	○	○
Meeting new people	○	○	○	○	○
Wanting to be physically fit	○	○	○	○	○
Improving my health and well-being	○	○	○	○	○
Improving my cardiovascular fitness	○	○	○	○	○
Develop/Improve leadership skills	○	○	○	○	○
Develop/Improve communication skills	○	○	○	○	○
Develop/Improve teamwork skills	○	○	○	○	○
Challenging myself	○	○	○	○	○

Q1.4 Are there any other aspects of the Girls Active Project that encouraged or motivated you to be a Leader? If so, please write them here:

_____

_____

_____

Q1.5.1 Would you recommend being a Project Leader to other students?

Yes	No	Unsure

Q1.5.2 Please explain, why you would/wouldn't recommend being a Project Leader (i.e., what are the advantages/disadvantages of being a GAP Project Leader?)

_____

_____

_____

Q1.6 If you were involved in the Girls Active Project again, what would you change?

_____

_____

_____

_____

Q1.7.1 Were there any barriers to you maintaining involvement in the Girls Active Project?

Yes	No	Unsure

Q1.7.2 If you answered 'yes' to the above, what were the barriers to you maintaining involvement?

_____

_____

Q2.1 On a scale of 1 (dislike very much) to 5 (like very much), please tell us <u>how much you liked</u> the following aspects of the Girls Active Project

	Dislike very much (1)	Dislike somewhat	Neither like nor dislike	Like somewhat	Like very much (5)
Organisation	○	○	○	○	○
Length of delivery (duration of classes)	○	○	○	○	○
Date(s) of delivery	○	○	○	○	○
Start and end time	○	○	○	○	○
Being a leader delivering the classes	○	○	○	○	○
Variety of activities each week	○	○	○	○	○
Completing the weekly logbooks	○	○	○	○	○
Working as part of a team	○	○	○	○	○
Overall satisfaction	○	○	○	○	○

Q2.2 Did you prefer being a Project Leader for the Girls Active Project online or in-person?

Online	In-Person	Unsure	Liked both equally

Q3.1 Did you understand the relevance of the Girls Active Project?

Yes	No	Unsure

Q3.2 Do you think the current pandemic (COVID-19) impacted participation in the GAP?

Yes	No	Unsure

Q3.3 In your opinion, please explain how the current pandemic impacted participation in the GAP:

_____

_____

_____

Q4.1 Would you like for the Girls Active Project to stay in the school?

Yes	No	Unsure

Q4.2 Would you continue to participate in the Girls Active Project if it stayed in the school permanently?

Yes	No	Unsure

Q4.3 Is there anything more the school can do to encourage or support you to take part in the Girls Active Project?

_____

_____

_____

Q5.1 Do you have any other comments you would like to share about the Girls Active Project?

If so, please feel free to make any additional observations here:

_____

_____

_____

THANK YOU ☺

Parents/Guardians Questionnaire - Online (post-intervention)

Hello and thank you for taking part in this survey.

The following questions will ask you about the Girls Active Project (after school programme Tuesdays, 4pm) at your daughter's school. This is a study being carried out by Dublin City University. We are testing a school-based programme aimed at improving the physical activity levels of teenage girls. We are inviting you to complete this survey to gain insight into your views of the after-school programme. There are no potential risks from involvement. Participation is voluntary and you may withdraw from the survey at any point. The information you provide will be kept strictly confidential and your participation in the study will be private. The information will be stored securely and in a way that protects your identity. If you have any question about the study, please contact Sara McQuinn (087-6121709, sara.mcquinn2@mail.dcu.ie).

If participants have concerns about this study and wish to contact an independent person, please contact: *The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000 e-mail* **rec@dcu.ie**

There are no right or wrong answers and please be as honest as you can. It will take approximately 10 minutes to complete.

Consent

Please note that your responses to this survey are anonymous and your participation will be kept strictly confidential.

I agree to take part in this survey: ○ Yes ○ No

Q1 Todays Date (dd/mm/yyyy):

Q2 Did you know about the Girls Active Project (after school programme, 4pm Tuesdays) at your daughter's school?

○ Yes (1) ○ No (2) ○ Unsure (3)

Q3 Did you understand the relevance of the Girls Active Project? ○ Yes (1) ○ No (2) ○ Unsure (3)

Q4 Did your daughter take part in the Girls Active Project (after school programme, 4pm Tuesdays)? ○ Yes (1)

○ No (2)

Display This Question:

If Did your daughter take part in the Girls Active Project (after school programme, 4pm Tuesdays)? = Yes

Q4.1.1 If yes, why do you think she participated?

_____

_____

Display This Question:

If Did your daughter take part in the Girls Active Project (after school programme, 4pm Tuesdays)? = Yes

Q4.1.2 Please read the below statements and in your opinion, on a scale of 1 (disagree a lot) to 5 (agree a lot), select the answer you feel is most appropriate to you:

My daughter...

	Disagree a lot (1)	Disagree a little	Neither agree nor disagree	Agree a little	Agree a lot (5)	Not Applicable
... enjoyed participating in the Girls Active Project	○	○	○	○	○	○
... found the programme fun and social	○	○	○	○	○	○
... joined because she wanted to be with her friends/meet new people	○	○	○	○	○	○
... participated because she wanted to improve her health and fitness	○	○	○	○	○	○
... participated because there were prizes/rewards	○	○	○	○	○	○
... liked that the Transition Year students delivered the exercise classes	○	○	○	○	○	○
... liked the timing, dates, and duration of the exercise classes	○	○	○	○	○	○
... liked that there was a variety of exercise classes	○	○	○	○	○	○
... would continue to participate in the Girls Active Project if it were to remain in the school	○	○	○	○	○	○

Display This Question:

If Did your daughter take part in the Girls Active Project (after school programme, 4pm Tuesdays)? = Yes

Q4.1.3 Are there any other aspects of the Girls Active Project your daughter seemed to like/dislike? If so, please write them here:

_____

_____

_____

Display This Question:

If Did your daughter take part in the Girls Active Project (after school programme, 4pm Tuesdays)? = No

Q4.2 If not, why do you think she did not participate?

_____

_____

_____

Q5 Would you like the Girls Active Project (after-school programme) to remain as an option to students at the school? ○ Yes (1) ○ No (2) ○ Unsure (3)

Q6 Please indicate if there is anything that the school can do to make it easier for you as a parent to encourage or support your daughter to take part in the Girls Active Project?

_____

Q7 Are there any comments or recommendations about the Girls Active Project you'd like to add? If so, please write them here:

_____

_____

End of Block: Evaluation

Thank you very much for completing the survey. By clicking the 'Next' tab your response will be recorded and you will be re-directed to another form.

Re-directed to another Qualtrics form:

GAP: Parents' Consent to Phone Interview

Thank you.

If you are willing to take part in a short (5-10 minute) recorded phone call interview with the lead researcher, Sara McQuinn, please leave your details below. An audio recorder will be used to record the phone call. The recording will be deleted after transcription. No identifying information will be on the transcription.

Participation will be kept strictly confidential; your information will be stored securely and in a way that protects your identity. By leaving your details below, you agree to take part in a recorded phone call interview.

Q1 Parent/Guardian Name:

_____

Q2 Telephone Number:

_____

Thank You. Thank you for completing the form. We will be in touch shortly.

Post-intervention: Semi-structured interview questions with Parent/Guardian

Implementation + Context

1. Can you remember how you heard/found out about the Girls Active Project (GAP)?
2. Could you understand the relevance (purpose) of GAP?
3. In your opinion, were there any factors that helped or hindered your daughter participating in the GAP? (Online and/or in-person)
   [barriers and/or facilitators that affected GAP implementation] 4. To

what extent did your daughter get involved/engage with the GAP?

Acceptability - Satisfaction

5. Was she happy with the GAP? Did your daughter enjoy being involved in the Girls Active Project? Why/why not?
6. What did she like/dislike about the GAP?
7. Did she prefer it online or in-person (if applicable)?
8. Did you think the timing (after-school) and duration of classes (45 minutes) were okay? Delivery (peer-led) and content (variety of activities) delivered were acceptable?
9. Is there anything the school can do to make it easier for you as a parent to encourage or support your daughter to take part in the GAP?

Compatibility – Sustainability

10. Do you think the GAP could be used long-term in the school? (Do you think there is potential?)
11. Would you like the GAP to remain as an option at the school?
12. In your opinion, what does the GAP have to offer that the other school sports teams and clubs don't?
13. Do you think your daughter would continue to be involved in/support the GAP if it stayed permanently in the school?

Additional Q

14. Any further comments, observations, recommendations you'd like to make about the GAP?

Thank you so much for your time

Post-intervention: Semi-structured interview questions
School Staff Members

Implementation + context

1. To what extent did you/your school/the students get involved/engage with the Girls Active Project (GAP)?
2. Could you understand the relevance of GAP?
3. In your opinion, what factors helped or hindered the GAP being implemented? (Online and in-person) [barriers and/or facilitators that affected GAP implementation]
    a. Do you think the current pandemic (COVID-19) impacted (positively and/or negatively) participation in the GAP? (and if so, how?)
4. What strategies & structures were built by the school to support the GAP?

Acceptability – Satisfaction

5. Did you/your school enjoy being involved in the Girls Active Project? Why/why not? [engagement/responsiveness]
6. What did you like/dislike about the GAP?
7. Were you happy with the GAP?
8. In your opinion, were the students (second years [intervention recipients] and Project Leaders [intervention providers]) engaged and/or happy with the GAP?
9. Did you like the classes - dates, times, length/duration, content variety, (peer-led) delivery?
10. Do you think the research and/or extra workload as part of this study was acceptable? (i.e., communication with research team, interviews and/or focus groups, sharing info. on social media, contacting parents, planning, emailing students, arranging Zoom classes, etc.)?

Compatibility – sustainability

11. Do you think the GAP could be sustainable/used long-term in the school? (Do you think there is potential? And if so, to what extent?)
12. In your opinion, what does the GAP have to offer that the other school sports teams and clubs don't?

13. Would you continue to be involved in/support the GAP if it stayed permanently in the school?
14. Moving forward, do you think it could work as a whole-school programme? Where all students (year one to six) are invited to join after school and Project Leaders deliver the programme. Why/why not?
15. If you were to be involved in the GAP again, is there anything you would you do differently? (and if so, what?)

Additional Q

16. Any further comments you'd like to make about the GAP?

Integrating the Girls Active Project into school policy

Sample 1 [School Name]: Physical activity policy

All students will have opportunities for physical activity beyond physical education class on a daily basis. Students will be encouraged to reduce sedentary time. Teachers will be expected to incorporate opportunities for physical activity in the classroom whenever possible and will be encouraged to serve as role models by being physically active alongside the students.

Lunch break

All school students will have at least X minutes a day of lunch period, during which moderate-to-vigorous physical activity will be encouraged.

Physical Activity Programmes

[School Name] will offer extra-curricular physical activity programmes, such as [list them here, including the Girls Active Project].

Sample 2 [School Name]: Physical activity policy

Policy statement:

[School Name] acknowledges that physical activity is essential to achieving and maintaining optimal health. Regular physical activity has many benefits, such as helping to maintain a healthy weight, and enhancing physical endurance, muscular strength and learning capacity.

[School Name] is committed to developing adolescent's fundamental movement skills and creating positive physical activity experiences for students, in order to encourage participation in regular physical activity throughout life. [School Name] recognises the significant role of parents, families and the community in promoting adolescent's physical activity and limiting student's sedentary and small screen recreation.

[School Name] aims to use a whole of school approach to promote physical activity.
This policy aims to:

1. Encourage students to participate in a variety of physical activity experiences
2. Endorse a school environment that promotes physical activity
3. Encourage family involvement and inform them about the benefits of physical activity

[School Name] will:

1. Teaching and Learning

Encourage students to participate in a variety of physical activity experiences by:

- Ensuring students have a diverse choice of activities in which they can participate
- Providing opportunities for competitive, non-competitive, structured, and un-structured physical activity
- Providing opportunities for students to be involved in the planning and organisation of physical activity

2. School ethos and environment

Endorse a school environment that promotes physical activity by:

- Ensuring the PE hall, sport fields, playground and equipment are available
- Providing adequate space, facilities, equipment and supplies to provide opportunities for students to be physically active
- Encouraging active play during lunch, breaks and after-school programmes
- Providing opportunities to join after-school programmes, such as the Girls Active Project

3. School Community and Partnerships

Encourage family involvement in physical activity and inform them about the benefits of physical activity by:

- Encouraging family involvement with school activities
- Informing parents about the different physical activity programmes available in the school via the school newsletter and social media platforms
- Ensuring parents and the school community have opportunities to review, make comment and contribute to the school physical activity policy
- Providing opportunities for staff to engage in regular physical activity
- Working with community and sporting organisations to provide physical activity opportunities to students and staff

Date: _____

Signed Principal: _____

Girls Active Project Plan

Class	Date/Time	Project Leaders	Exercise/Activity
1			
2			
3			
4			
5			
6			
7			
8			

Exercise Classes: Suggested by Project Leaders

- Dance
- Circuits
- Boxercise
- Football (Soccer)
- Yoga
- GAA Football
- Zumba
- Relay-races
- Hip-hop
- Hurdles
- Basketball
- Boxing
- 'Just Dance' videos
- H.I.I.T.

School Name

Certificate of Achievement

Presented to Project Leader

In recognition of your time and
dedication to the
Girls Active Project

Girls Active Project

Project Manager

Date

Health Research Board

SPHeRE Structured Population and Health-services Research Education

DCU

School Name

Certificate of Award

This acknowledges that

_____

has successfully participated in the
Girls Active Project

Girls Active Project

_____
Project Manager

_____
Date

HRB Health Research Board

SPHeRE Structured Population and Health-services Research Education

DCU

Appendix E: Published papers

BMC Public Health

RESEARCH

Open Access

Co-design of a school-based physical activity intervention for adolescent females in a disadvantaged community: insights from the Girls Active Project (GAP)

Sara McQuinn[1*], Sarahjane Belton[2], Anthony Staines[1] and Mary Rose Sweeney[1]

Abstract

Background: Globally, adolescents' physical activity (PA) participation rates are low, particularly among lower socio-economic groups, with females consistently the least active. The aim of this study was to co-design, with adolescent females, a school-based PA intervention in a single-sex, females-only designated disadvantaged post-primary school in Ireland. This involved using the Behaviour Change Wheel (BCW) and Public and Patient Involvement (PPI). This paper outlines the novel methodological approach taken.

Methods: The three stages 1) understand the behaviour, 2) identify intervention options, and 3) identify content and implementation options of the BCW guide is described. A student PPI Youth Advisory Group (YAG) ($n=8$, aged 15–17) was established. Mixed-methods were used with students ($n=287$, aged 12–18) and teachers ($n=7$) to capture current self-reported PA levels and to identify factors influencing adolescent females' PA behaviour in their school setting. The intervention options, content and implementation options were identified through discussion groups with the YAG. The Template for Intervention Description and Replication (TIDieR) checklist was used to specify details of the intervention.

Results: Just 1.4% of the students in this sample reported meeting the recommended PA guidelines. Students identified having more *'time'* as the strongest predictor to becoming more active in school (Mean = 4.01, 95% CI 3.91 to 4.12). Social influences, environmental context and resources, behavioural regulation, beliefs about capabilities, goals, and reinforcement emerged from the qualitative data as factors influencing PA behaviour at school. The BCW co-design process resulted in the identification of seven intervention functions, four policy categories and 21 Behaviour Change Techniques. The Girls Active Project (GAP) intervention, a peer-led, after-school PA programme was proposed.

Conclusions: This paper describes how the BCW, a comprehensive, evidence-based, theory-driven framework was used in combination with PPI to co-design a school-based intervention aimed to increase adolescent females' PA levels. This approach could be replicated in other settings to develop targeted behavioural interventions in populations with specific demographic characteristics.

Keywords: Physical activity, Behaviour change wheel, Adolescent female, Intervention development, School-based intervention, COM-B, TDF, BCTs

*Correspondence: sara.mcquinn2@mail.dcu.ie
[1] School of Nursing, Psychotherapy and Community Health, Faculty of Science and Health, Dublin City University, Dublin 9, Ireland
Full list of author information is available at the end of the article

Background

Worldwide, more than three-quarters (81%) of adolescents (aged 11-17) do not meet the World Health Organisation recommended physical activity (PA) guidelines [1]. The World Health Organisation recommends that children and adolescents (aged 5–17) do at least an average of 60 min a day of moderate to vigorous physical activity (MVPA) [2]. The robust evidence that informed these guidelines on PA for children and adolescents found that greater amounts and higher intensities of PA are associated with multiple beneficial health outcomes, including cardiometabolic health, physical fitness, bone health, cognitive outcomes, reduced adiposity and a reduced risk of experiencing depression [3]. Research indicates that PA levels decline during adolescence [4–6] and that there are clear gender differences between the PA levels of adolescent females and males, with females less likely to meet recommended guidelines [1, 7, 8]. Evidence also suggests that socio-economic status is correlated to adolescents' PA participation [9, 10], where females with lower socio-economic status are consistently the least active [7]. Inactive adolescents are at a greater risk of long-term ill health [11], and given that participation in PA during adolescence can be a significant contributor to levels of PA in adulthood [12, 13], tackling the decline in PA during adolescence is a major public health priority.

There is no widely accepted explanation for the causes of adolescent females' physical inactivity, but evidence suggest influences are multifactorial, including psychological, social and environmental factors [14, 15]. Females have cited many barriers to their participation, such as time restraints, competing priorities, social influences, low perceived competence, gender social stereotypes and a dislike for structured sports [16–21]. In addition, Martins et al. (2021) found that females and low socio-economic status adolescents faced even further difficulties with environmental factors that were perceived by adolescents to be barriers to PA, including space, infrastructure, equipment and unsuitable PA programmes [18]. Indeed, research indicates that targeting ecological domains beyond the individual level is important in PA interventions for adolescents [22], whilst tailoring these interventions to specific target populations is essential [23].

The current World Health Organisation 'Global Action Plan on Physical Activity (2018–2030)' stated the need to strengthen the development and implementation of behavioural public health interventions targeted at females and vulnerable or marginalised populations, that engage with and increase PA opportunities [24]. The school environment is well-known as a potential setting for targeting PA behaviour among adolescents [25, 26], yet the evidence for the effectiveness of school-based activity interventions is varied [27]. Love et al. (2019) found that current school-based efforts did not positively impact young people's PA across the full day [28], whilst other reviews found multi-component interventions to be effective in the promotion of PA [29–31], with certain intervention strategies, such as after-school PA programmes indicating efficacy [30].

Public and Patient Involvement (PPI) is defined "as research being carried out 'with' or 'by' members of the public rather than 'to', 'about' or 'for' them" [32]. There is evidence to suggest that PPI in research may facilitate the process of translating research evidence into practice and policy [32, 33], contribute to reducing health research waste [34], and can have beneficial impacts for the service users, researchers and community [35], and on the quality and appropriateness of health research [36]. With the aim to capture the contextual input necessary to represent the unique youth experience, the use of PPI 'youth advisory groups' in health research has increased in recent years [37]. Of note, Dennehy et al. [38] found that young people can provide a unique perspective on the design, conduct and interpretation of research that it otherwise not accessible to adult researchers. Findings support however, that more work needs to be done to increase young people's involvement in youth-related research [37, 39] and to enable them to influence the development of interventions that target health and well-being [40].

Theoretical framework underpinning the intervention design

Best practice guidelines for developing interventions recommend using theory as a framework to design the intervention aimed at changing behaviour and suggest that complex interventions may work best if tailored to local circumstances [41]. Indeed, there is compelling evidence that theory-driven school-based PA interventions may be more effective in increasing adolescents females' PA levels than non-theory based interventions [31, 42]. Michie et al. (2011) developed the Behaviour Change Wheel (BCW) from 19 behaviour change frameworks [43, 44]. It is a comprehensive method for developing interventions and is applicable to a range of health behaviours [44]. A 'Behaviour Change Wheel Guide' outlines three stages (eight steps) that should be used to design the behaviour change intervention [43]. These are described in the Methods section.

The COM-B model is at the centre of the Behaviour Change Wheel framework, which suggests that capability, opportunity and motivation (COM) interact to influence behaviour (B) (Fig. 1). There are six COM-B components: physical capability, psychological capability, social opportunity, physical opportunity, reflective

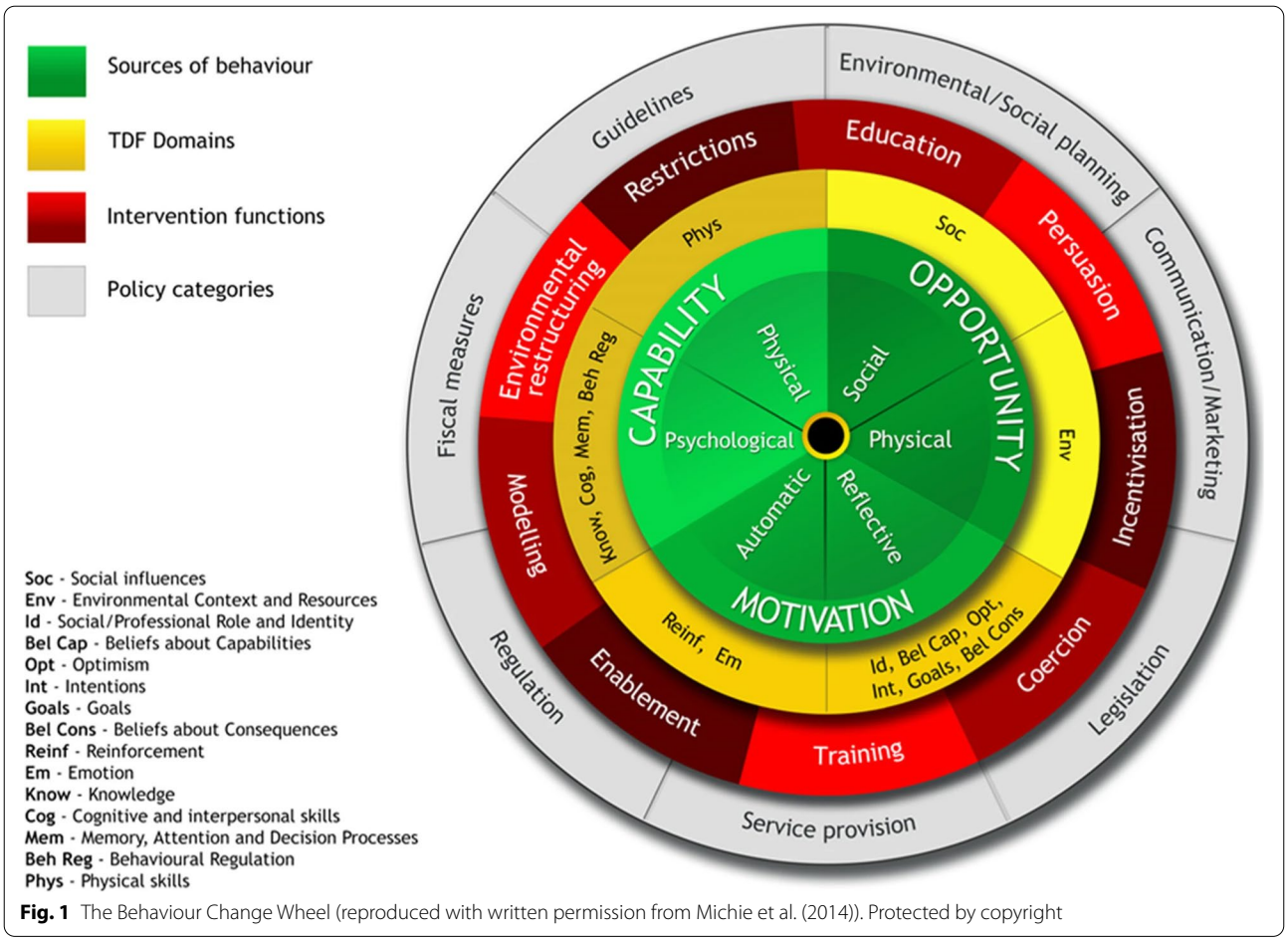


Fig. 1 The Behaviour Change Wheel (reproduced with written permission from Michie et al. (2014)). Protected by copyright

motivation and automatic motivation. There are three layers surrounding the COM-B model. The Theoretical Domains Framework, containing 14 domains, is an integrative framework developed for cross-disciplinary implementation and other behaviour change research [45]. It was added to the Behaviour Change Wheel (forming the second layer in Fig. 1) to allow deeper exploration of the factors influencing behaviour change. The following two layers represent the intervention functions (third layer, Fig. 1), and policy categories (fourth layer, Fig. 1). The Behaviour Change Wheel [43] provides an APEASE (Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity) criteria for researchers to consider when selecting relevant intervention options and content. After information is obtained from the Behaviour Change Wheel, behaviour change techniques can be identified via the behaviour change technique taxonomy [46]. The COM-B model and Behaviour Change Wheel has been successfully used in different contexts to inform and design behaviour change intervention, including providing sexual counselling [47], decreasing sedentary behaviour in the workplace [48] and more specifically, increasing PA [49–53].

The aim of this study was to co-design the Girls Active Project (GAP) intervention to increase PA levels of adolescent females in a single-sex, females-only, designated disadvantaged post-primary school, using the Behaviour Change Wheel (BCW) and Public and Patient Involvement (PPI). To our knowledge, this is the first study that has used this methodological approach.

Methods

Study design

The 'Behaviour Change Wheel Guide' was followed for this intervention development study [43]. A mixed-method approach was used via questionnaires and semi-structured focus groups with a sample of adolescent females (aged 12 to 18) and teachers to understand the target behaviour. Discussion groups with a PPI Youth Advisory Group (adolescent females aged 15 to 17) were used to co-design the school-based PA intervention through identifying intervention options and content. Ethical approval for this study was granted

by Dublin City University Research Ethics Committee (DCUREC/2019/005).

Recruitment

School

One single-sex, females-only, designated disadvantaged post-primary school in Dublin, Ireland was recruited. In Ireland, a classification system known as DEIS (Delivering Equality of Opportunity in Schools) is used by the Department of Education to indicate that the school is based in a community at risk of disadvantage and social exclusion [54]. Taking into account the normal attrition rates in such studies, an email of invitation to participate in the Girls Active Project was sent to the school principal of nine single-sex, females-only, DEIS post-primary schools in Dublin, and a follow-up phone call was made to explain the purpose of the project. The Girls Active Project involved two phases; intervention development and a feasibility trial of the intervention. Three schools showed interest and two accepted the invitation. Just one school retained, thus the scope of the project was widened to include more students. The participating school had 6 year groups and students were aged from 12 to 18.

Research participants and PPI contributors

Research and Public and Patient Involvement (PPI) are separate activities, differing in whether the public are involved as 'research participants' or as 'contributors to the research process', i.e. PPI contributors. Using the terms 'focus group' and 'discussion group' to differentiate between research and public involvement methods has contributed to improved clarity in research [55]. For the purposes of this study, the following definitions by Doria et al. (2018) were used:

'Focus groups' refer to research activities. In focus groups, researchers collect data by speaking with a group of research subjects about their experiences. Researchers use this information to answer research questions and share their findings in academic journals and gatherings.

'Discussion groups' refer to engagement or involvement activities. Discussion groups are a way for the public to help plan research projects. Their contributions are not treated as research data, but instead they help make decisions that shape the research process.

Research participants All students in the school were invited to complete a short anonymous questionnaire during school hours via an electronic portable device. Since the questionnaire was of low risk to students, parental/guardian opt-out (passive) consent was proposed [56, 57]. Conversations took place with the school regarding parental/guardian opt-out consent where they welcomed this process. A week prior to data collection, every student was provided with an information sheet and a parental/guardian opt-out consent form to read and take home to parents/guardians. Students and parents/guardians had time to understand the information and make an informed decision. At the start of the questionnaire, students were asked to provide their assent. Students were excluded from the study if they had not provided assent or if their parent/guardian had completed the parental/guardian opt-out written consent form. Six Junior Cycle students (Years 1 to 3) and six Senior Cycle students (Years 4 to 6) were selected by the physical education teacher and invited to take part in an audio-recorded focus group facilitated by the researcher (SMQ) during school hours. Each focus group aimed to include two students from each year group and a mix of perceived PA levels, based on, for example whether the students participated in physical education class or were involved in sports teams or not. It was believed that the physical education teacher was best placed to have knowledge regarding this. Each student provided written informed assent and parental/guardian consent prior to taking part in the focus group. A Girls Active Project 'Steering Committee' was established in the school. The physical education teacher provided information sheets to members of school staff and parents from the parents council inviting them to join the Steering Committee. All Steering Committee members provided written informed consent before taking part in data collection. More information on these data collection methods are explained below (Behaviour Change Wheel Step 4).

PPI contributors Eight Transition Year students (aged 15 to 17) joined a Girls Active Project 'Youth Advisory Group' and participated in five PPI discussion groups to co-design the school-based PA intervention. In Ireland, Transition Year is a one-year school programme that can be taken in the year after the Junior Cycle and before the two-year Leaving Certificate programme [58]. It is not a standard academic year. The year is designed around giving students life skills and a more hands-on aspect to learning. Written informed assent and parental/guardian consent was obtained from the eight Youth Advisory Group members (PPI contributors). The researcher (SMQ) facilitated five discussion groups during school hours, each lasting 80 min (a double-class). A guide on how to actively involve young people in research [59] was adhered to. The school principal and staff designated time and space for the discussion groups and ensured that the students were available.

The behaviour change wheel

The step-by-step method for designing behaviour change interventions in the Behaviour Change Wheel guide was

used [43]. This included three stages (eight steps) in the intervention design process: understand the behaviour (Stage 1), identify intervention options (Stage 2) and identify content and implementation options (Stage 3).

Stage 1: understand the behaviour (steps 1 to 4)

The need to increase moderate to vigorous PA levels in adolescent females is already well established in the literature [1, 24]. The first PPI discussion group was set-up with the Youth Advisory Group to introduce the researcher (SMQ), explain the specified target behaviour (increase PA levels), the purpose of the Girls Active Project and their role as contributors to the research process. Step 4 of the Behaviour Change Wheel involved identifying what needed to change. The Behaviour Change Wheel guide [43] recommends that data is collected from multiple sources and from more than one method to understand what needs to change, as this will increase confidence in the analysis. Drawing from both the COM-B model and Theoretical Domains Framework, this study used a mixed-method approach (questionnaires and semi-structured focus groups) with multiple research participants (students and teachers).

Questionnaires The student questionnaire took approximately 10 min to complete. It was anonymous and captured information including their age, year group (year 1 to 6) and current PA levels via the PACE+ scale [60]. The PACE+ scale is a two-item PA questionnaire for assessing attainment of PA guidelines and has been previously validated in a sample of 10–18 year old Irish youth [61]. This instrument has been used with adolescents both nationally [8] and internationally [62] and has acceptable reliability. Michie and colleagues developed a COM-B Self-Evaluation Questionnaire (COM-B-Qv1) for individuals relevant to the COM-B model [43]. It contains 23 different statements categorised into 'capability', 'opportunity' and 'motivation'. The individual responds with a yes or no answer. For example, 'For me to do physical activity at school, I would have to … have more physical strength, e.g. build up muscles for demanding physical work'. Its aim is to gain an insight into what it would take for the individual to change their behaviour. Similar to Murtagh et al. (2018) where they used the Behaviour Change Wheel to design the components of a community-based intervention to improve adolescent female's PA, the research team ensured that all of the examples provided in the COM-B-Qv1 were relevant to the target behaviour (PA) and target audience (adolescents aged 12–18). To gain a further understanding into the factors influencing students' participation in PA, the research team replaced the yes or no answer with a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), similar to that used by Ellis et al. (2019), when identifying factors influencing postnatal PA [50]. The questionnaire was piloted amongst the Youth Advisory Group at the first discussion group. They understood the questions and no amendments were necessary based on their feedback. The Youth Advisory Group helped to administer the questionnaires using electronic portable devices over a one-day period, during which the researcher (SMQ) and the Youth Advisory Group visited each classroom individually. Teachers and/or Special Needs Assistants were present if any child required assistance due to reading or physical difficulties. In addition to the COM-B-Qv1, Michie et al. (2014) developed a COM-B Behavioural Diagnosis Form (COM-B-D) for groups/populations. The research team made the same slight adaptations to the COM-B-D and administered it to the Steering Committee via a paper-based questionnaire. These questionnaires along with all other data collection tools used can be found in the attached Supplementary Information File 1.

Focus groups Three semi-structured, audio-recorded focus groups each lasting between 30 to 50 min were facilitated by the researcher (SMQ) during school hours; one with six Junior Cycle students, one with six Senior Cycle students and one with the Steering Committee. The aim of the focus groups were to further investigate which of the COM-B components might influence adolescent females' PA behaviour at school. Questions asked in the focus groups were developed using the COM-B model and the Theoretical Domains Framework. The Theoretical Domains Framework has been validated for use in behaviour change and implementation research [45]. The topic guide was assessed by the Youth Advisory Group at the first discussion group. They understood the questions and no amendments were necessary based on their feedback. Handwritten notes were taken by researcher (SMQ) during each focus group.

Data analysis Questionnaire data was analysed using IBM SPSS Statistics V.25, including the descriptive data analysis of participant characteristics. Physical activity (PACE+) data were scored according to recommended guidelines [60]. The mean, standard deviation (SD) and 95% confidence interval (CI) for each COM-B statement response and for each COM-B component was calculated and categorised into: agree (≥ 4), neutral ($\geq 3 < 4$) and disagree (< 3). The focus groups were transcribed verbatim. Participant confidentiality and anonymity was maintained by using pseudonyms [63]. The COM-B model and Theoretical Domains Framework were used as a combined deductive framework for the analysis [64].

Each transcript was read and re-read several times and coded by the researcher (SMQ). These coded transcripts were reviewed by the research team (SMQ, AS, SJB and MRS) and any discrepancies were resolved by discussion to generate a selection of factors influencing adolescent females' PA behaviour at school.

Stage 2: identify intervention options (steps 5 and 6) and Stage 3: identify content and implementation options (steps 7 and 8)

The remaining four discussion groups with the Youth Advisory Group (PPI contributors) focused on Stage 2 and Stage 3 of the Behaviour Change Wheel. Lay language was used and the Youth Advisory Group were briefly taught about research and study design in a fun environment. The researcher (SMQ) intended to build rapport with the PPI contributors. They played their own music, engaged with each discussion group and shared their thoughts and unique perspectives as both adolescent females, and students attending the school. The researcher (SMQ) aimed for each discussion group to be enjoyable, and supportive, and for the PPI contributors to feel valued and heard. The researcher (SMQ) took notes throughout each discussion group. The analysed results from the questionnaires and focus groups (Step 4) were presented to the Youth Advisory Group. Following Behaviour Change Wheel guidance [43], the researcher (SMQ) and Youth Advisory Group identified potentially relevant intervention functions by linking the COM-B components relevant to the factors influencing adolescent females' participation in PA at school, with intervention functions. Michie et al. (2014) described an 'intervention function' as broad categories of means by which an intervention can change behaviour. The APEASE (Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity) criteria was used to select the most appropriate intervention functions for the Girls Active Project intervention. The next step (Step 6) in the Behaviour Change Wheel involved linking the intervention function to policy categories that are likely to be appropriate and effective in supporting each intervention function [43]. The APEASE criteria was used to select the policy categories most appropriate for the Girls Active Project intervention. Step 7 required identifying the most fitting behaviour change techniques that could result in the increase of adolescent females' PA levels at school. A behaviour change technique is defined as "an active component of an intervention designed to change behaviour" (Michie et al., 2014, p.145). The Behaviour Change Wheel includes an extensive taxonomy of 93 consensually agreed, distinct Behaviour Change Techniques [46]. The Behaviour Change Wheel guide offers a list of behaviour change techniques that are frequently used per intervention function. Behaviour change techniques that did not meet the APEASE criteria within the context of adolescent females' PA behaviour at school were excluded, and the most appropriate behaviour change techniques were shortlisted and decided on through discussion. The final step (Step 8) included applying the APEASE criteria to select the most appropriate modes of delivery for the Girls Active Project intervention. Intervention dimensions including content, provider, setting, recipient, intensity and duration were also deliberated and decided upon. Intervention recruitment and retention strategies were discussed and Girls Active Project posters were designed to display in the school. The Template for Intervention Description and Replication (TIDieR) checklist [65], was employed to specify details of the intervention containing the who, what, how and where of proposed intervention delivery (Supplementary Information File 3). This was discussed with members of the Steering Committee and school principal for feedback and approval. The feasibility trial was registered online: https://doi.org/10.17605/OSF.IO/75HWJ (date of registration: 9th December 2020).

Results

The results of this intervention development study are presented below in accordance with the three stages (eight steps) of the Behaviour Change Wheel intervention design process: understand the behaviour (Stage 1), identify intervention options (Stage 2) and identify content and implementation options (Stage 3). Lastly, an outline of the proposed Girls Active Project intervention is provided.

Stage 1: understand the behaviour (steps 1 to 4)

Research participants' characteristics

The student questionnaire was completed by two hundred and eighty-seven students ($n=287$). A total of 330 females were present in the school on the day of data collection, i.e., 87% of the eligible population completed the questionnaire. There were no missing data. The students ranged from first year to sixth year, aged 12 to 18 (Mean age = 14.82, SD = 1.71). A total of 1.4% reported to meet the recommended PA guideline, i.e. an average of 60 min a day of moderate to vigorous physical activity (MVPA). While almost all females achieved at least 60 min of MVPA 1 day a week (89%), just 15% achieved it five times a week. The mean number of days per week that students undertook at least 60 min of MVPA declined as they got older (age 12 = mean number of days 3.3, to age 18 = mean number of days 2.6.). Six Junior Cycle students (age range = 12 to 15) and six Senior Cycle students (age

range = 15 to 18) participated in the focus groups. Seven teachers (3 male, 4 female) joined the Steering Committee and completed the questionnaire and focus group ($n = 7$).

What needs to change? (step 4)

Table 1 presents student responses to the COM-B statements ($n = 287$). The majority of factors were identified as being 'neutral', i.e., mean scores of ≥3 and < 4. ***'Have more time'*** (physical opportunity) to be active in school was identified by the students as the strongest predictor (Mean = 4.01, 95% CI 3.91 to 4.12). This was followed by ***'develop a habit of doing it'*** (automatic motivation) (Mean = 3.97, 95% CI 3.87 to 4.07), and ***'feel that I want to do it enough'*** (automatic motivation) (Mean = 3.82, 95% CI 3.71 to 3.93). Students would not be more active if they *'have more money'* (physical opportunity) (Mean = 2.99, 95% CI 2.85 to 3.12) (i.e. 'disagree' mean score < 3). Across the six COM-B components, 'automatic motivation' was the strongest predictor to them being active at school with an overall mean score of 3.78 (95% CI 3.69 to 3.87), followed by 'reflective motivation' (Mean = 3.76, 95% CI 3.67 to 3.85).

According to the Steering Committee (n = 7), the strongest predictors to increase adolescent females' PA participation at school were if the students ***'develop a habit of doing it'*** (automatic motivation) (Mean = 4.71, 95% CI 4.26 to 5.17), ***'have more support from others'*** (social opportunity) (Mean = 4.71, 95% CI 4.26 to 5.17) and ***'overcome mental obstacles'*** (psychological capability) (Mean = 4.71, 95% CI 4.26 to 5.17). To *'have more money'* (physical opportunity) (Mean = 2.29, 95% CI 1.01 to 3.56) or to *'have the necessary materials'* (physical opportunity) (Mean = 2.57, 95% CI 2.08 to 3.07) were not regarded by the Steering Committee as predictors to students' PA participation.

The focus group responses identified six domains in the Theoretical Domains Framework as factors influencing adolescent females' PA behaviour at school. Using the COM-B model, psychological capability, physical opportunity, social opportunity, reflective motivation and automatic motivation were recognised as potentially important COM-B components to target. A summary of the identified domains and their associated COM-B component is provided in Table 2.

Psychological capability: Behavioural regulation. Many students didn't plan when they'll participate in PA or have a system in place that objectively managed, monitored, encouraged or regulated their PA behaviour. *"[We have] no [reminders], unless, you're part of a team and you've training"* (Student B, Senior Cycle). *Physical opportunity: Environmental context and resources*. This was the only domain where there was a clear difference in opinion. Barriers were identified by students in the school context that discouraged them to participate in PA, such as a lack of options *"there isn't as many* [sport] *teams for seniors"* (Student C, Senior Cycle) and the changing of uniforms for physical education class. The Steering Committee believed that the students had many choices and opportunities to be active at school, *"We have lots of options"* (Teacher F, Steering Committee), *"There's very little we don't have"* (Teacher B, Steering Committee).

Social opportunity: Social influence. The influence of peers and classmates was identified as both a facilitator to PA participation *"if your friends are there with you, you have more confidence"* (Student B, Junior Cycle) *"I'd probably end up quitting if it weren't for the people on the team"* (Student B, Senior Cycle), and a barrier to PA participation *"you won't do it if there's someone in the group you don't get on with, or if none of your friends are doing it"* [and] *"I don't want to look stupid, or have people laugh at me"* (Student D, Junior Cycle). Steering Committee members also regarded peers' influence as both a barrier, *"they won't play because they're afraid of what their mates would say"* (Teacher F, Steering Committee). *"It's always about how they look, and how they're perceived. That's the number one barrier from what I've seen"* (Teacher C, Steering Committee) and a facilitator to their participation in PA, *"I think being in a group of friends is a really positive aspect of them engaging in physical activity because we know with* [Teacher G], *we do our class and its groups of friends that come, and it's a positive influence all the time"* (Teacher A, Steering Committee).

Reflective motivation: Beliefs about capabilities. *"In terms of capabilities, I think there is loads of capabilities, but they don't often see it"* (Teacher F, Steering Committee). Students' lack of confidence deterred them from being active or to try new sports and activities. They felt self-conscious and often compared their own capabilities to that of their classmates, *"you become very aware of yourself when you're surrounded by girls who are very good at it, and you start to close into yourself"* (Student A, Senior Cycle). *Reflective motivation: Goals.* Other commitments, such as homework and exams resulted in students not prioritising PA or setting goals to participate in PA, *"just trying to fit everything in, you're supposed to get 8 h of sleep, then 3 h of study a night, and then be active as well?"* (Student C, Senior Cycle). The Steering Committee also acknowledged this, particularly as students got older, *"their commitment levels just fall off, and their priorities change"* (Teacher C, Steering Committee).

Automatic motivation: Reinforcement. Students identified negative reinforcements, such as getting a note in their school journal if they didn't bring in their correct uniform for physical education class, but needed more positive reinforcements to participate in PA at school.

Table 1 COM-B Questionnaire statement responses by students ($n = 287$)

Questionnaire statement*			Questionnaire Response (%)					
For me to do physical activity at school, I would have to …	**Mean (SD)**	**95% CI**	**1**	**2**	**3**	**4**	**5**	**Categorisation ****
Capability								
1. Know more about why it is important, e.g. have a better understanding of the benefits of exercising more	3.17 (0.99)	3.06 to 3.29	4.9	20.2	35.2	32.4	7.3	Neutral
2. Know more about how to do it, e.g. have a better understanding of effective ways of exercising or being physically active	3.49 (0.99)	3.37 to 3.60	2.8	15.0	26.1	42.9	13.2	Neutral
3. Have better physical skills, e.g. learn different exercises or movements to help me be physically active	3.49 (1.02)	3.37 to 3.61	3.5	14.3	26.1	41.8	14.3	Neutral
4. Have better mental skills, e.g. learn how to reason more effectively	3.25 (1.04)	3.13 to 3.38	4.5	20.9	29.3	35.2	10.1	Neutral
5. Have more physical strength, e.g. build up muscles for demanding physical work	3.19 (1.13)	3.06 to 3.32	7.0	23.0	26.5	31.4	12.2	Neutral
6. Have more mental strength, e.g. develop stronger resilience against barriers to being more active	3.37 (1.03)	3.25 to 3.49	2.4	22.0	24.4	39.0	12.2	Neutral
7. Overcome physical limitations, e.g. to get around problems of stature of disability	3.17 (1.06)	3.05 to 3.29	7.3	19.5	29.6	35.9	7.7	Neutral
8. Overcome mental obstacles, e.g. develop stronger resilience against the temptation to not exercise	3.49 (1.06)	3.37 to 3.61	3.8	16.0	23.0	41.5	15.7	Neutral
9. Have more physical stamina, e.g. develop a great capacity to maintain physical effort	3.56 (0.97)	3.45 to 3.67	3.5	10.8	25.1	47.4	13.2	Neutral
10. Have more mental stamina, e.g. develop a greater capacity to maintain mental effort	3.49 (0.97)	3.38 to 3.61	2.8	13.6	27.2	44.3	12.2	Neutral
Mean score: psychological capability component (statements: 1,2,4,6,8,10)	3.38 (0.70)	3.30 to 3.46						Neutral
Mean score: physical capability component (statements: 3,5,7,9)	3.35 (0.73)	3.27 to 3.44						Neutral
Opportunity								
11. Have more time to do it, e.g. create dedicated time during the day	4.01 (0.91)	3.91 to 4.12	1.0	6.3	15.3	44.9	32.4	Agree
12. Have more money, e.g. be given or earn funds to support the behaviour	2.99 (1.17)	2.85 to 3.12	7.7	33.1	24.4	22.6	12.2	Disagree
13. Have the necessary materials, e.g. acquire better clothes/shoes/other equipment for the task	3.59 (1.07)	3.47 to 3.72	4.9	10.8	24.0	40.8	19.5	Neutral
14. Have it more easily accessible, e.g. easier access to facilities	3.60 (0.98)	3.49 to 3.71	1.7	12.9	26.5	41.5	17.4	Neutral
15. Have more people around me doing it, e.g. be part of a "crowd" who are doing it	3.26 (1.20)	3.12 to 3.40	9.8	19.2	20.2	36.9	13.9	Neutral
16. Have more triggers to prompt me, e.g. have more reminders at strategic times	3.30 (0.93)	3.20 to 3.41	3.5	15.0	36.2	38.3	7.0	Neutral
17. Have more support from others, e.g. have my friends or classmates behind me	3.42 (1.08)	3.30 to 3.55	4.9	15.3	28.2	35.9	15.7	Neutral
Mean score: physical opportunity component (statements: 11,12,13,14)	3.55 (0.73)	3.46 to 3.63						Neutral
Mean score: social opportunity component (statements: 15,16,17)	3.33 (0.80)	3.24 to 3.42						Neutral
Motivation								
18. Feel that I want to do it enough, e.g. feel more of a sense of pleasure or satisfaction from exercise	3.82 (0.94)	3.71 to 3.93	1.7	7.7	20.6	46.7	23.3	Neutral
19. Feel that I need to do it enough, e.g. care more about the negative consequences of not doing it	3.55 (1.03)	3.43 to 3.67	4.2	10.8	27.9	39.7	17.4	Neutral
20. Believe that it would be a good thing to do, e.g. have a stronger sense that I should do it	3.75 (0.91)	3.64 to 3.86	2.1	7.0	23.7	48.4	18.8	Neutral
21. Develop better plans for doing it, e.g. have a clearer and better developed plan for exercising regularly	3.76 (0.88)	3.66 to 3.86	1.7	5.9	24.7	49.5	18.1	Neutral
22. Develop a habit of doing it, e.g. get into a pattern of exercising regularly without having to think	3.97 (0.88)	3.87 to 4.07	1.0	5.2	18.5	46.3	28.9	Neutral
Mean score: automatic motivation component (statements: 18,19,22)	3.78 (0.76)	3.69 to 3.87						Neutral
Mean score: reflective motivation component (statements: 20,21)	3.76 (0.78)	3.67 to 3.85						Neutral

* participants responded on a scale of 1 (strongly disagree) to 5 (strongly agree)

** mean response to statement categorised as agree ≥ 4, neutral $\geq 3 < 4$, disagree < 3

Table 2 Summary of behavioural diagnosis using the Theoretical Domain Framework and COM-B components over the three focus groups ($n = 19$)

TDF Domain	Domain Definition	Summary	Participant Quote	COM-B Component
Behavioural regulation	Anything aimed at managing or changing objectively observed or measured actions	Adolescent females needed to have systems in place that they could use for monitoring whether they participated in PA. They needed to action-plan, self-monitor and adopt procedures or ways of working that encouraged them to do PA.	"[we have] no [reminders], unless, you're part of a team and you've training" (Student B, Senior Cycle). "I think reminders would work. Like get the teachers to write 'PE tomorrow' on the board. Or get the prefects to remind the class to remind them to bring in the gear for the next day" (Student F, Junior Cycle).	Psychological Capability
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour.	Some of the students felt that time, the changing of uniforms for PE class, not having PE as an option and the lack of sport options available in the school, were barriers to being active. The Steering Committee felt the school offered many opportunities for the students to be active.	"it's a massive effort to change into PE tracksuits, so [students] just say they forgot them and not do PE" (Student D, Junior Cycle). "there isn't as many [sport] teams for seniors" (Student C, Senior Cycle). "if you do honours maths you can't do PE, cause its during that time" (Student B, Senior Cycle). "there's very little we don't have" [and] "there is no day after school that the hall is free, and the lunch times too" (Teacher B, Steering Committee). "we have lots of options" (Teacher F, Steering Committee).	Physical Opportunity

Table 2 (continued)

TDF Domain	Domain Definition	Summary	Participant Quote	COM-B Component
Social influence	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours.	Adolescents needed social support from their friends, family and classmates to exercise, and the opportunity to be part of a group and provide encouragement. Many of the females felt nervous about exercising alone and worried about how they would be perceived by their peers.	"I wanted to join the fitness club, but none of my friends would do it" (Student A, Junior Cycle). "you won't do it if there's someone in the group you don't get on with, or if none of your friends are doing it" [and] "I don't want to look stupid, or have people laugh at me" (Student D, Junior Cycle) "if your friends are there with you, you have more confidence" (Student B, Junior Cycle). "I'd probably end up quitting if it weren't for the people on the team" (Student B, Senior Cycle). "people would rather do other stuff, like hang out with your friends" (Student F, Senior Cycle). "they won't play because they're afraid of what their mates would say" (Teacher F, Steering Committee). "it's always about how they look, and how they're perceived. That's the number one barrier from what I've seen" (Teacher C, Steering Committee). "I think being in a group of friends is a really positive aspect of them engaging in physical activity because we know with [Teacher G], we do our class and its groups of friends that come, and it's a positive influence all the time" (Teacher A, Steering Committee).	Social Opportunity
Beliefs about capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use.	Adolescent females lacked confidence in doing PA, especially alone. They found it difficult to try new sports or activities and became self-conscious when doing so.	"it's difficult when you're trying something new" (Student F, Junior Cycle). "you become very aware of yourself when you're surrounded by girls who are very good at it, and you start to close into yourself" (Student A, Senior Cycle). "I think their confidence levels are on the floor" (Teacher C, Steering Committee). "in terms of capabilities, I think there is loads of capabilities, but they don't often see it" (Teacher F, Steering Committee).	Reflective Motivation

Table 2 (continued)

TDF Domain	Domain Definition	Summary	Participant Quote	COM-B Component
Goals	Mental representations of outcomes or end states that an individual wants to achieve.	Other priorities, for example homework, exams, family and social life competed for adolescent female's time. They struggled to balance it all and needed to feel that PA was a priority.	"when teachers give us homework, they give us a lot and like you don't have the time to do it at home, and you want to do exercise, but you can't because you've stuff at home to do" (Student B, Junior Cycle). "just trying to fit everything in, you're supposed to get 8 h of sleep, then 3 h of study a night, and then be active as well?" (Student C, Senior Cycle). "their commitment levels just fall off, and their priorities change" (Teacher C, Steering Committee).	Reflective Motivation
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus.	Adolescent females needed to feel that they wanted to do PA and for it to be fun/enjoyable. They liked having choice/autonomy and being with friends. There were punishments in place for not partaking in PE at school, but felt that they wanted more positive reinforcement for them to participate in PA.	"stuff with friends. Or even if they did 'trial classes', which would introduce new people to a sport" (Student F, Junior Cycle). "they [teachers] don't change the sport, even if we say we don't like it" (Student D, Senior Cycle). "it's important to balance fun and competition – it wouldn't be fun without the competition either, a mix of the two is good" (Student A, Senior Cycle). "I think in first year, they say you have to join at least one team but that's it. They tell us to join one team, but we're not followed up on it" (Student E, Senior Cycle). "you'd get a bad note into your journal if you didn't bring in your PE gear or if you refuse to take part" (Student C, Senior Cycle).	Automatic Motivation

PA Physical Activity, *PE* Physical Education, *TY* Transition Year

They wanted to feel encouraged to participate and liked having choices. Enjoyment was critical, and a good balance between competition and fun, *"It's important to balance fun and competition, it wouldn't be fun without the competition either, a mix of the two is good"* (Student A, Senior Cycle). Steering Committee members believed that more positive reinforcement could be beneficial, and suggested rewards for students' PA participation, such as 'certificates for attendance'.

Stage 2: identify intervention options (steps 5 and 6)

The five COM-B components (psychological capability, physical opportunity, social opportunity, reflective motivation and automatic motivation) that were identified as potentially important (Step 4) were mapped directly onto nine intervention functions. After application of the APEASE criteria, seven intervention functions (education, persuasion, incentivisation, training, environmental restructuring, modelling and enablement) and four policy categories (communication/marketing, guidelines, environmental/social planning and service provision) were selected. Intervention functions (coercion and restriction) and policy categories (fiscal measures, regulation and legislation) were not considered acceptable or practical in this study context. More information on this selection process is provided in the Supplementary Information File 2.

Stage 3: identify content and implementation options (steps 7 and 8)

The majority of the 93 Behaviour Change Techniques listed were identified as potentially relevant. After careful deliberation and application of the Behaviour Change Wheel APEASE criteria, 21 were selected as most appropriate to increase adolescent females' PA levels in this school setting. The 21 Behaviour Change Techniques, their definitions and strategies on how they will be operationalised are presented in Table 3. The preferred mode of delivery was 'face-to-face' at a group-level via peer-delivered exercise classes. This was supported by 'distance' delivery at a population-level. Details of the Girls Active Project intervention and benefits of participating in PA will be communicated to the students, parents/guardians and school staff via the school's digital media (social media), newsletter and posters displayed in the school. This aims to provide information about the Girls Active Project, and also encourage social support from students' families, peers and school staff. For mode of delivery (Step 8), a summary of the APEASE criteria selection process and intervention dimensions can be found in the Supplementary Information File 2.

The Girls Active Project intervention

The proposed Girls Active Project intervention was a peer-led, after-school PA programme. Exercise classes would be delivered by Transition Year students (intervention providers known as 'Project Leaders') to other students (intervention recipients) on a weekly basis for 45-min after school. Classes would be supervised by an adult. Project Leaders work as a team to choose what activities they deliver (e.g. dancing, boxing, football) and change it on a weekly-basis to offer variety to the students attending. The Girls Active Project intervention aimed to be enjoyable, inclusive and supportive. Intervention recipients would have opportunities to win prizes (e.g. vouchers or other valued objects) and receive a 'Girls Active Project Certificate' after their participation. The completed TIDieR checklist is shown in Supplementary Information File 3. Following discussions with the school principal and physical education teacher, it was agreed that the Girls Active Project would be implemented and integrated into the school PA policy, and the intervention would be trialled the following academic term. The feasibility trial was registered online: https://doi.org/10.17605/OSF.IO/75HWJ (date of registration: 9th December 2020). The findings from the feasibility trial will be reported on separately.

Discussion

This methodological paper outlines how the Behaviour Change Wheel, a comprehensive, evidence-based, theory-driven framework was systematically used in combination with a PPI approach to develop a school-based intervention to increase adolescent females' PA levels in a single-sex, females-only, designated disadvantaged post-primary school in Ireland. This transparent intervention development process to co-design a behaviour change intervention could facilitate future replication, and may be useful for other researchers. The use of the Behaviour Change Wheel and Theoretical Domains Framework contributes to behavioural science methodology. Furthermore, the behavioural analysis performed adds to the body of knowledge on the range of factors influencing adolescent females' PA behaviour.

Understanding adolescent females' physical activity participation at school

Consistent with previous research [1, 7, 8], the PA levels of adolescent females in this sample were far below recommended guidelines for optimum health. As part of Step 4 in the Behaviour Change Wheel, the aim was to systematically identify the factors influencing adolescent females' PA behaviour at a single-sex, females-only post-primary school using the Theoretical Domains Framework and COM-B model. Data from twomethods

Table 3 Selected behaviour change techniques for the Girls Active Project intervention and intervention strategy

Selected Behaviour Change Technique (code) Definition[a]	Girls Active Project Intervention strategy
Goal setting (behaviour) (1.1) Set or agree a goal defined in terms of the behaviour to be achieved.	Intervention recipients set a goal to attend a weekly after-school PA programme where they partake in an exercise class.
Action planning (1.4) Prompt detailed planning of performance of the behaviour (must include at least one of context, frequency, duration and intensity). Context may be environmental (physical or social) or internal (physical, emotional or cognitive).	Recipients are asked to plan to attend the weekly after-school PA programme.
Monitoring of behaviour by others without feedback (2.1) Observe or record behaviour with the person's knowledge as part of a behaviour change strategy.	Recipients' behaviour is monitored at the weekly after-school PA programme.
Social support (practical) (3.2) Advise on, arrange, or provide practical help (e.g., from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour.	Practical help is provided to recipients at the after-school PA programme. Parents/guardians are advised (via written form) to provide practical help to facilitate their daughters participation. School staff are advised (verbally) to provide practical help to facilitate students' participation, such as volunteering to supervise the weekly after-school programme.
Social support (emotional) (3.3) Advise on, arrange, or provide emotional social support (e.g., from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour.	Emotional social support is provided to recipients at the after-school programme. School staff and parents/guardians are advised to provide encouragement and emotional support to facilitate PA participation.
Instruction on how to perform a behaviour (4.1) Advise or agree on how to perform the behaviour.	Project Leaders (intervention providers) advise on how to perform PA at the after-school programme.
Information about health consequences (5.1) Provide information (e.g., written, verbal, visual) about health consequences of performing the behaviour.	Information on the benefits of regular participation in PA are explained to intervention recipients (verbally).
Monitoring of emotional consequences (5.4) Prompt assessment of feelings after attempts at performing the behaviour.	Each week, intervention recipients are asked how they feel after the exercise class.
Demonstration of the behaviour (6.1) Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g., via film, pictures, for the person to aspire to or imitate.	Project Leaders (intervention providers) demonstrate how to perform PA at the after-school programme.
Prompts/cues (7.1) Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance.	Intervention recipients receive emails from the school to remind them to participate in the weekly after-school PA programme. School staff and parents/guardians are advised to provide regular verbal reminders. These prompts reinforce other BCTs by reminding recipients of the benefits of PA (5.1) and action planning (1.4).
Behavioural practice/rehearsal (8.1) Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill.	Recipients practice PA at each exercise class in the after-school programme.
Habit formation (8.3) Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour.	Recipients repeatedly participate in PA on a weekly basis at the after-school programme.
Generalisation of a target behaviour (8.6) Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation.	Intervention recipients are advised to be active during the week too. This generalisation of PA also reinforces the BCT (information about health consequences, code 5.1) by reminding recipients of the benefits of PA.
Credible source (9.1) Present verbal or visual communication from a credible source in favour of or against the behaviour.	Present verbal communication by the research team explaining key benefits of regular PA for health.
Material incentive (behaviour) (10.1) Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour.	Inform intervention recipients that they are entered into a raffle to win prizes (e.g. vouchers or other valued objects) if and only if there has been progress and/or an effort to participate in the after-school PA programme.
Material reward (behaviour) (10.2) Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress in performing the behaviour.	Recipients that have made progress and/or an effort to participate in the after-school PA programme are entered into a raffle to win prizes (e.g. vouchers or other valued objects). Prizes are delivered to raffle-winners.

Table 3 (continued)

Selected Behaviour Change Technique (code) Definition[a]	Girls Active Project Intervention strategy
Non-specific reward (10.3) Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour.	Recipients receive a researcher signed 'Girls Active Project Certificate of Award' for their participation. Project Leaders (intervention providers) also receive a researcher signed 'Girls Active Project Certificate of Achievement' for their participation in the Girls Active Project.
Social reward (10.4) Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour.	Congratulate intervention recipients after each exercise class that they participate in.
Non-specific incentive (10.6) Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour.	Inform intervention recipients that they will receive a (researcher) signed 'Girls Active Project Certificate of Award' for their participation in the Girls Active Project.
Restructuring the social environment (12.2) Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments).	Implement the Girls Active Project peer-led, after-school programme into the school environment to facilitate PA. Include the Girls Active Project in the School PA policy to serve as the school's commitment to support and encourage their students to participate in PA. The policy is agreed to by the principal and Steering Committee and signed by the school principal. Advise the school that it is pre-arranged for an adult (e.g., Steering Committee member, physical education teacher, school staff, parent/guardian) to supervise the weekly programme. For the feasibility study, the researcher and physical education teacher will supervise the PA programme.
Verbal persuasion about capability (15.1) Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed.	Empower, encourage and motivate intervention recipients to be physically active. Tell recipients that they can successfully increase their participation in PA, despite current fitness levels and/or capabilities.

[a] Based on definitions reported in Michie et al. (2014)

Abbreviations: *PA* Physical Activity, *PE* Physical Education, *GAP* Girls Active Project, *BCT* Behaviour Change Technique

(questionnaires and semi-structured focus groups) with two groups of stakeholders (students and teachers) were complementary; the questionnaire quantified the factors influencing adolescent females' PA behaviour at school and the qualitative data provided in-depth perspectives explaining these factors.

In the current study, 'having more time' was identified by the students as the strongest predictor to them being more active at school. Previous research indicates that time constraints are a major barrier to PA participation for adolescent females [16, 18, 20]. Lack of time was cited by post-primary females as the main reason for not taking part in more activities/sport in a national study conducted in 2010 [16], followed by feelings of incompetence, not liking sport and no suitable activities offered. Students in this current study identified barriers to PA in the school environment, such as a lack of PA options and the changing into their physical education uniforms. These barriers have also been cited in previous studies [17–21]. The adolescent females that were not part of a sports-team identified a lack of self- behavioural regulation, and many of the students acquired limiting beliefs about their capabilities to do PA. Indeed, low levels of perceived competence [16, 20, 21], low levels of self-efficacy for being physically active [15, 18] or a lack of confidence in skills [17], have often been cited by adolescent females as common barriers to PA participation. Of note, research indicates that behaviour regulation and perceived competence are correlated with PA in adolescent females [66, 67]. Consistent with previous research [16, 18, 20] both the Steering Committee and students in this study recognised that social influences, particularly their peers' influence, can be either a barrier or facilitator to PA participation. Lastly, adolescent females in this study identified a lack of positive reinforcements at school that would encourage them to participate in PA. They wanted increased choices in PA options and for PA to be 'fun' and enjoyable. Providing adolescent females with 'youth agency' and autonomy in PA activities, more emphasis on fun and involvement rather than skill and competition, increased choice, and offering a variety of activities to promote PA are common recommendations across the literature [18–20].

Intervention development

Similar to two previous studies that used the Behaviour Change Wheel to design PA interventions, the process was considered time-consuming [51, 52] due to the large volume of choice. Despite this, the research team considered the Behaviour Change Wheel to be a useful framework to co-design the intervention. Given the scope of options provided, other behaviour change interventions

using the Behaviour Change Wheel in the school-setting may produce different results. The discussion groups allowed the researcher (SMQ) and Youth Advisory Group (PPI contributors) to consider the full range of options and to choose the most appropriate through a systematic evaluation of theory and evidence, whilst ensuring that the range of opportunities being created were matched to the preferences of the students. The experience of capturing the views of adolescent females in the intervention design process and identifying specific strategies that respond to their interests and needs was perceived to be invaluable by the research team.

The proposed Girls Active Project intervention was a peer-led, after-school PA programme, containing 21 Behaviour Change Techniques. There is evidence to suggest that after-school PA programmes [68], changes in the school environment [30], and peer support [29] can be promising intervention strategies to increase adolescents' PA participation. Moreover, a systematic review by Ginis et al. (2013) found that peer-delivered PA interventions can lead to significant increases in PA that are similar in magnitude to increases achieved by those delivered by professionals [69].

Strengths and limitations

Strengths

This paper describes a novel approach to designing a school-based PA intervention using the Behaviour Change Wheel in combination with a PPI approach. Obtaining data via a mixed-methods approach (questionnaires and focus groups) and use of multiple sources (students and teachers) strengthened our understanding of adolescent females' PA behaviour in this context. Stakeholder buy-in played a significant role in this study. The Youth Advisory Group, students and school staff, including the Steering Committee members and school principal were fully supportive of the Girls Active Project. The Youth Advisory Group in particular took ownership of their role as PPI contributors and truly engaged in the research process. A high proportion of the eligible research participants (students attending the school) completed the questionnaire. Previous research suggests that a contributing factor to a high response rate could be the use of parental/guardian opt-out consent [56, 57].

Limitations

A limitation of using parental/guardian opt-out consent was that ethically, no personal identifying information could be collected. This included students' home street address, often used to identify one's social deprivation status Individual socio-economic status data was not collected. This is a limitation to this study. This study was conducted in one single-sex, females-only, designated disadvantaged post-primary school in Ireland. These findings may not be generalisable to the wider community. The views and contributions of the eight students who joined the Youth Advisory Group may not represent the students in the school. The quantitative data was collected in a day, thus females that were absent that day did not contribute. Lastly, the PA levels of adolescent females in this sample were self-reported (subjective), which is dependent on students' recall ability [70].

Conclusion

The PA levels of adolescent females in this sample were far below recommended guidelines for optimum health. This methodological paper outlines how the Behaviour Change Wheel, a comprehensive, evidence-based, theory-driven framework was systematically used in combination with a PPI approach to co-design a school-based intervention to increase adolescent females' PA levels. The intervention was tailored to overcome the barriers to adolescent females' PA participation and take account of the preferences of adolescent females. The paper describes how a mixed-method approach using the Behaviour Change Wheel and Theoretical Domains Framework can be successfully applied through a systematic process to understand the factors influencing adolescent females' PA behaviour in the school setting. There are implications to this research. Firstly, the transparent intervention development process described could facilitate future replication and may be useful for other researchers. Secondly, the behavioural analysis performed adds to the body of knowledge on the range factors influencing adolescent females' PA behaviour. Thirdly, this work has informed practice in the post-primary school setting - the Girls Active Project intervention has now been implemented and its feasibility study will be reported on separately.

Abbreviations

GAP: Girls Active Project; PA: Physical activity; MVPA: Moderate-to-vigorous physical activity; PPI: Public and Patient Involvement; YAG: Youth Advisory Group; SC: Steering Committee; BCW: Behaviour Change Wheel; APEASE: Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side effects/safety and Equity; COM-B: Capability, Opportunity, Motivation – Behaviour; TDF: Theoretical Domains Framework; BCTs: Behaviour change techniques.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-022-12635-w.

Additional file 1.

Additional file 2.

Additional file 3.

Acknowledgements
Thank you to the school principal, Steering Committee, Youth Advisory Group and to all students who participated in the questionnaire and focus groups. To Lucy Whiston and the PPI Ignite Network team at Dublin City University.

Authors' contributions
SMQ contributed to the design, data collection, data analysis, data interpretation and drafting the manuscript. AS, SJB and MRS contributed to the development and design of the study, advised on data collection and analysis. All authors reviewed and revised the final manuscript in preparation for peer review. The author(s) read and approved the final manuscript.

Authors' information
Sara McQuinn, SPHeRE PhD Scholar, MSc, BSc.
School of Nursing, Psychotherapy and Community Health, Faculty of Science and Health, Dublin City University, Dublin 9, Ireland. sara.mcquinn2@mail.dcu.ie.

Funding
S McQuinn is funded by the Health Research Board SPHeRE/2013/1.

Availability of data and materials
The datasets during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was granted by the Institutional Research Ethics Committee at Dublin City University (DCUREC/2019/005). Informed consent and assent was obtained from parents/guardians, research participants and Youth Advisory Group (PPI contributors). All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Written permission has been granted by Professor Susan Michie to reproduce Fig. 1 'The Behaviour Change Wheel'. Photos used in Supplementary Information File 1 have been provided by the University, Dublin City University Marketing Department. Consent has been granted to use the photos for this research.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]School of Nursing, Psychotherapy and Community Health, Faculty of Science and Health, Dublin City University, Dublin 9, Ireland. [2]School of Health and Human Performance, Faculty of Science and Health, Dublin City University, Glasnevin, Dublin 9, Ireland.

Received: 26 April 2021 Accepted: 10 November 2021
Published online: 29 March 2022

References

1. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Health. 2020;4(1):23–35. https://doi.org/10.1016/S2352-4642(19)30323-2.
2. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451–62.
3. Chaput J-P, Willumsen J, Bull F, Chou R, Ekelund U, Firth J, et al. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. Int J Behav Nutr Phys Act. 2020;17(1):141.
4. Murphy J, Sweeney MR, McGrane B. Physical activity and sports participation in irish adolescents and associations with anxiety, depression and mental wellbeing. Findings from the physical activity and wellbeing (paws) study. Phys Act Health. 2020;4(1):107–19.
5. Corder K, Winpenny E, Love R, Brown HE, White M, Sluijs EV. Change in physical activity from adolescence to early adulthood: a systematic review and meta-analysis of longitudinal cohort studies. Br J Sports Med. 2019;53(8):496–503. https://doi.org/10.1136/bjsports-2016-097330.
6. Dumith SC, Gigante DP, Domingues MR, Kohl HW. Physical activity change during adolescence: a systematic review and a pooled analysis. Int J Epidemiol. 2011;40(3):685–98. https://doi.org/10.1093/ije/dyq272.
7. Inchley J, Currie D, Budisavljevic S, Torsheim T, Jåstad A, Cosma A. Spotlight on adolescent health and well-being. In: Findings from the 2017/2018 Health Behaviour in School-Aged Children (HBSC) Survey in Europe and Canada. International Report. Volume 1. Key Findings. Copenhagen: WHO Regional Office for Europe; 2020. Available from: https://apps.who.int/iris/bitstream/handle/10665/332091/9789289055000-eng.pdf.
8. Woods C, Powell C, Saunders J, O'Brien W, Murphy M, Duff C, et al. The Children's Sport Participation and Physical Activity Study 2018 (CSPPA 2018): Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland, Sport Ireland, and Healthy Ireland, Dublin, Ireland and Sport Northern Ireland, Belfast, Northern Ireland; 2018. Cited 2020 Jan 30. Available from: https://www.sportireland.ie/research/csppa-2018.
9. Borraccino A, Lemma P, Iannotti R, Zambon A, Dalmasso P, Lazzeri G, Giacchi M, Cavallo F. Socio-economic effects on meeting PA guidelines: comparisons among 32 countries. Med Sci Sports Exerc. 2009;41:749–56. https://doi.org/10.1249/MSS.0b013e3181917722.
10. Stalsberg R, Pedersen AV. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of the evidence. Scand J Med Sci Sports. 2010;20(3):368–83.
11. Shrestha R, Copenhaver M. Long-Term Effects of Childhood Risk Factors on Cardiovascular Health During Adulthood. Clin Med Rev Vasc Health. 2015;2015(7):1–5.
12. Huotari P, Nupponen H, Mikkelsson L, Laakso L, Kujala U. Adolescent physical fitness and activity as predictors of adulthood activity. J Sports Sci. 2011;29(11):1135–41. https://doi.org/10.1080/02640414.2011.585166.
13. Telama R, Yang X, Leskinen E, Kankaanpää A, Hirvensalo M, Tammelin T, et al. Tracking of physical activity from early childhood through youth into adulthood. Med Sci Sports Exerc. 2014;46(5):955–62.
14. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc. 2000;32(5):963–75.
15. Graham DJ, Bauer KW, Friend S, Barr-Anderson DJ, Nuemark-Sztainer D. Personal, behavioral, and socio-environmental correlates of physical activity among adolescent girls: cross-sectional and longitudinal associations. J Phys Act Health. 2014;11(1):51–61. https://doi.org/10.1123/jpah.2011-0239.
16. Woods C, Moyna N, Quinlan A, Tannehill D, Walsh J. The Children's Sport Participation and Physical Activity Study 2010 (CSPPA 2010). Dublin: School of Health and Human Performance, Dublin City University, and The Irish Sports Council; 2010. Cited 2017 Dec 3. Available from: https://www.ucd.ie/t4cms/CCLSP_Study_Report1.pdf.
17. Cowley ES, Watson PM, Foweather L, Belton S, Thompson A, Thijssen D, et al. "Girls Aren't Meant to Exercise": perceived influences on physical activity among adolescent girls—The HERizon Project. Children. 2021;8(1):31.
18. Martins J, Costa J, Sarmento H, Marques A, Farias C, Onofre M, et al. Adolescents' perspectives on the barriers and facilitators of physical activity: an updated systematic review of qualitative studies. Int J Environ Res Public Health. 2021;18(9):4954.
19. Rees R, Kavanagh J, Harden A, Shepherd J, Brunton G, Oliver S, et al. Young people and physical activity: a systematic review matching their views to effective interventions. Health Educ Res. 2006;21(6):806–25.
20. Corr M, McSharry J, Murtagh EM. Adolescent girls' perceptions of physical activity: a systematic review of qualitative studies. Am J Health Promot. 2018;33(5):806–19.
21. Slater A, Tiggemann M. "Uncool to do sport": A focus group study of adolescent girls' reasons for withdrawing from physical activity. Psychol Sport Exerc. 2010;11(6):619–26.
22. Perry CK, Garside H, Morones S, Hayman LL. Physical activity interventions for adolescents: an ecological perspective. J Prim Prev. 2012;33(2–3):111–35. https://doi.org/10.1007/s10935-012-0270-3.

23. Heath GW, Parra DC, Sarmiento OL, Andersen LB, Owen N, Goenka S, Montes F, Brownson RC. Evidence-based intervention in physical activity: lessons from around the world. Lancet. 2012;380(9838):272–81. https://doi.org/10.1016/S0140-6736(12)60816-2.
24. World Health Organization. Global action plan on physical activity 2018–2030: more active people for a healthier world. Geneva: World Health Organization; 2018. Available from: http://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf
25. Hills AP, Dengel DR, Lubans DR. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. Prog Cardiovasc Dis. 2015;57(4):368–74.
26. Story M, Nanney MS, Schwartz MB. Schools and obesity prevention: creating school environments and policies to promote healthy eating and physical activity. Milbank Q. 2009;87(1):71–100.
27. Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. Cochrane Database Syst Rev. 2013;(2):CD007651. https://doi.org/10.1002/14651858.CD007651.pub2.
28. Love R, Adams J, van Sluijs EMF. Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. Obes Rev. 2019;20(6):859–70.
29. Camacho-Miñano MJ, NM LV, Barr-Anderson DJ. Interventions to promote physical activity among young and adolescent girls: a systematic review. Health Educ Res. 2011;26(6):1025–49.
30. Messing S, Rütten A, Abu-Omar K, Ungerer-Röhrich U, Goodwin L, Burlacu I, et al. How Can Physical Activity Be Promoted Among Children and Adolescents? A Systematic Review of Reviews Across Settings. Front Public Health. 2019;7 Cited 2019 Nov 6. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2019.00055/full.
31. Owen MB, Curry WB, Kerner C, Newson L, Fairclough SJ. The effectiveness of school-based physical activity interventions for adolescent girls: a systematic review and meta-analysis. Prev Med. 2017;105:237–49.
32. INVOLVE. Briefing notes for researchers: involving the public in NHS, public health and social care research. Eastleigh: INVOLVE; 2012. Available from: http://www.invo.org.uk/wp-content/uploads/2014/11/9938_INVOLVE_Briefing_Notes_WEB.pdf.
33. Staley K. Exploring impact: public involvement in NHS, public health and social care research. Eastleigh: INVOLVE; 2009. Cited 2019 Oct 21. Available from: https://www.invo.org.uk/posttypepublication/exploring-impact-public-involvement-in-nhs-public-health-and-social-care-research/.
34. Minogue V, Cooke M, Donskoy A-L, Vicary P, Wells B. Patient and public involvement in reducing health and care research waste. Res Involv Engagem. 2018;4(1):5.
35. Brett J, Staniszewska S, Mockford C, Herron-Marx S, Hughes J, Tysall C, et al. A systematic review of the impact of patient and public involvement on service users, researchers and communities. Patient. 2014;7(4):387–95.
36. Brett J, Staniszewska S, Mockford C, Herron-Marx S, Hughes J, Tysall C, et al. Mapping the impact of patient and public involvement on health and social care research: a systematic review. Health Expect. 2014;17(5):637–50.
37. Sellars E, Pavarini G, Michelson D, Creswell C, Fazel M. Young people's advisory groups in health research: scoping review and mapping of practices. Arch Dis Child. 2020; Cited 2020 Nov 27; Available from: https://adc.bmj.com/content/early/2020/11/17/archdischild-2020-320452.
38. Dennehy R, Cronin M, Arensman E. Involving young people in cyberbullying research: The implementation and evaluation of a rights-based approach. Health Expect. 2018;1–11. https://doi.org/10.1111/hex.12830.
39. Jacquez F, Vaughn LM, Wagner E. Youth as partners, participants or passive recipients: a review of children and adolescents in Community-Based Participatory Research (CBPR). Am J Commun Psychol. 2013;51(1–2):176–89.
40. Larsson I, Staland-Nyman C, Svedberg P, Nygren JM, Carlsson I-M. Children and young people's participation in developing interventions in health and well-being: a scoping review. BMC Health Serv Res. 2018;18 Cited 2018 Sep 25. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6027768/.
41. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M. Developing and evaluating complex interventions: the new Medical Research Council guidance. BMJ. 2008;337:a1655.
42. Pearson N, Braithwaite R, Biddle SJH. The effectiveness of interventions to increase physical activity among adolescent girls: a meta-analysis. Acad Pediatr. 2015;15(1):9–18. https://doi.org/10.1016/j.acap.2014.08.009.
43. Michie S, Atkins L, West R. The Behaviour Change Wheel. A guide to designing interventions. London: Silverback Publishing; 2014.
44. Michie S, Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci. 2011;6.
45. Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. Implement Sci. 2012;7:37.
46. Michie S, Richardson M, Johnston M, Abraham C, Francis J, Hardeman W, et al. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. Ann Behav Med. 2013;46(1):81–95.
47. Sharry JM, Murphy PJ, Byrne M. Implementing international sexual counselling guidelines in hospital cardiac rehabilitation: development of the CHARMS intervention using the behaviour change wheel. Implementation Sci. 2016;11(1):1–11.
48. Ojo SO, Bailey DP, Brierley ML, Hewson DJ, Chater AM. Breaking barriers: using the behavior change wheel to develop a tailored intervention to overcome workplace inhibitors to breaking up sitting time. BMC Public Health. 2019;19(1):1–17.
49. Clarke AL, Jhamb M, Bennett PN. Barriers and facilitators for engagement and implementation of exercise in end-stage kidney disease: Future theory-based interventions using the Behavior Change Wheel. Semin Dial. 2019;32(4):308–19.
50. Ellis K, Pears S, Sutton S. Behavioural analysis of postnatal physical activity in the UK according to the COM-B model: a multi-methods study. BMJ Open. 2019;9(8):e028682.
51. Murtagh EM, Barnes AT, McMullen J, Morgan PJ. Mothers and teenage daughters walking to health: using the behaviour change wheel to develop an intervention to improve adolescent girls' physical activity. Public Health. 2018;158:37–46.
52. Webb J, Foster J, Poulter E. Increasing the frequency of physical activity very brief advice for cancer patients. Development of an intervention using the behaviour change wheel. Public Health. 2016;133:45–56.
53. Flannery C, McHugh S, Anaba AE, Clifford E, O'Riordan M, Kenny LC, et al. Enablers and barriers to physical activity in overweight and obese pregnant women: an analysis informed by the theoretical domains framework and COM-B model. BMC Pregnancy Childbirth. 2018;18(1):178.
54. Department of Education. DEIS: Delivering Equality of Opportunity in Schools: Department of Education and Skills; 2017. Cited 2021 Apr 8. Available from: https://www.education.ie/en/schools-colleges/services/deis-delivering-equality-of-opportunity-in-schools-/.
55. Doria N, Condran B, Boulos L, Curtis Maillet DG, Dowling L, Levy A. Sharpening the focus: differentiating between focus groups for patient engagement vs. qualitative research. Res Involv Engagem. 2018;4(1):19.
56. Junghans C, Feder G, Hemingway H, Timmis A, Jones M. Recruiting patients to medical research: double blind randomised trial of "opt-in" versus "opt-out" strategies. BMJ. 2005;38583.625613:AEv1.
57. Tigges BB. Parental Consent and Adolescent Risk Behavior Research. J Nurs Scholarsh. 2003;35(3):283–9.
58. Department of Education. Transition Year: Department of Education and Skills; 2021. Cited 2021 Apr 8. Available from: https://www.education.ie/en/Schools-Colleges/Information/Curriculum-and-Syllabus/Transition-Year-/.
59. Kirby P. A guide to actively involving young people in research: for researchers, research commissioners, and managers. Eastleigh: INVOLVE Support Unit; 2004. Available from: https://www.invo.org.uk/wp-content/uploads/2012/01/InvolvingYoungPeople2004.pdf.
60. Prochaska JJ, Sallis JF, Long B. A Physical Activity Screening Measure for Use With Adolescents in Primary Care. Arch Pediatr Adolesc Med. 2001;155(5):554–9.
61. Hardie Murphy M, Rowe DA, Belton S, Woods CB. Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. BMC Public Health. 2015;15:1080.
62. Currie C, Inchley J, Molcho M, Lenzi M, Veselska Z, Wild F, editors. Health Behaviour in School-aged Children (HBSC) Study Protocol: Background, Methodology and Mandatory items for the 2013/14 Survey. St Andrews: CAHRU; 2014. Cited 2018 Nov 18. Available from: https://risweb.st-andre

ws.ac.uk/portal/en/researchoutput/health-behaviour-in-schoolaged-children-hbsc-study-protocol-background-methodology-and-mandatory-items-for-the-201314-survey(78422155-ea90–4044-97f5-85b04bc97cf9)/export.html.
63. Kaiser K. Protecting respondent confidentiality in qualitative research. Qual Health Res. 2009;19(11):1632–41.
64. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. BMC Med Res Methodol. 2013;13(1):117.
65. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ. 2014;34:g1687.
66. Craike MJ, Polman R, Eime R, Symons C, Harvey J, Payne W. Associations between behavior regulation, competence, physical activity, and health for adolescent females. J Phys Act Health. 2014;11(2):410–8.
67. Biddle SJH, Whitehead SH, O'Donovan TM, Nevill ME. Correlates of participation in physical activity for adolescent girls: a systematic review of recent literature. J Phys Act Health. 2005;2(4):423–34.
68. Mears R, Jago R. Effectiveness of after-school interventions at increasing moderate-to-vigorous physical activity levels in 5- to 18-year olds: a systematic review and meta-analysis. Br J Sports Med. 2016;50(21):1315–24. https://doi.org/10.1136/bjsports-2015-094976.
69. Ginis KAM, Nigg CR, Smith AL. Peer-delivered physical activity interventions: an overlooked opportunity for physical activity promotion. Transl Behav Med. 2013;3(4):434–43.
70. Sylvia LG, Bernstein EE, Hubbard JL, Keating L, Anderson EJ. Practical guide to measuring physical activity. J Acad Nutr Diet. 2014;114(2):199–208. https://doi.org/10.1016/j.jand.2013.09.018.

Publisher's Note

Pilot and Feasibility Studies

RESEARCH

Open Access

Feasibility of a peer-led, after-school physical activity intervention for disadvantaged adolescent females during the COVID-19 pandemic: results from the Girls Active Project (GAP)

Sara McQuinn[1*], Sarahjane Belton[2], Anthony Staines[1] and Mary Rose Sweeney[1]

Abstract

Introduction: There is a critical need for interventions that can be feasibly implemented and are effective in successfully engaging adolescent females in physical activity (PA). A theory-based, peer-led, after-school PA intervention, the *Girls Active Project* (GAP), was codesigned with adolescent females. This study aimed to assess the feasibility of implementing and evaluating the GAP programme.

Setting: One single-sex, female-only, designated disadvantaged postprimary school (students aged 12–18) in Dublin, Ireland.

Methods: Mixed methods were applied with multiple stakeholders over a 12-week trial (March to May 2021). A single-arm study design was used to examine intervention: reach, dose, fidelity, acceptability, compatibility and context. Feasibility of using proposed self-reported outcome measures (moderate-to-vigorous PA levels, self-rated health, life satisfaction, PA self-efficacy and PA enjoyment) was also explored. Due to school closure resulting from the COVID-19 pandemic, the intervention was delivered both online and in person in the school setting.

Results: Eight exercise classes were peer delivered by project leaders ($n = 6$, students aged 15–17) to intervention recipients (students aged 13-14). Recruitment was low ($n = 8$, 10% of eligible students, mean age: 13.3 *SD*: 0.46), yet retention was high ($n = 7/8$, 88%). Attendance rates were satisfactory (68%), and the intervention was implemented with high fidelity (87%). Data completion rates suggested proposed self-reported outcome measures were deemed appropriate ($\geq$ 95%), except for weight (50%) and height data (80%). Despite COVID-19 hindering intervention implementation, both quantitative and qualitative data suggested that stakeholders were satisfied and perceived the in-person delivered intervention to be compatible with the school setting. Recommended refinements included extending class duration, introducing different rewards, and boosting programme awareness.

Conclusions: Further thought must be given on how to increase recruitment. Overall, the in-person delivered after-school PA programme was well-received by stakeholders and shows promise as an intervention that can be feasibly

*Correspondence: sara.mcquinn2@mail.dcu.ie

[1] School of Nursing, Psychotherapy and Community Health, Faculty of Science and Health, Dublin City University, Dublin 9, Ireland
Full list of author information is available at the end of the article

implemented and evaluated. Suggested improvements to the GAP intervention programme are recommended, before continuing to a more robust evaluation.

Trial registration: 10.17605/OSF.IO/75HWJ (prospectively registered, date of registration: 9th December 2020)

Keywords: Physical activity, Adolescents, Female, Behaviour change, Feasibility, Intervention, Peer led, School, Mixed methods, Implementation, COVID-19

Key messages regarding feasibility

- What uncertainties existed regarding the feasibility? It was unclear if the Girls Active Project programme to increase adolescent females PA levels could be successfully implemented and evaluated in a postprimary school setting.
- What are the key feasibility findings? Recruitment was low, yet retention was high. The intervention was implemented as intended, and most of the proposed self-reported outcome measures were deemed appropriate. Stakeholders indicated satisfaction with the in-person delivered intervention and perceived it to be compatible with the school setting.
- What are the implications of the feasibility findings for the design of the main study? The in-person delivered intervention shows promise; however, further work is required to revise and test recruitment strategies. Prior to the main study, refinements to the intervention should be made based on stakeholder recommendations, while further consideration needs to be given to retaining proposed self-reported outcome measures weight and height, and introducing direct observation to assess fidelity.

Background

Despite evidence continuing to accumulate on the health benefits of regular physical activity (PA) for adolescents [1, 2], globally, 85% of adolescent females (aged 11–17) are insufficiently physically active [3]. PA levels are particularly low among females of lower socio-economic status [4, 5]. The World Health Organization recommends that adolescents accumulate at least an average of 60 min a day of moderate-to-vigorous intensity physical activity (MVPA) [6]. An age-related decline in PA participation during adolescence is a consistent finding in the literature [7, 8], with national evidence to suggest [9] that the largest reduction in PA levels for females occurs between second (aged 13–14) and third year (aged 14–15) in postprimary school. Efforts made to increase the PA levels of adolescents are of particular importance since PA appears to track reasonably well from adolescence to adulthood [10]. Furthermore, there is evidence emerging to suggest that the on-going COVID-19 pandemic has caused a further decrease in PA participation [11, 12], especially for adolescents of lower socio-economic status [11].

There is a critical need to strengthen the development and implementation of effective interventions to increase adolescent female PA levels [3, 13]. The school environment is well-known as a potential setting for targeting adolescent PA behaviour [14]. Evidence suggests, however, school-based PA interventions have been minimally successful at increasing PA levels [15–18]. This indicates that changing adolescent PA behaviour through school-based interventions can be challenging. Previous reviews suggest that multicomponent [16, 19] interventions and interventions that use a theoretical model or framework [18, 19] might be most effective in the promotion of PA for adolescents, with certain intervention strategies, such as after-school PA programmes conducted in the school setting showing potential [20].

At postprimary school level in Ireland, traditional team-based and structured sports dominate extra-curricular PA, i.e., PA or sport played before, during or after school, but not part of the curriculum [21]. Given that participation is higher among males (70%) than females (57%) and in more affluent students (66%) than less affluent students (56%) [21], a call for additional extracurricular PA programmes that appeal to adolescent females of lower socio-economic status may be warranted. In Ireland, a classification system known as DEIS (Delivering Equality of opportunity in Schools) is used by the Department of Education to indicate that a school is based in a community at risk of disadvantage and social exclusion [22]. The Girls Active Project (GAP) programme was codesigned with adolescent females in a designated disadvantaged (DEIS) postprimary school in Ireland using the behaviour change wheel [23] in combination with a public and patient involvement (PPI) approach. This novel approach was applied to systematically codesign a contextually appropriate school-based and theory-based PA intervention that aimed to meet the needs of adolescent females and provide relevant and meaningful opportunities for them to be active. Details of the intervention development process are available elsewhere [24]. The GAP is a novel, multicomponent, peer-led PA programme. It offers female adolescents a readily accessible

fun and unstructured opportunity to be active with peers in a supportive and inclusive environment. The females who codesigned the GAP programme chose for the programme to be peer delivered after school in the school setting. The GAP includes strategies that are commonly recommended across the literature to promote adolescent females' PA, such as incorporating social support [25, 26] and providing females with autonomy through choice of activity, alongside offering a diverse range of activities [27–29]. Moreover, given that lack of time has been identified as a key barrier to school PA policy implementation [30], engaging students to deliver intervention components may possibly reduce the burden on teachers [31]. Using a peer-led approach (such as that used in the GAP programme) in school-based interventions has become increasingly popular and has shown potential in increasing adolescent female PA levels [32–34], with findings to suggest that peer-led PA interventions may be equally as effective as those delivered by professionals [35]. The next step was to assess feasibility of the GAP intervention programme.

There is a growing appreciation of the significant role that feasibility studies play in the development and evaluation of complex interventions, primarily its value of progressing to a larger-scale trial or effectiveness study [36–38]. This small-scale real-world testing can provide information for researchers to enhance the thoroughness of a future trial [39, 40] and through publication may benefit other researchers [41, 42]. Following the Medical Research Council framework guidance [36], this study aimed to investigate the feasibility of implementing and evaluate the GAP intervention (Trial number: https://doi.org/10.17605/OSF.IO/75HWJ). The research team selected the feasibility measures deemed most appropriate for this study based on the research objectives and available data [43]. These included the following: reach, dose, fidelity, acceptability, compatibility and context. This study also explored the feasibility of measuring the proposed self-reported outcomes (minutes of daily moderate-to-vigorous PA (MVPA), height, weight, self-rated health, life satisfaction, self-efficacy related to PA and PA enjoyment) that will be used to evaluate efficacy in a future trial [41], by assessing their completion rates. Reporting data completion rates is consistent with previous feasibility studies [44, 45] and proves useful as this information can help inform intervention refinements and provide additional support for the feasibility of using these outcome measures [43].

The specific objectives of this feasibility study were as follows:

1. Capture the recruitment and retention rates of intervention recipients and explore factors influencing participation (reach).
2. Determine attendance rates and the extent to which intervention providers implemented the intervention as intended (dose and fidelity).
3. Assess the feasibility of using proposed self-reported outcome measures (data completion rates).
4. Explore stakeholders' satisfaction with the intervention (acceptability).
5. Examine the perceived fit and sustainability of the intervention in the school setting (compatibility).
6. Understand context, i.e. the external factors that affected intervention implementation (context).

Method

Design and setting

A mixed-methods single-arm feasibility trial was conducted in a female-only, designated disadvantaged postprimary school in Dublin, Ireland. This school had previously participated in the codesign of the GAP programme [24] and was therefore familiar with the intervention and proposed processes involved. To ensure it reflected the realities of the intervention setting [37], this study involved multiple stakeholders (intervention recipients, intervention providers, school staff and parents/guardians). The feasibility measures and their definitions, stakeholders involved, data collection tools and the timeframe of each objective as they relate to the present study are provided in Table 1. The reporting of this study followed the Consolidated Standards of Reporting Trials (CONSORT) 2010 [46] statement with extension to randomised pilot and feasibility trials (Supplementary file 1) and the Template for Intervention Description and Replication (TIDieR) checklist [47] (Supplementary file 2). Ethical approval for this study was granted by the Dublin City University Research Ethics Committee (DCUREC/2019/005).

The COVID-19 pandemic implications for this study

In January 2021, there was a nationwide lockdown that involved national school closures. Consequently, although the intervention was originally designed to be delivered in person on school grounds, it was divided into two phases. Both phases were delivered at the same time (4 pm) each week on the same day (Tuesday). Four classes were delivered via Zoom during phase 1 using the online school platform. When schools fully reopened in April 2021, four classes were delivered in person (phase 2) in the school sports hall or playing field. In response to COVID-19-related social restrictions, just 1 year group

Table 1 Data collection procedures and schedule of measures

Objective	Measure ***Definition***	Stakeholder(s)	Data collection tool	Data collection timeframe				
				Week 1: phase 1 baseline	**Week 8: mid**	**Week 8: phase 2 baseline**	**Week 12: post**	**During (throughout week 1-12)**
				Online	**Paper based/ in person**	**Paper based/in person**	**Online/paper based/in person**	**Online/in person**
1. To capture the recruitment and retention rates of intervention recipients and explore factors influencing participation	**Reach**[a] *Participation rate in the innovation by the intended audience*	Intervention recipients	Recruitment and retention records (i.e. #who were eligible, #who consented, #who enrolled, #who stayed)	X	X	X	X	X
			Demographic section in questionnaire	X		X[c]		
			Feedback questionnaire and focus group		X		X	
		Parents/guardians	Questionnaire				X	
2. To determine attendance rates and the extent to which intervention providers implemented the intervention as intended	**Dose**[b] ***Dose delivered:*** *The number/amount of intended units delivered/provided (i.e. dose is a function of the efforts of intervention providers)* ***Dose received****: Extent to which participants engage or interact with is receptive or use intervention (i.e. dose is a function of the efforts of intervention participants)* **Fidelity**[b] *The extent to which the programme was implemented as planned*	Intervention recipients	Attendance records					X
		Intervention providers	Project leader logbooks					X

Table 1 (continued)

Objective	Measure *Definition*	Stakeholder(s)	Data collection tool	Data collection timeframe				
				Week 1: phase 1 baseline	**Week 8: mid**	**Week 8: phase 2 baseline**	**Week 12: post**	**During (throughout week 1-12)**
				Online	**Paper based/ in person**	**Paper based/in person**	**Online/paper based/in person**	**Online/in person**
3. To assess the feasibility of using proposed self-reported outcome measures	'Data completion rates' of outcome measures were used as an indicator to the following: **Feasibility of future trial design to conduct a full trial**[a] *Measures informing implementation trial methods including the feasibility, acceptability, or quality of data collection procedures, survey items, tools, or data management strategies*	Intervention recipients	#Outcome measures completed (% data completion)	X	X	X[c]	X	
4. To explore stakeholders' satisfaction with the intervention	**Acceptability**[a] *Service providers or support system's satisfaction with the innovation*	Intervention recipients	Feedback questionnaire and focus group		X		X	
		Intervention providers	Feedback questionnaire				X	
		Intervention providers	Focus group		X		X	
		Parents/guardians	Questionnaire and semi-structured interview				X	
		School staff	Semi-structured interview				X	

Table 1 (continued)

Objective	Measure *Definition*	Stakeholder(s)	Data collection tool	Data collection timeframe				
				Week 1: phase 1 baseline	Week 8: mid	Week 8: phase 2 baseline	Week 12: post	During (throughout week 1-12)
				Online	Paper based/ in person	Paper based/in person	Online/paper based/in person	Online/in person
5. To examine the perceived fit and sustainability of the intervention in the school setting	**Compatibility (appropriateness)**[a] *Perceived fit of the innovation with organisation's values, mission ,and priorities*	Intervention recipients	Feedback questionnaire and focus group		X		X	
		Intervention providers	Feedback questionnaire				X	
		Intervention providers	Focus group		X		X	
		Parents/guardians	Questionnaire and semi-structured interview				X	
		School staff	Semi-structured interview				X	
6. To understand context, i.e. the external factors that affected intervention implementation	**Context**[a] *Political, economic, or social influences on implementation of the innovation*	Intervention recipients	Feedback questionnaire and focus group		X		X	
		Intervention providers	Feedback questionnaire				X	
		Intervention providers	Focus group		X		X	
		Parents/guardians	Questionnaires and semi-structured interviews				X	
		School staff	Semi-structured interviews				X	

Abbreviations: *PA* physical activity, *MVPA* moderate to vigorous intensity physical activity

[a] Based on measure and terminology reported in Pearson et al. [43]

[b] Based on measure and terminology reported in Steckler and Linnan [48]

[c] Applicable to newly enrolled intervention recipients

was invited to participate as 'intervention recipients'. This was a protective measure to avoid integrating students from different year groups and to accommodate for social distancing (2 m). Furthermore, school guidelines permitted just one researcher (SMQ) to attend the school to collect data during intervention implementation.

Recruitment and participants

Intervention providers (who delivered it)

Intervention providers were six volunteer transition year students (aged 15–17) known as project leaders ($n = 6$). In Ireland, transition year is a 1-year school programme that can be taken in the year after the junior cycle (students aged 12–15) and before the 2-year leaving certificate programme (students aged 15–18) [49]. It is not a standard academic year. Instead, the year is designed around giving students life skills and a more hands-on aspect to learning. The six project leaders who expressed an interest were familiar with the GAP programme from the codesign process [24]. As a recognition for their time and effort, project leaders could use the GAP to contribute towards 'Gaisce', a national self-development programme for young people in Ireland between the age of 15 and 25 [50]. At the end of the study, each project leader also received a 'Girls Active Project' certificate as an expression of appreciation (Supplementary file 4).

Intervention recipients (to whom it was delivered)

Given that national evidence suggests the largest reduction in PA levels for females occur between second (aged 13–14) and third year (aged 14–15) in postprimary school [9], the school principal, physical education teacher and authors agreed to target the second-year students ($n = 78$, aged 13–14). Intervention recipients were recruited over two rounds, with the second round required due to low recruitment experienced at phase online (during COVID-19 school closure). The number of intervention recipients who were invited, consented and completed the questionnaires was recorded at week 1 (phase one baseline), week 8 (phase 2 baseline) and week 12 (post-intervention). The number of recipients who withdrew or were lost to follow-up were recorded at mid-intervention (week 8) and post-intervention (week 12). A standard threshold for study attrition (> 20%) was employed [43, 51].

The GAP intervention programme was pitched to second-year students and their parents/guardians as a fun, free, peer-led exercise programme suitable for all fitness levels that included a variety of activities and provided opportunities to win prizes. Recruitment strategies for both phases included an information email sent from the school to each second-year student and school social media posts on behalf of the research team. 'Girls Active Project' posters made by students [24] were displayed in the school prior to school closure (pre-COVID-19 lockdown, December 2020). In addition, a 'word-of-mouth' campaign [52] was employed in phase 2 (in person, April 2021). This involved project leaders visiting each of the second-year classrooms with the researcher (SMQ) during school hours to encourage them to participate in the intervention. Project leaders explained the purpose of the GAP intervention programme and answered any questions their peers had.

Adolescent females were eligible to take part in this study if they were (**a**) a project leader or (b) a second-year student. Eligible students received a letter of invitation from the school on behalf of the research team containing information sheets, assent and parental/guardian consent forms and a PA readiness questionnaire for them and their parent/guardian to read and sign. If the parent/guardian answered 'yes' to any of the questions in the PA readiness questionnaire, they were advised to talk to their general practitioner to discuss if their daughter is able to participate in the physical requirements of the PA programme. Students were excluded from the study if they had not provided assent or parental/guardian consent or they had been advised by their general practitioner not to undertake PA. Participating students were assigned identification codes to protect identity.

Other key stakeholders

At post-intervention, the parent/guardian of each second-year student ($n = 78$) was sent a text message from the school that contained a link to an anonymous online Qualtrics questionnaire [53]. Informed consent was provided online. A reminder text message was sent a week later. Parents/guardians provided their contact details if they were willing to participate in a short, semi-structured, audio-recorded phone call interview. School staff members (two physical education teachers and school principal) were invited to participate in a semi-structured, audio-recorded interview on school grounds at post-intervention. The three school staff members provided written informed consent prior to the interview.

Intervention delivery

As a team, intervention providers (project leaders) delivered a 45-min exercise class after school once per week to intervention recipients. Project leaders mutually decided what was delivered (intervention content) and changed it each week. This current study comprised eight classes over a 12-week period (March to May 2021) to accommodate school holidays (2 weeks during April). Training for the project leaders consisted of meetings during school hours, either online or in person, with the physical education teacher and

Table 2 The behaviour change techniques employed during the Girls Active Project intervention trial [23]

Behaviour change technique	Week 1_class 1: HIIT	Week 2_class 2: dance	Week 3_class 3: boxing	Week 4_class 4: dance	Week 8_class 5: boxing	Week 9_class 6: Football	Week 10_Class 7: basketball	Week 11_class 8: dance
Goal setting (behaviour)	X				X			
Action planning	X	X	X	X	X	X	X	
Monitoring of behaviour by others without feedback	X	X	X	X	X	X	X	X
Social support (practical)	X	X	X	X	X	X	X	X
Social support (emotional)	X	X	X	X	X	X	X	X
Instruction on how to perform a behaviour	X	X	X	X	X	X	X	X
Information about health consequences	X	X	X	X	X	X	X	X
Monitoring of emotional consequences	X	X	X	X	X	X	X	X
Demonstration of the behaviour	X	X	X	X	X	X	X	X
Prompts/cues	X	X	X	X	X	X	X	X
Behavioural practice/rehearsal	X	X	X	X	X	X	X	X
Habit formation	X	X	X	X	X	X	X	X
Generalisation of a target behaviour	X	X	X	X	X	X	X	X
Credible source	X				X			
Material incentive (behaviour)	X				X			
Material reward (behaviour)				X				X
Non-specific reward								X
Social reward	X	X	X	X	X	X	X	X
Non-specific incentive	X				X			
Restructuring the social environment	X	X	X	X	X	X	X	X
Verbal persuasion about capability	X	X	X	X	X	X	X	X

researcher (SMQ) to collaboratively discuss and for project leaders to ultimately decide: what was delivered (for example boxing) and how (for example 5-min warm-up including skipping, 30 min of boxing with intervals of bodyweight exercises, 5 min cool down and stretches). The activities (listed in Table 2) were a result of these discussions, and outlines when the 21 behaviour change techniques were employed during this intervention trial. At the start of each phase (week 1 and week 8), the recipients were encouraged to set a goal to attend each week and were informed of the potential rewards for participation, i.e. a signed 'Girls Active Project' certificate and entries into a raffle to win prizes, including €20 vouchers. The 'class plan' template and certificates can be found in Supplementary file 4. Procedures to standardise delivery were used [54], and a general class structure was followed:

a) Welcome and introductions made to intervention recipients and mention the purpose of the GAP programme
b) Intervention recipients given a chance to contribute and ask questions
c) Exercises explained and demonstrated and intervention recipients given a chance to practise the exercises
d) Intervention recipients congratulated for participating and reminded about next week's class.

It was not mandatory for students to have their cameras on during online classes (phase 1). If project leaders preferred not to deliver the class with their cameras on, a suitable YouTube exercise video was chosen instead. A physical education teacher was present to offer any modifications to exercises if required. Researcher (SMQ) attended each class to assist in supervision and if needed offer encouragement and consultation to project leaders.

Data collection

Quantitative and qualitative data were gathered to assess intervention feasibility. All data collection tools used can be found in Supplementary file 3.

Questionnaires

Recipients were asked to complete a self-reported questionnaire at every data collection time-point (week 1, week 8 and week 12). The questionnaire was piloted and modified with the students who codesigned the intervention [24] to ensure there was no ambiguity in the questions and to identify any potential problems the recipients might experience. At baseline, recipients were asked to complete the questionnaire at home online (week 1, phase 1), via a link to a Qualtrics [53] questionnaire or on paper (week 8, phase 2) administered by the researcher (SMQ) during agreed scheduled school hours. This included a short demographic section capturing date of birth, nationality, disability status and the name of the street they lived on. Street names were mapped against a publicly available 'deprivation indices' [55] for Ireland, which identifies underprivileged areas by estimating deprivation on an 8-point scale (1 = extremely affluent to 8 = extremely disadvantaged) [55]. Self-reported outcome measures were captured at every data collection time-point: week 1 (phase one baseline), week 8 (mid-intervention and phase 2 baseline), and week 12 (post-intervention). Previously validated scales were used to measure the outcomes, including minutes of daily moderate-to-vigorous intensity PA (MVPA) [56–58], self-rated health [58], life satisfaction [59], self-efficacy related to PA [60–62] and PA enjoyment [61, 63–65]. Clear instructions were provided in written form to each recipient on how to accurately measure and take note of their height (to the nearest cm) and weight (to the nearest 0.1 kg) at home. Data completion rates are expressed as overall percentages. The mean scores, standard deviations and ranges for each measure are also presented to provide context.

Self-reported feedback questionnaires were developed by the authors to capture stakeholder experiences with various aspects of the intervention. This feedback questionnaire was integrated into the recipients questionnaire at week 8 (mid-intervention) and week 12 (post-intervention). A 5-point Likert scale (1: dislike very much to 5: like very much) was used to assess recipients' satisfaction with the programme. A predetermined mean score of ≥ 3.5 out of 5 was considered feasible [66]. Recipients were asked to rate factors influencing participation, such as 'my friends', using a 5-point Likert scale (1: not at all to 5: extremely). Perceived sustainability was assessed by asking recipients if they would like the programme to remain in the school and if they would continue to participate if it did. Recipients were also asked to share opinions on how to improve the programme. Project leaders were asked to complete a similar feedback questionnaire at post-intervention (week 12).

A total of 20 parents/guardians participated in the online questionnaire ($n = 20$, response rate: 26%). It took approximately 6 min to complete. Parents/guardians of second-year students were asked to explain why they thought their daughter did or did not participate, if they would like for the programme to remain as an option for students attending the school and provide suggestions on what the school could do to make it easier for them as a parent/guardian to enable their daughter to participate. Parents/guardians of intervention recipients indicated their daughter's satisfaction with the programme by rating various statements, (e.g. my daughter enjoyed participating in the GAP) using a 5-point Likert scale (1: disagree a lot to 5: agree a lot).

Attendance and delivery logbooks

Student attendance was recorded and monitored by the physical education teacher and researcher (SMQ). Project leaders were asked to complete a short (approximately 3 min), self-reported provider checklist ('project leader logbook') online using a Qualtrics [53] questionnaire after each class that they attended. Project leaders received weekly reminder emails to complete the logbook. The delivery logbook contained an implementation checklist that was developed by the authors. The checklist assessed if the class aims (based on the behaviour change techniques (Table 2)) were delivered that day. A total of 38 logbooks were requested. Intervention fidelity was measured via the degree to which the treatment (exercise classes) was delivered as intended by project leaders. Levels of fidelity previously reported in the literature were applied, with 80–100% interpreted as 'high' fidelity, 51–79% as 'moderate' and 0–50% as 'low' fidelity [67–70]. This study aimed for a benchmark of 80% fidelity. Total fidelity is expressed as an average of the class aims being delivered across the eight exercise classes.

Semi-structured focus groups and interviews

Four semi-structured focus groups occurred during school hours, two with intervention recipients and two with project leaders (week 8 and week 12) lasting approximately 20 min (range: 17–26 min). Two parents/guardians participated in a semi-structured phone call interview, lasting on average 9 min (range: 7–11 min). These interviews were intentionally designed and specifically promoted as being short with the intention of increasing parental/guardian engagement. Despite being short, the questions asked complemented the parent/guardian questionnaire and addressed study objectives.

Semi-structured interviews with the three school staff members occurred on school grounds at post-intervention lasting on average 26 min (range: 20–33 min).

Topic guides used for the focus groups and interviews were developed by the authors and aimed to explore stakeholders' satisfaction with the GAP programme and its perceived sustainability in the school and to identify any contextual factors that may have affected implementation. Stakeholders revealed what they liked and disliked about the programme, reasons for participation, and provided recommendations for future implementation. Each semi-structured focus group and interview was audio recorded, and hand-written notes were taken by the researcher (SMQ). The audio recordings were transcribed verbatim, and pseudonyms were assigned to protect participant identity.

Data analysis

Descriptive analyses were performed using the Statistical Package for Social Sciences (SPSS) version 25. Each proposed outcome measure is represented by a mean score, as well as a rate of completion. Focus group and interview transcripts were analysed using a six-step thematic approach [71]. Initially, each transcript was read and re-read several times by the researcher (SMQ), who developed a sample coding frame. These coded transcripts were reviewed by the remaining authors (SJB, AS and MRS). The coding frame was refined iteratively by SMQ, SJB, AS and MRS with subsequent discussions. Anonymised illustrative quotes supporting emerging themes were highlighted and agreed by researchers.

Results

Enrolment, who participated and why? (Objective 1)

A total of ten second-year students returned the relevant documents to take part. Of which, eight completed the baseline questionnaire (six at week 1 and two at week 8) and participated in the intervention (n = 8/78, 10.3%). One student who consented did attend but was absent on both days of data collection. Another student did not respond to emails and was eventually lost to follow-up. Seven recipients completed data collection at week 12, post-intervention (n = 7/8, 87.5%) (Fig. 1). During the in person delivered classes (phase 2), the physical education teacher and researcher (SMQ) observed that additional second-year students attended yet failed to return the necessary documents to participate in data collection. Of the eight recipients who did complete the baseline questionnaire, the mean age was 13.25 (range: 13–14, *SD*: 0.46), all of Irish nationality (n = 8, 100%) and with no reported disability (n = 8, 100%). The deprivation indices based on home street addresses ranged from 'disadvantaged' to 'very disadvantaged' (mean: 6.4, range: 6 'disadvantaged' to 7 'very disadvantaged', *SD*: 0.52).

Facilitating factors that influenced participation shifted between both phases of the intervention. Improving health and well-being and challenging oneself were the highest rated factors in phase 1 (mean: 4.8, *SD*: .45), whereas being with others was the number one facilitator (mean: 4.8, *SD*: 0.45) during phase 2, followed by wanting to be physically fit (mean: 4.40, *SD*: 0.89). Fun, enjoyment and socialising with peers were identified as key motivators, 'that's why I did it, I just went, and I actually really liked it because it's a nice way to spend time with the girls as well' (Intervention recipient I, post-intervention focus group). Other facilitators to participation included the desire to feel like they have achieved something and the lack of alternative options during the COVID-19 pandemic. Most parents/guardians believed their daughter participated to improve health and fitness, 'she wanted to get more active and to be more involved in after school activities' (parent K, post-intervention questionnaire) and to spend time with peers, 'I think she participated because she enjoys trying out new things and hanging out with her friends' (parent J, post-intervention questionnaire). Of less concern, recipients rated the 'Girls Active Project' certificate (mean: 1.80, SD: 1.30, phase 1) and family (mean: 2.0, SD: 1.23, phase 2) as the lowest motivating factors. Recipients scored the rewards, including vouchers, as a 'slightly' motivating factor in both phases of the intervention (mean: 2.8, *SD*: 0.45, phase 1 vs mean: 2.4, *SD*: .89, phase 2). Despite the project leaders deeming the rewards a success, 'I think they were amazing. I think they enjoyed it and they definitely appreciated it. They were like 'I got a voucher for doing something I actually enjoyed', and then they were like I'm going to keep doing that' (project leader B, post-intervention focus group), recipients described the rewards as just a 'bonus', and not a leading factor influencing involvement.

Attendance, and was the intervention implemented as intended? (Objective 2)

Project leaders delivered eight exercise classes, and all planned behaviour change techniques were employed. No adverse events were reported. On average, providers attended 79% of classes (71% phase 1 vs 87.5% phase 2). Attendance was slightly lower for recipients (68%), with no significant difference found between phase 1 (67.8%) and phase 2 (68.7%). A total of 31 delivery logbooks (15 at phase 1 and 16 at phase 2) out of a possible 38 were completed (82% completion rate). On average, most of the exercise classes started on time (94%) and were delivered as planned (87%), 'We gave the class the exact plans as we did in our head, it was great, everyone cooperated

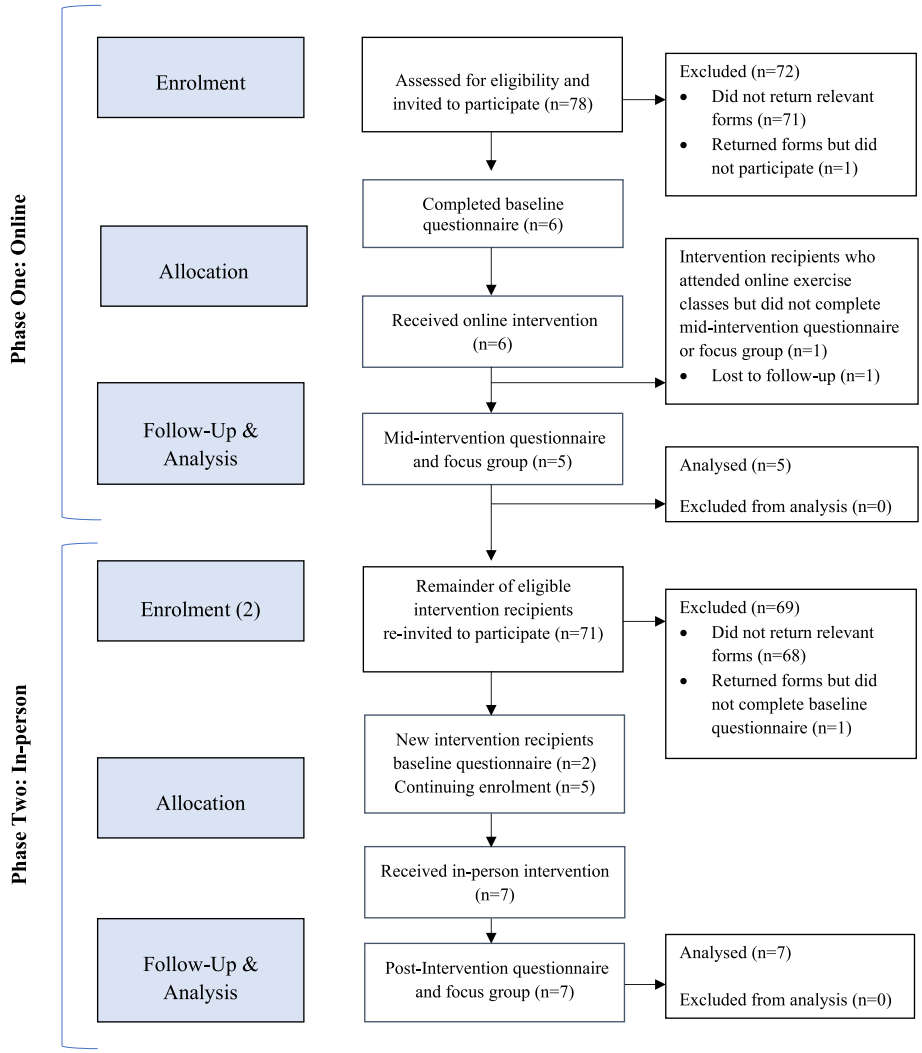


Fig. 1 Flow chart of intervention recipients through this study based on the CONSORT 2010 flow diagram [46]

Table 3 Implementation checklist responses[a] based on project leaders logbooks

Class aim	Phase 1: online (15 logbooks)	Phase 2: in person (16 logbooks)	Total intervention (31 logbooks)
1. Welcome and introductions were made	100% yes	100% yes	100% yes
2. Purpose of the Girls Active Project was mentioned	93% yes	69% yes	80% yes
3. Recipients were given a chance to contribute to the discussion and ask questions	93% yes	100% yes	97% yes
4. Exercises were explained and demonstrated	93% yes	88% yes	90% yes
5. Recipients were given a chance to practice the exercises	50% yes	75% yes	63% yes
6. Recipients were congratulated for joining the class and encouraged to be active	100% yes	94% yes	97% yes
7. Recipients were reminded about next week's class	93% yes	75% yes	83% yes
Total fidelity	**89%**	**86%**	**87%**

[a] Options, yes/no/unsure

Table 4 Measure completion and scores for proposed self-reported outcome data

Measure	Week 1: baseline (phase 1), online			Week 8: mid-intervention and baseline (phase 2), paper-based			Week 12: post-intervention, paper based			Overall
	Mean (SD)	Range	Percent completed	Mean (SD)	Range	Percent completed	Mean (SD)	Range	Percent completed	Percent completed
MVPA (7 days)	3.75 (1.9)	0–5 days	100 (6/6)	4.1 (1.7)	1–7 days	100 (7/7)	4.0 (1.6)	1–7 days	100 (7/7)	**100 (20/20)**
Height (m)	1.61 (.07)	1.49–1.68	100 (6/6)	1.65 (.04)	1.60–1.70	57 (4/7)	1.65 (.03)	1.60–1.70	86 (6/7)	**80 (16/20)**
Weight (kg)	51.1 (8.5)	44.4–66.0	100 (6/6)	55.6 (14.7)	45.2–66.0	29 (2/7)	53.0 (2.8)	51.0–55.0	29 (2/7)	**50 (10/20)**
Self-rated health	3.5 (0.55)	3–4	100 (6/6)	3.3 (0.76)	2–4	100 (7/7)	3.3 (0.76)	2–4	100 (7/7)	**100 (20/20)**
Life satisfaction	8.0 (1.3)	7–10	100 (6/6)	7.0 (2.3)	3–10	100 (7/7)	7.0 (2.3)	3–10	100 (7/7)	**100 (20/20)**
PA self-efficacy	4.1 (0.42)	3.4–4.5	100 (6/6)	4.0 (0.70)	2.9–4.5	100 (7/7)	4.1 (0.78)	2.9–4.9	100 (7/7)	**100 (20/20)**
PA enjoyment	68.2 (13.3)	45–79	100 (6/6)	73.5 (7.8)	60–80	86 (6/7)	74.6 (4.5)	69–80	100 (7/7)	**95 (19/20)**

Scale scores, MVPA (0–7 days); height (metre), weight (kg), self-rated health (1: 'poor' to 4: 'excellent'), life satisfaction (0: 'worst possible life' to 10: 'best possible life'), PA self-efficacy (average of 8 items on a 5-point Likert scale, 1: disagree a lot to 5: agree a lot), PA enjoyment (total scores range from 16: lowest to 80: maximum enjoyment)

Abbreviations: *SD* standard deviation, *MVPA* moderate to vigorous physical activity, *M* metre, *kg* kilogram, *PA* physical activity

brilliantly!' (project leader F, written extract from logbook phase 2). Project leader absence or an unrelated injury was cited as reasons why a class was not delivered as planned. The implementation checklist results are presented in Table 3. On average, 87% of the aims were delivered (89% phase 1 vs 86% phase 2). During phase 1, project leaders believed the recipients were practising the exercises (aim 5), although said it was difficult to judge because some recipients had their cameras off, 'I think they were actually doing it, but they were just embarrassed' (project leader A, mid-intervention focus group).

Are the proposed outcome measures feasible? (Objective 3)

On average, the rates of completion for the self-reported outcomes were high at 90%. Table 4 provides a summary of the outcome data and completion rates at the three data collection time-points. Weight (kg) and height (m) data were completed the least by recipients at 50% and 80%, respectively. Completion of MVPA levels, self-rated health, life satisfaction and PA self-efficacy were 100% at all data collection time-points.

Were the stakeholders satisfied with the intervention? (Objective 4)

Satisfaction levels reported by intervention recipients and project leaders at mid-intervention (week 8) and post-intervention (week 12) for each aspect of the programme are presented in Table 5. Overall satisfaction rates for both recipients and project leaders indicated high acceptability of the intervention. Two aspects of the intervention achieved a mean score of < 3.5 out of 5 and thus considered not feasible. This included the intervention 'being online' (mean: 3.4, *SD*: 0.55) and project leaders 'completing the weekly logbooks' (mean: 3.3, *SD*: 1.0).

Seven parents/guardians of second-year students answered 'yes' to their daughter taking part in the intervention ($n = 7/15$, 47%). Most agreed that their daughter enjoyed the programme (mean: 4.7, *SD*: 0.82, range: 3–5); liked that it was peer led (mean: 4.4, *SD*: 0.89, range: 3–5) and offered variety (mean: 4.6, *SD*: 0. 55, range: 4–5); and liked the timing, dates and duration of the classes (mean: 4.8, *SD*: 0. 50, range: 4–5).

Overall, the qualitative data also suggested that stakeholders were satisfied with the intervention. Both recipients and project leaders preferred the intervention delivered in person, 'it went a lot better than I thought it would online, but I preferred it face-to-face' (project leader B, post-intervention focus group). Project leaders did not indicate any dissatisfaction with completing the logbooks, 'Just the survey? Oh, that was fine, got that done in like 5 minutes' (project leader D, post-intervention focus group). For one project leader, the timing and dates coincided with other commitments; however, they recognised that 'it's really hard to find a time that suits everyone' (project leader E, post-intervention focus group). Project leaders enjoyed working with peers and learning new skills 'we learned how to take initiative, like if stuff goes wrong, we adapted and planned different classes and stuff' (project leader A, post-intervention focus group) and their leadership role, 'it gave us a leadership role in the school for sure. It made you feel included, and it made you feel like you had a place to go after school where everyone had the same interests, and you were all there for the same reason' (project leader D, post-intervention focus group). To improve intervention acceptability, project leaders recommended to extend class duration and provide extra time at the start of the class to setting up, 'we could try set up everything before second years [recipients] arrive so that we are prepared, and it doesn't take up class time' (project leader E, feedback questionnaire). Additional promotional activities from the school to encourage participation was also suggested, 'the school didn't really like promote it that much, like they could have posted it more and put it on the Instagram pages, I think that would have of like helped more people come' (project leader A, post-intervention focus group).

Recipients disliked that not many students enrolled and equally suggested that the school further promotes the GAP programme through weekly reminders, more posters and announcements via the school intercom and social media posts, 'put up a few pictures or a link or if there was a little video put together of what one class is literally like' (intervention recipient D, post-intervention focus group). Recipients described how they enjoyed the exercise classes because they got to spend time with friends, relieve stress, did not feel judged and liked that the project leaders were close in age. They also expressed their satisfaction with the variety of activities offered as it introduced them to new activities, 'they're things that like I wouldn't pick myself but then when I done it, it was good' (intervention recipient B, mid-intervention focus group) and kept it fun, 'if it was the same every week, it would just get boring like' (intervention recipient C, post-intervention focus group). In the phone call interview, one parent/guardian described how it was the variety that attracted her daughter to participate, 'it was because you were doing a bit of something different every week. That's what made her, that's what appealed to her' (parent 2, interview). Both parents/guardians suggested additional encouragement from the school would increase participation and improve its acceptability, 'I suppose if they could point out that it was more fun

Table 5 Satisfaction levels reported by intervention recipients and intervention providers on aspects of the Girls Active Project at mid-intervention and post-intervention

Aspect of the Girls Active Project intervention	Intervention recipients ($n = 5$)		Intervention recipients ($n = 7$)		Intervention providers ($n = 6$)		Categorisation[a]
	Week 8: mid-intervention (phase 1)		Week 12: post-intervention (phase 2)		Week 12: post-intervention (overall)		
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	
Organisation	4.6 (0.55)	4–5	5.0 (.00)	5–5	4.3 (0.82)	3–5	Feasible
Class duration	4.6 (0.55)	4–5	5.0 (.00)	5–5	4.2 (0.41)	4–5	Feasible
Dates of delivery	4.8 (0.45)	4–5	4.7 (0.76)	3–5	4.0 (1.1)	2–5	Feasible
Start and end time	4.8 (0.45)	4–5	5.0 (.00)	5–5	3.5 (0.55)	3–4	Feasible
Variety of activities	4.4 (0.89)	3–5	4.9 (0.38)	4–5	4.8 (0.41)	4–5	Feasible
Delivery of activities (project leaders)	4.8 (0.45)	4–5	4.9 (0.38)	4–5	NA	NA	Feasible
Information provided	4.6 (0.55)	4–5	4.6 (0.79)	3–5	NA	NA	Feasible
It being online	3.4 (0.55)	3–4	NA	NA	NA	NA	Not feasible
It being in person	NA	NA	5.0 (.00)	5–5	NA	NA	Feasible
Being a leader delivering the classes	NA	NA	NA	NA	4.8 (0.41)	4–5	Feasible
Completing the weekly logbooks	NA	NA	NA	NA	3.3 (1.0)	2–5	Not feasible
Working as part of a team	NA	NA	NA	NA	4.7 (0.52)	4–5	Feasible
Overall satisfaction	5.0 (.00)	5–5	4.7 (0.76)	3–5	4.7 (0.52)	4–5	Feasible

Scale scores: 5-point Likert scale (1: dislike very much to 5: like very much)

Abbreviations: *SD* standard deviation, *NA* not applicable

[a] A predetermined mean score of $\geq$ 3.5 out of 5 was considered feasible

than anything, you know? It wasn't like it was work' (parent 2, interview).

School staff members also liked that the programme provided students with an opportunity to try new activities, 'I think when you give those opportunities then of doing a variety of things where they get the opportunity to try them out, it's huge because then that could be their thing that they actually go on to do' (school staff member A, interview). They believed the students involved enjoyed it, 'you can see them laughing and joking, and that's what I liked about it, it's simple and effective and they come away from it happy' (school staff member B, interview) and particularly liked that, unlike many other extra-curricular PA programmes, the emphasis was not on competition or performance, 'it was about getting involved and just enjoying physical activity, which I really enjoyed that aspect of it' (school staff member C, interview). Staff members expressed satisfaction with the intervention being peer-led 'it's great because I think we have students that have a great ability to lead and they obviously look up to each other, especially the younger years to the older years' (school staff member A, interview) and cited many positive impacts the intervention had on the students involved, alongside being active, such as socialising, gaining a sense of belonging, and particularly for project leaders, to feel trusted and develop leadership skills.

To enhance intervention acceptability, staff members recommended extending class duration from 45 min to 1 h, creating more reminders and introducing different rewards to maintain student involvement, such as a 'Girls Active Project' t-shirt. Staff members considered the intervention acceptable yet were open to modifications, 'I think as it goes on in the future, we'll see where it can be developed as well when it's more established in the school. And then if there are tweaks and things that need changing, we could do it then' (school staff member C, interview).

Was the intervention perceived as compatible with the school setting? (Objective 5)

All project leaders (100%, $n = 6/6$), most parents/guardians (92%, $n = 12/13$) and most recipients (80%, $n = 4/5$ phase 1 vs 85.7%, $n = 6/7$ phase 2) wanted the programme to remain in the school. Project leaders perceived the programme as an appropriate fit, 'I loved it and it would be a great thing to keep in the school' (project leader C, feedback questionnaire), with six of them (100%, $n = 6/6$) reporting that they would recommend becoming a project leader to other students 'I would definitely recommend it as it is an amazing, fun and rewarding experience

and not only does it develop your fitness skills, but your leadership ones also' (project leader E, feedback questionnaire). More recipients reported that they would continue to participate if it were delivered in person than online (85.7%, $n = 6/7$ phase 2 vs 60%, $n = 3/5$ phase 1). During the post-intervention focus group, some of the recipients explained how they never participated in other after-school PA programmes because they perceived them to be competitive in nature. If given the chance, however, they would continue to participate in the GAP programme because it was significantly less competitive, 'this was a lot more chill' (intervention recipient C, post-intervention focus group). Likewise, staff members acknowledged how the programme attracted students that were not usually involved in extra-curricular PA clubs, 'it's the same girls all the time doing the same sports, whereas the GAP actually opens up exercise to a bigger cohort because you're not attracting the same people, which is good' (school staff member B, interview). They perceived this as important as it offered an opportunity for the 'noncompetitive' students to engage with PA, 'the non-competitive people, they need to have something. I mean, those are the people you're trying to keep involved and to get active, so yeah, absolutely, I think it [the GAP programme] needs to be as fundamental as the other sports, 100%' (school staff member A, interview). School staff members were optimistic about the intervention's long-term potential in the school. One staff member believed it was less administratively demanding and required limited involvement in terms of class delivery when compared to other after-school PA programmes, 'it's easier. I think it gets better results for less time. So, why wouldn't you do that?' (school staff member B, interview). The perceived sustainability of the intervention was also influenced by student enjoyment, 'I think it's also far more likely that they continue doing physical activity if it's enjoyable in the first place. So, as a lifelong learning thing, I think it's far more sustainable, even than playing on the school team, because lots of people do that for a year or two and then they drop off anyway even if they were sporty. So, from the point of view of enjoyment and doing it from a health promoting point of view, I think this was far more sustainable and I think they're likely to go with it' (school staff member C, interview).

What were the external factors that affected intervention implementation? (Objective 6)

Barriers

There were external barriers to recruitment. Stakeholders acknowledged that employing recruitment strategies was difficult due to the COVID-19 pandemic, especially during school closure, 'it's extremely hard to do in COVID. Besides emailing and telephone calling, and getting them to talk to their friends like, they're not in school' (school staff member B, interview). Recruiting and engaging students online were identified as barriers, 'initially it had to be online you know, and that doesn't really work for a lot of our students, as we learned' (school staff member C, interview). Staff members stated that many students did not attend compulsory academic classes online; therefore, anything extra-curricular was considered increasingly challenging. Additionally, project leaders suggested that the intervention being online was a barrier to participation, 'you're tired from doing online school and then you just want to take a break after it, and then it's hard to go back online to do it' (project leader A, post-intervention focus group). Recipients reported homework and distinct to phase 1 (online), failing to remember 'quarantine brain got the best of everyone' (intervention recipient B, mid-intervention focus group) as barriers to participation.

The COVID-19 pandemic continued to affect intervention implementation during phase 2 (in person). Project leaders felt constrained, 'even now in school we're limited in what we can do because of Corona' (project leader B, mid-intervention focus group). The eight parents/guardians of second-year students whose daughter did not take part in the intervention ($n = 8/15$, 53%) listed homework, other commitments such as music, a dislike for after-school activities and anxiety and fears surrounding the COVID-19 pandemic as barriers to enrolment, 'she is finding it hard to settle back into school since lockdown, with her anxiety of school' (parent B, questionnaire).

Facilitators

In contrast to the above, some recipients also considered the COVID-19 pandemic as an external facilitator to enrolment due to the lack of other PA options available, 'like this was definitely a good option like you know what I mean, something to do when everything else was closed' (intervention recipient A, mid-intervention focus group). Project leaders could also recognise COVID-19 as a facilitator to enrolment, 'loads of the places weren't open at the time to go and do your exercises' (project leader D, post-intervention focus group). Staff members identified the school reopening (phase 2, April 2021 post lockdown) as an external factor that positively affected intervention implementation as it allowed for the 'word of mouth' recruitment strategy to be implemented, 'the numbers definitely increased over the weeks and when they'd be in class talking, they'd talk to each other and encourage each other to go, which is… that's huge' (school staff member B, interview). Staff members believed that with time, enrolment into the in-person

delivered PA programme would have increased. Other identified facilitators included the following: stakeholder buy-in via the schools' steady support and commitment, including use of the online platforms and sport hall facilities; the positive working relationship and regular communication with the research team; and the project leaders, 'they're confident students, they're enthusiastic. So, you know, that's a huge strength in a way' (school staff member A, interview).

Discussion

This paper presents the reach, dose, fidelity, acceptability and compatibility of the peer-led, after-school GAP intervention programme, the data completion rates of proposed self-reported outcome measures and identifies the external factors to implementation. The peer-led, after-school PA programme was trialled for the first time over a 12-week period with disadvantaged adolescent females in a single-sex, female-only, designated disadvantaged postprimary school in Ireland during the COVID-19 pandemic. This study encountered significant contextual barriers and challenges with recruitment. The in-person delivered programme, however, shows promise as an intervention that can be feasibly implemented and evaluated. Results indicated the intervention was implemented as intended and was deemed acceptable and compatible with the school setting. The following paragraphs discuss the strengths and challenges of this trial and provide recommendations for future research.

Strengths

Retention rates were high, providing support for the feasibility of this trial. Peers, enjoyment, improving health and fitness and the wide variety of activities offered were regarded as essential for initiating and maintaining interest. The logbooks signified that the exercise classes were delivered with high fidelity (> 80%), suggesting that the intervention was delivered as intended. These results, however, must be interpreted with caution since, as often required [72], the fidelity measures used were developed specific to this intervention, making it difficult to use valid and reliable fidelity measures. The average dose received by recipients (68%) compared positively to similar feasibility studies on after-school PA interventions for adolescent females, such as the Girls-Peer Activity (G-PACT) project [32] which recorded an average of 40% and 47% attendance in each 'class' and 'choice' school, respectively, and the Bristol Girls Dance Project [73] with an average of 13.3 sessions attended out of a maximum of 18 (74%). This was a positive finding given that previous reviews [16, 20] on after-school PA programmes have emphasised the importance of high programme attendance rates as the effectiveness of a programme strongly depended on attendance. In general, completion rates for the proposed self-reported outcome measures were high. This demonstrated recipients' comprehension of the proposed measures and could indicate the feasibility of using these outcome measures in a future study.

Positive stakeholder responses were particularly welcome, given the unprecedented circumstances of the COVID-19 pandemic during intervention implementation. Consistent with previous school-based PA interventions for adolescent females [74, 75], the stakeholders in this study acknowledged the programme's potential to engage inactive students and provide an alternative option to students who may not be attracted to the competitive and performance-focused nature of traditional extra-curricular PA programmes. The stakeholders also recognised the positive impact the programme had on the students involved, alongside being active, such as skill development, which is likely to have implications for ongoing delivery. The benefits associated with being a student peer 'mentor' or 'leader' have been documented in past peer-led PA interventions [74, 76, 77].

Despite recent findings to support the use of online interventions to encourage adolescents engagement with PA [78], given that the GAP programme was designed and originally intended to be delivered in person after school in the school setting, it was perhaps unsurprising that the in-person delivered programme (phase 2) was deemed more acceptable than online (phase 1). Since time and staff availability are recognised barriers to the implementation of PA policies in schools [30], it was promising to discover that this peer-led intervention was considered easier to manage and less administratively demanding than other extra-curricular PA programmes. High intervention compatibility was also likely to be due to the codesign work [24] previously conducted with students in the school. Importantly, this process enabled the programme to be embedded within the school curriculum and allowed for project leaders' time to contribute towards the already established 'Gaisce' award [50]. Steady support and commitment from the school, and the enthusiastic project leaders, were cited as factors that helped intervention implementation. This highlighted the importance of stakeholder buy-in, as found in previous school-based PA initiatives [79, 80]. Finally, tailoring interventions to the individual school context is important for scaling up [79, 81]. Stakeholders' willingness to modify the intervention suggested that they were engaged and felt empowered to tailor the programme to suit their context. This in itself is a positive finding.

Challenges

Despite two rounds of recruitment, enrolment was low. Recruitment is crucial to the success of research

programmes as high enrolment rates demonstrate that the programme reached the population for which it was designed. Adolescent females, particularly from disadvantaged groups [82, 83], however, can be a difficult population to reach. The challenges of recruiting adolescent females into PA interventions have been recognised in previous research [32, 52, 84].

This study encountered additional contextual barriers to recruitment attributable to the COVID-19 pandemic. Employing recruitment strategies during school closure (phase 1) was difficult given students were not present in school and the lack of engagement with 'online school'. Another factor which may have proven to impact recruitment is that after-school PA programmes are often available to all students in the school or split into junior (first, second and third-year students aged 12–15) and senior cycle (4th, 5th and 6th-year students aged 15–18). As previously discussed, just 1 year group was invited to take part in this study. This would be unusual school practice and could have made the recruitment process more difficult. It was observed that additional students attended the in-person programme (phase 2) yet failed to return the relevant documents to participate in data collection. The perceived burden of returning documents could be a reason for this. Student absenteeism was a barrier to data collection identified in this study. A future trial could encounter similar challenges given that evidence suggests lower socio-economic status is associated with higher levels of absenteeism at school among adolescent females [85]. Despite the fact that the rewards used in this study (certificates and vouchers) were selected by students in the codesign process [24], recipients did not in actuality perceive these rewards as strong motivators influencing participation.

The two proposed self-reported outcome measures least completed by recipients were weight and height data. This could indicate that despite the detailed written instructions provided, requesting recipients to record these measurements at home and complete the questionnaires at school was not feasible. Project leaders deemed completing weekly logbooks as unfeasible in the feedback questionnaires; however, they did not indicate any dissatisfaction with the task in the focus groups. The online programme (phase 1) was also deemed unacceptable by intervention recipients. Most stakeholders agreed that phase 1 (online) went better than anticipated but found phase 2 (in person on school grounds) more acceptable and sustainable. This unique aspect to the study was necessary due to school closure resulting from the COVID-19 pandemic. Ultimately, similar to O'Kane et al. [86], who reported challenges with remote data collection during COVID-19 lockdown, phase 1 of this current study (online) was largely dependent on students' engagement with home learning.

Recommended refinements

Low enrolment rates in this study could suggest current recruitment strategies were ineffective; thus, further work is required to develop and test recruitment methods. This could involve codesigning strategies with students, parents and school staff to ensure the revised strategies are relevant, acceptable and practical. The 'word of mouth' campaign used in phase 2 was considered valuable by stakeholders in this study; however, students recommended to further boost programme awareness via school announcements and additional posts on social media, including short videos. Similar to Jago et al. [52], stakeholders in this study recommended extra emphasis on enjoyment of classes when pitching the programme to increase participation. Using a parental/guardian, passive (opt-out) approach has allowed for greater recruitment of adolescents in previous low-risk, nonintrusive, school-based PA interventions [32, 34, 44, 74, 79], such as the Girls-Peer Activity (G-PACT) [32] (94% using passive consent vs 26% using active consent) and the GoActive programme [87] (78% using passive consent vs 23% using active consent). This refinement, however, is dependent on ethical approval from the institutional research ethics board and agreement from the participating school. Another viable approach to recruitment [52] includes providing females the opportunity to sample an exercise class in a 'taster session' before committing to the programme. This could enable students to understand what the GAP programme would involve, without the pressure of signing up.

The motivating factors to participation identified in this study, such as being with others and a desire to improve health and fitness, could also prove useful when revising recruitment strategies for a future trial. Indeed, given that friend involvement can be an important factor affecting PA participation [25, 26], recruiting friend groups could be used as a potential strategy [84, 88] to increase recruitment. Other school-based PA interventions have found merit in providing small rewards to facilitate sustained involvement [73, 76], such as sports bags or pens [76]. One stakeholder in this study suggested using different rewards, such as a 'Girls Active Project' t-shirt. Further work with adolescent females to identify what rewards, if any, are acceptable and desirable is warranted to potentially improve recruitment and retention in a future trial.

As per usual school practice for after-school PA programmes, a future trial, if permitted, should invite additional year groups to take part. Proposed strategies to improve research with socially disadvantaged groups,

such as using flexible data collection methods [82], may need to be considered as a means to increase level of participation in data collection. The PA questionnaire used in this study to assess the attainment of PA guidelines had a high completion rate (100%) across all time points. This approach should be combined with an objective measure, such as accelerometers, to examine the intervention's potential impact on increasing MVPA levels [89, 90].

Given the low completion rate for self-reported weight, a future trial should reconsider using weight and height measures. Body image has been previously cited by adolescent females, especially those with low perceived competence and high weight status, as an internal barrier to PA participation [91]. In contrast, Demetriou et al. [20] found that females were more receptive than males to after-school PA interventions that promoted weight control. Further discussions with stakeholders could be beneficial in deciding if to include weight and height (either self-reported and/or objective) measures in a future trial. Additionally, further work with project leaders is necessary to revise the delivery logbooks to improve acceptability, while future research could assess the feasibility of using direct observation to monitor fidelity. Evidence suggests observational measures [54, 92, 93] or using a mixed-methods approach (audio recordings, direct observation and self-reported checklists) [70] to assess fidelity of intervention delivery may provide a more insightful understanding of fidelity and its influencing factors. Furthermore, alongside revising recruitment strategies, stakeholders suggested extending class duration from 45 min to 1 h, allocating extra time for project leaders to set-up at school prior to the exercise class and creating more reminders for recipients to attend class.

Strengths and limitations of this study

There are strengths to this study. This paper contributes to the expanding literature on feasibility studies of school-based PA interventions. Although unintended, the two-phase delivery of the intervention during COVID-19 allowed us to compare feasibility between an online and in-person delivered after-school PA intervention. This feasibility study used a mixed-methods approach and included multiple stakeholders perspectives (i.e. intervention recipients, providers, parents/guardians, physical education teachers and school principal). This allowed us to collect rich meaningful data on feasibility and acceptability of the intervention. Another strength of this study are the learnings and practical recommendations provided for future research.

There are a number of limitations to this study. Although it is acceptable given that this study's primary aim was to evaluate feasibility, this study involved a small sample size, and therefore, caution in generalisation is warranted. This study did not include an economic evaluation. Assessing the feasibility of using an objective measure (e.g. accelerometers) to capture adolescent MVPA levels was not possible due to school closure and travel restrictions. This study used self-reported PA data, which is dependent on students' recall ability [89, 90]. Furthermore, while many of the evaluation tools used in this study allowed for specificity, a limitation of this approach is the lack of evidence for the reliability or validity of the scores that such scales generate. This limitation has been acknowledged in similar evaluations of school-based adolescent PA interventions [72, 79].

Conclusion

The in-person delivered intervention was well-received by stakeholders involved and shows promise as an intervention that can be feasibly implemented and evaluated. Despite the COVID-19 pandemic hindering intervention implementation, classes were delivered as intended, and retention was high. Enrolment, however, was low, amplifying the need for further work on revising and testing recruitment strategies. There were important lessons to be learned from this study, both with and without the lens of the COVID-19 pandemic. This paper contributes to the growing body of knowledge on feasibility studies of after-school PA interventions, where the sharing of this detailed feasibility work may benefit other researchers in reusing techniques that have proved successful or in avoiding similar challenges. The novel GAP intervention programme should be revised using the recommendations from this study, before continuing to a more robust evaluation.

Abbreviations

GAP: Girls Active Project; PA: Physical activity; MVPA: Moderate-to-vigorous intensity physical activity; BCW: Behaviour change wheel; BCTs: Behaviour change techniques.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40814-022-01149-2.

Additional file 1: Supplementary file 1. GAP Feasibility Trial_CONSORT checklist

Additional file 2: Supplementary file 2. GAP TIDieR checklist

Additional file 3: Supplementary file 3. Data Collection Tools

Additional file 4: Supplementary file 4. GAP Materials

Acknowledgements

A huge thank you to the students, school staff, and parents/guardians who participated in this study, especially the project leaders for being an undeniable source of positivity and inspiration. Thank you to the Health Research Board SPHeRE programme who funded this research and to Oisín McQuinn for designing the GAP logo. We are grateful to Dr. Jenny McSharry, Dr. Emma Cowley, Dr. Joey Murphy, Dr. Méabh Corr, Dr. Elaine Murtagh and Dr. John Murphy for their time and expert advice.

Authors' contributions
SMQ contributed to the design, data collection, data analysis, data interpretation and drafting the manuscript. AS, SJB and MRS contributed to the development and design of the study, advised on data collection and analysis. All authors reviewed and revised the final manuscript in preparation for peer review. The authors read and approved the final manuscript.

Funding
This research was funded by the Health Research Board SPHeRE/2013/1.

Availability of data and materials
The datasets during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethical approval for this study was granted by the Institutional Research Ethics Committee at Dublin City University (DCUREC/2019/005). Informed consent and assent was obtained from parents/guardians, school staff, intervention recipients and intervention providers. All methods were carried out in accordance with relevant guidelines and regulations.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]School of Nursing, Psychotherapy and Community Health, Faculty of Science and Health, Dublin City University, Dublin 9, Ireland. [2]School of Health and Human Performance, Faculty of Science and Health, Dublin City University, Glasnevin, Dublin 9, Ireland.

Received: 18 January 2022 Accepted: 10 August 2022

References

1. Chaput JP, Willumsen J, Bull F, Chou R, Ekelund U, Firth J, et al. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. Int J Behav Nutr Phys Act. 2020;17(1):141.
2. Janssen I, LeBlanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7(1):40.
3. Guthold R, Stevens GA, Riley LM, Bull FC. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. Lancet Child Adolesc Health. 2020;4(1):23–35.
4. Inchley J, Currie D, Budisavljevic S, Torsheim T, Jåstad A, Cosma A. Spotlight on adolescent health and well-being. Findings from the 2017/2018 Health Behaviour in School-aged Children (HBSC) survey in Europe and Canada. International Report. Volume 1. Key Findings. Copenhagen: WHO Regional Office for Europe; 2020. Available from: https://apps.who.int/iris/bitstream/handle/10665/332091/9789289055000-eng.pdf.
5. Borraccino A, Lemma P, Iannotti R, Zambon A, Dalmasso P, Lazzeri G, et al. Socio-economic effects on meeting PA guidelines: comparisons among 32 countries. Med Sci Sports Exerc. 2009;41(4):749–56.
6. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451–62.
7. Corder K, Sharp SJ, Atkin AJ, Andersen LB, Cardon G, Page A, et al. Age-related patterns of vigorous-intensity physical activity in youth: the International Children's Accelerometry Database. Prev Med Rep. 2016;4:17–22.
8. Dumith SC, Gigante DP, Domingues MR, Kohl HW. Physical activity change during adolescence: a systematic review and a pooled analysis. Int J Epidemiol. 2011;40(3):685–98.
9. Murphy J, Sweeney MR, McGrane B. Physical activity and sports participation in Irish adolescents and associations with anxiety, depression and mental wellbeing. Findings from the Physical Activity and Wellbeing (Paws) Study. Phys Act Health. 2020;4(1):107–19.
10. Telama R. Tracking of physical activity from childhood to adulthood: a review. Obes Facts. 2009;2(3):187–95.
11. Rossi L, Behme N, Breuer C. Physical activity of children and adolescents during the COVID-19 pandemic—a scoping review. Int J Environ Res Public Health. 2021;18(21):11440.
12. Ng K, Cooper J, McHale F, Clifford J, Woods C. Barriers and facilitators to changes in adolescent physical activity during COVID-19. BMJ Open Sport Exerc Med. 2020;6(1):e000919.
13. van Sluijs EMF, Ekelund U, Crochemore-Silva I, Guthold R, Ha A, Lubans D, et al. Physical activity behaviours in adolescence: current evidence and opportunities for intervention. Lancet. 2021;398(10298):429–42.
14. Hills AP, Dengel DR, Lubans DR. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. Prog Cardiovasc Dis. 2015;57(4):368–74.
15. Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. Cochrane Database Syst Rev. 2013;2013(2):CD007651.
16. Messing S, Rütten A, Abu-Omar K, Ungerer-Röhrich U, Goodwin L, Burlacu I, et al. How can physical activity be promoted among children and adolescents? A systematic review of reviews across settings. Front Public Health. 2019;7:55. Available from: https://www.frontiersin.org/articles/10.3389/fpubh.2019.00055/full [cited 6 Nov 2019].
17. Love R, Adams J, van Sluijs EM. Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. Obes Rev. 2019;20(6):859–70.
18. Lai SK, Costigan SA, Morgan PJ, Lubans DR, Stodden DF, Salmon J, et al. Do school-based interventions focusing on physical activity, fitness, or fundamental movement skill competency produce a sustained impact in these outcomes in children and adolescents? A systematic review of follow-up studies. Sports Med. 2014;44(1):67–79.
19. Owen MB, Curry WB, Kerner C, Newson L, Fairclough SJ. The effectiveness of school-based physical activity interventions for adolescent girls: a systematic review and meta-analysis. Prev Med. 2017;105:237–49.
20. Demetriou Y, Gillison F, McKenzie TL. After-school physical activity interventions on child and adolescent physical activity and health: a review of reviews. Adv Physiol Educ. 2017;7(2):191–215.
21. Woods C, Powell C, Saunders J, O'Brien W, Murphy M, Duff C, et al. The Children's Sport Participation and Physical Activity Study 2018 (CSPPA 2018): Department of Physical Education and Sport Sciences, University of Limerick, Limerick, Ireland, Sport Ireland, and Healthy Ireland, Dublin, Ireland and Sport Northern Ireland, Belfast, Northern Ireland; 2018. Available from: https://www.sportireland.ie/research/csppa-2018 [cited 30 Jan 2020].
22. Department of Education. DEIS: delivering equality of opportunity in schools [Internet]. Department of Education and Skills. 2017. Available from: https://www.education.ie/en/schools-colleges/services/deis-delivering-equality-of-opportunity-in-schools-/ [cited 8 Apr 2021].
23. Michie S, Atkins L, West R. The behaviour change wheel. A guide to designing interventions. London: Silverback Publishing; 2014.
24. McQuinn S, Belton S, Staines A, Sweeney MR. Co-design of a school-based physical activity intervention for adolescent females in a disadvantaged community: insights from the Girls Active Project (GAP). BMC Public Health. 2022;22(1):615.
25. Mendonça G, Cheng LA, Mélo EN, de Farias Júnior JC. Physical activity and social support in adolescents: a systematic review. Health Educ Res. 2014;29(5):822–39.
26. Salvy SJ, de la Haye K, Bowker JC, Hermans RCJ. Influence of peers and friends on children's and adolescents' eating and activity behaviors. Physiol Behav. 2012;106(3):369–78.
27. Martins J, Costa J, Sarmento H, Marques A, Farias C, Onofre M, et al. Adolescents' perspectives on the barriers and facilitators of physical activity: an updated systematic review of qualitative studies. Int J Environ Res Public Health. 2021;18(9):4954.
28. Rees R, Kavanagh J, Harden A, Shepherd J, Brunton G, Oliver S, et al. Young people and physical activity: a systematic review matching their views to effective interventions. Health Educ Res. 2006;21(6):806–25.
29. Mitchell F, Gray S, Inchley J. 'This choice thing really works … ' Changes in experiences and engagement of adolescent girls in physical education

classes, during a school-based physical activity programme. Phys Educ Sport Pedagog. 2015;20(6):593–611.
30. Nathan N, Elton B, Babic M, McCarthy N, Sutherland R, Presseau J, et al. Barriers and facilitators to the implementation of physical activity policies in schools: a systematic review. Prev Med. 2018;107:45–53.
31. Lubans DR, Morgan PJ, Aguiar EJ, Callister R. Randomized controlled trial of the physical activity leaders (PALs) program for adolescent boys from disadvantaged secondary schools. Prev Med. 2011;52(3):239–46.
32. Owen MB, Kerner C, Taylor SL, Noonan RJ, Newson L, Kosteli MC, et al. The feasibility of a novel school peer-led mentoring model to improve the physical activity levels and sedentary time of adolescent girls: the girls peer activity (G-PACT) Project. Children. 2018;5(6):67.
33. Carlin A, Murphy MH, Nevill A, Gallagher AM. Effects of a peer-led Walking In ScHools intervention (the WISH study) on physical activity levels of adolescent girls: a cluster randomised pilot study. Trials. 2018;19(1):31.
34. Sebire SJ, Jago R, Banfield K, Edwards MJ, Campbell R, Kipping R, et al. Results of a feasibility cluster randomised controlled trial of a peer-led school-based intervention to increase the physical activity of adolescent girls (PLAN-A). Int J Behav Nutr Phys Act. 2018;15(1):50.
35. Ginis KAM, Nigg CR, Smith AL. Peer-delivered physical activity interventions: an overlooked opportunity for physical activity promotion. Transl Behav Med. 2013;3(4):434–43.
36. Skivington K, Matthews L, Simpson SA, Craig P, Baird J, Blazeby JM, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. BMJ. 2021;374:n2061.
37. Hallingberg B, Turley R, Segrott J, Wight D, Craig P, Moore L, et al. Exploratory studies to decide whether and how to proceed with full-scale evaluations of public health interventions: a systematic review of guidance. Pilot Feasibility Stud. 2018;4(1):104.
38. Beets MW, von Klinggraeff L, Weaver RG, Armstrong B, Burkart S. Small studies, big decisions: the role of pilot/feasibility studies in incremental science and premature scale-up of behavioral interventions. Pilot Feasibility Stud. 2021;7(1):173.
39. Eldridge SM, Lancaster GA, Campbell MJ, Thabane L, Hopewell S, Coleman CL, et al. Defining feasibility and pilot studies in preparation for randomised controlled trials: development of a conceptual framework. PLoS One. 2016;11(3):e0150205.
40. Bird L, Arthur A, Cox K. "Did the trial kill the intervention?" experiences from the development, implementation and evaluation of a complex intervention. BMC Med Res Methodol. 2011;11(1):24.
41. El-Kotob R, Giangregorio LM. Pilot and feasibility studies in exercise, physical activity, or rehabilitation research. Pilot Feasibility Stud. 2018;4:137. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6090705/ [cited 16 Oct 2018].
42. Lancaster GA, Thabane L. Guidelines for reporting non-randomised pilot and feasibility studies. Pilot Feasibility Stud. 2019;5(1):114.
43. Pearson N, Naylor PJ, Ashe MC, Fernandez M, Yoong SL, Wolfenden L. Guidance for conducting feasibility and pilot studies for implementation trials. Pilot Feasibility Stud. 2020;6(1):167.
44. Corepal R, Best P, O'Neill R, Kee F, Badham J, Dunne L, et al. A feasibility study of 'The StepSmart Challenge' to promote physical activity in adolescents. Pilot Feasibility Stud. 2019;5(1):132.
45. Iadarola S, Pellecchia M, Stahmer A, Lee HS, Hauptman L, Hassrick EM, et al. Mind the gap: an intervention to support caregivers with a new autism spectrum disorder diagnosis is feasible and acceptable. Pilot Feasibility Stud. 2020;6(1):124.
46. Eldridge SM, Chan CL, Campbell MJ, Bond CM, Hopewell S, Thabane L, et al. CONSORT 2010 statement: extension to randomised pilot and feasibility trials. BMJ. 2016 Oct;24(355):i5239.
47. Hoffmann TC, Glasziou PP, Boutron I, Milne R, Perera R, Moher D, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ. 2014;348:g1687.
48. Steckler A, Linnan L. Process Evaluation for Public Health Interventions and Research. Wiley; 2002. p. 440.
49. Department of Education. Transition Year: Department of Education and Skills; 2021. Available from: https://www.education.ie/en/Schools-Colleges/Information/Curriculum-and-Syllabus/Transition-Year-/ [cited 8 Apr 2021].
50. Department of Children, Equality, Disability, Integration and Youth. Gaisce | Irish President's Award | Get Involved: Gaisce; 2020. Available from: https://www.gaisce.ie/ [cited 2 Nov 2021].
51. Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ. 2011;343:d5928.
52. Jago R, Davis L, McNeill J, Sebire SJ, Haase A, Powell J, et al. Adolescent girls' and parents' views on recruiting and retaining girls into an after-school dance intervention: implications for extra-curricular physical activity provision. Int J Behav Nutr Phys Act. 2011;8(1):91.
53. Qualtrics. Qualtrics XM // The leading experience management software: Qualtrics; 2021. Available from: https://www.qualtrics.com/uk/ [cited 2 Nov 2021]
54. Bellg AJ, Borrelli B, Resnick B, Hecht J, Minicucci DS, Ory M, et al. Enhancing treatment fidelity in health behavior change studies: best practices and recommendations from the NIH Behavior Change Consortium. Health Psychol. 2004;23(5):443–51.
55. Pobal. Deprivation Indices: Pobal - government supporting communities; 2021. Available from: https://maps.pobal.ie/WebApps/DeprivationIndices/index.html [cited 2 Nov 2021].
56. Prochaska JJ, Sallis JF, Long B. A physical activity screening measure for use with adolescents in primary care. Arch Pediatr Adolesc Med. 2001;155(5):554–9.
57. Hardie Murphy M, Rowe DA, Belton S, Woods CB. Validity of a two-item physical activity questionnaire for assessing attainment of physical activity guidelines in youth. BMC Public Health. 2015;15:1080.
58. Currie C, Inchley J, Molcho M, Lenzi M, Veselska Z, Wild F. Health Behaviour in School-aged Children (HBSC) Study protocol: background, methodology and mandatory items for the 2013/14 Survey. St Andrews: CAHRU; 2014. Available from: https://risweb.st-andrews.ac.uk/portal/en/researchoutput/health-behaviour-in-schoolaged-children-hbsc-study-protocol-background-methodology-and-mandatory-items-for-the-201314-survey(78422155-ea90-4044-97f5-85b04bc97cf9)/export.html [cited 18 Nov 2018].
59. Cantril H. The pattern of human concerns. New Brunswick: Rutgers University Press; 1965. p. 456.
60. Motl RW, Dishman RK, Trost SG, Saunders RP, Dowda M, Felton G, et al. Factorial validity and invariance of questionnaires measuring social-cognitive determinants of physical activity among adolescent girls. Prev Med. 2000;31(5):584–94.
61. Dishman RK, Hales DP, Sallis JF, Saunders R, Dunn AL, Bedimo-Rung AL, et al. Validity of social-cognitive measures for physical activity in middle-school girls. J Pediatr Psychol. 2010;35(1):72–88.
62. Dishman RK, Motl RW, Saunders RP, Dowda M, Felton G, Ward DS, et al. Factorial invariance and latent mean structure of questionnaires measuring social-cognitive determinants of physical activity among Black and White adolescent girls. Prev Med. 2002;34(1):100–8.
63. Motl RW, Dishman RK, Saunders R, Dowda M, Felton G, Pate RR. Measuring enjoyment of physical activity in adolescent girls. Am J Prev Med. 2001;21(2):110–7.
64. Carraro A, Young MC, Robazza C. A contribution to the validation of the Physical Activity Enjoyment Scale in an Italian sample. Soc Behav Pers. 2008;36(7):911.
65. Moore J, Yin Z, Hanes J, Duda J, Gutin B, Barbeau P, et al. Measuring enjoyment of physical activity in children: validation of the Physical Activity Enjoyment Scale. J Appl Sport Psychol. 2009;21:S116–29.
66. Corr M, McMullen J, Morgan PJ, Barnes A, Murtagh EM. Supporting our lifelong engagement: mothers and teens exercising (SOLE MATES); a feasibility trial. Women Health. 2020;60(6):618–35.
67. Borrelli B, Sepinwall D, Ernst D, Bellg AJ, Czajkowski S, Breger R, et al. A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. J Consult Clin Psychol. 2005;73(5):852–60.
68. Perepletchikova F, Kazdin AE. Treatment integrity and therapeutic change: issues and research recommendations. Clin Psychol. 2005;12(4):365–83.
69. Garbacz LL, Brown DM, Spee GA, Polo AJ, Budd KS. Establishing treatment fidelity in evidence-based parent training programs for externalizing disorders in children and adolescents. Clin Child Fam Psychol Rev. 2014;17(3):230–47.
70. Toomey E, Matthews J, Hurley DA. Using mixed methods to assess fidelity of delivery and its influencing factors in a complex self-management

intervention for people with osteoarthritis and low back pain. BMJ Open. 2017;7(8):e015452.
71. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol. 2006;3(2):77–101.
72. Maynard BR, Peters KE, Vaughn MG, Sarteschi CM. Fidelity in after-school program intervention research: a systematic review. Res Soc Work Pract. 2013;23(6):613–23.
73. Jago R, Sebire SJ, Cooper AR, Haase AM, Powell J, Davis L, et al. Bristol girls dance project feasibility trial: outcome and process evaluation results. Int J Behav Nutr Phys Act. 2012;9(1):83.
74. Gorely T, Harrington DM, Bodicoat DH, Davies MJ, Khunti K, Sherar LB, et al. Process evaluation of the school-based girls active programme. BMC Public Health. 2019;19(1):1187.
75. Jenkinson KA, Naughton G, Benson AC. The GLAMA (Girls! Lead! Achieve! Mentor! Activate!) physical activity and peer leadership intervention pilot project: a process evaluation using the RE-AIM framework. BMC Public Health. 2012;12(1):55.
76. Jong ST, Croxson CHD, Foubister C, Brown HE, Guell C, Lawlor ER, et al. Reach, recruitment, dose, and intervention fidelity of the goactive school-based physical activity intervention in the UK: a mixed-methods process evaluation. Children. 2020;7(11):231.
77. Glazzard J, Rose A, Ogilvie P. The impact of peer mentoring on students' physical activity and mental health. J Public Ment Health. 2021;20(2):122–31.
78. Goodyear VA, Skinner B, McKeever J, Griffiths M. The influence of online physical activity interventions on children and young people's engagement with physical activity: a systematic review. Phys Educ Sport Pedagog. 2021;0(0):1–15.
79. Corder KL, Brown HE, Croxson CH, Jong ST, Sharp SJ, Vignoles A, et al. A school-based, peer-led programme to increase physical activity among 13- to 14-year-old adolescents: the GoActive cluster RCT. Public Health Res. 2021;9(6):1–134.
80. Belton S, Britton Ú, Murtagh E, Meegan S, Duff C, McGann J. Ten Years of 'Flying the flag': an overview and retrospective consideration of the active school flag physical activity initiative for children—design, development & evaluation. Children (Basel). 2020;7(12):300 Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7766853/ [cited 12 Apr 2021].
81. Sutherland R, Campbell E, McLaughlin M, Nathan N, Wolfenden L, Lubans DR, et al. Scale-up of the physical activity 4 everyone (PA4E1) intervention in secondary schools: 24-month implementation and cost outcomes from a cluster randomised controlled trial. Int J Behav Nutr Phys Act. 2021;18(1):137.
82. Bonevski B, Randell M, Paul C, Chapman K, Twyman L, Bryant J, et al. Reaching the hard-to-reach: a systematic review of strategies for improving health and medical research with socially disadvantaged groups. BMC Med Res Methodol. 2014;14(1):42.
83. Withall J, Jago R, Fox KR. Why some do but most don't. Barriers and enablers to engaging low-income groups in physical activity programmes: a mixed methods study. BMC Public Health. 2011;11(1):507.
84. Edwards MJ, May T, Kesten JM, Banfield K, Bird EL, Powell JE, et al. Lessons learnt from the Bristol Girls Dance Project cluster RCT: implications for designing and implementing after-school physical activity interventions. BMJ Open. 2016;6(1):e010036.
85. Sosu EM, Dare S, Goodfellow C, Klein M. Socioeconomic status and school absenteeism: a systematic review and narrative synthesis. Rev Educ. 2021;9(3):e3291.
86. O'Kane SM, Lahart IM, Gallagher AM, Carlin A, Faulkner M, Jago R, et al. Changes in physical activity, sleep, mental health, and social media use during COVID-19 lockdown among adolescent girls: a mixed-methods study. J Phys Act Health. 2021;18(6):677–85.
87. Corder K, Brown HE, Schiff A, van Sluijs EMF. Feasibility study and pilot cluster-randomised controlled trial of the GoActive intervention aiming to promote physical activity among adolescents: outcomes and lessons learnt. BMJ Open. 2016;6(11):e012335.
88. Garcia JM, Sirard JR, Deutsch NL, Weltman A. The influence of friends and psychosocial factors on physical activity and screen time behavior in adolescents: a mixed-methods analysis. J Behav Med. 2016;39(4):610–23.
89. Sylvia LG, Bernstein EE, Hubbard JL, Keating L, Anderson EJ. A practical guide to measuring physical activity. J Acad Nutr Diet. 2014;114(2):199–208.
90. Kang M, Mahar MT, Morrow JR. Issues in the assessment of physical activity in children. J Phys Educ Recreat Dance. 2016;87(6):35–43.
91. Corr M, McSharry J, Murtagh EM. Adolescent girls' perceptions of physical activity: a systematic review of qualitative studies. Am J Health Promot. 2019;33(5):806–19.
92. Walton H, Spector A, Tombor I, Michie S. Measures of fidelity of delivery of, and engagement with, complex, face-to-face health behaviour change interventions: a systematic review of measure quality. Br J Health Psychol. 2017;22(4):872–903.
93. Borrelli B. The assessment, monitoring, and enhancement of treatment fidelity in public health clinical trials. J Public Health Dentist. 2011;71(s1):S52–63.

Publisher's Note