Exploring a National Female Team Sport Talent Development Environment

Orlaith Curran, BSc., MProf

Supervisor: Dr. Áine MacNamara

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Student Declaration

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

Signature of Candidate

Student Number: 59318313

Date: 24th November 2022

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List of Abbreviations

Abbreviation	Definition
AFL	Australian Football League
ANOVA	Analysis of Variance
ATDE	Athletic Talent Development Environment
CI	Confidence Interval
CSF	Collaboration Success Factor
CV	Coefficient of Variation
DMGT	Differentiated Model of Giftedness and Talent
ESF	Environment Success Factors
GPS	Global Positioning System
HDOP	Horizontal Dilution of Position
HSR	Relative High Speed Running
LSM	Relative Low Speed Movement
M	Mean
m.min-1	Metres Per Minute (i.e. relative distance)
MBD	Magnitude-Based Decision
NGB	National Governing Body
NJAG	National Junior Age Grade
PCDEQ	Psychological Characteristics for Developing Excellence Questionnaire
PCDEQ2	Psychological Characteristics for Developing Excellence Questionnaire Version 2
PCDE	Psychological Characteristics of Developing Excellence
POP	Performance-Outcome-Process
SD	Standard Deviation
SMM	Shared Mental Model
sRPE	Session Rate of Perceived Exertion
SWC	Smallest Worthwhile Change
TD	Talent Development
TDE	Talent Development Environment
TDEQ	Talent Development Environment Questionnaire
TDEQ-5	Talent Development Environment Questionnaire (5 factor)
TDist	Total Distance
VHSR	Relative Very High Speed Running
AFLW	Women's Australian Football League
η2ρ	Partial eta Squared

List of Publications

1) Curran, O., MacNamara, A., & Passmore, D. (2019). What about the girls? Exploring the gender data gap in talent development. *Frontiers in Sport and Active Living*, 1(3), pp. 1-7. doi: 10.3389/fspor.2019.00003

   Contribution:

   a) Lead on study design, data collection and data analysis
   b) Lead on writing of study with collaboration from all authors

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   Contribution:

   a) Lead on study design, data collection and data analysis
   b) Lead on writing of study with collaboration from all authors

3) Curran, O., Passmore, D., & MacNamara, A. (2022). Singing off the same hymn sheet? Examining coherence in a talent development pathway (part 2), *Journal of Sports Sciences*, 40(8), pp. 863-870. doi: 10.1080/02640414.2021.2021702

   Contribution:

   a) Lead on study design, data collection and data analysis
   b) Lead on writing of study with collaboration from all authors

4) Curran, O., Neville, R. D., Passmore, D. & MacNamara, A. (2022). Variability in locomotor activity in a female junior international hockey team. *Journal of Science and Medicine in Sport,* 25(7), pp. 586-592. doi: 10.1016/j.jsams.2022.02.007

   Contribution:

   a) Lead on data collection
   b) Collaborated on study design and data analysis
   c) Lead on writing of study with collaboration from all authors

Abstract

Title: Exploring a National Female Team Sport Talent Development Environment

Author: Orlaith Curran

National sport organisations are creating female specific pathway programmes to assist young high potential female athletes to reach the elite senior level. However, current talent development (TD) research mostly reflects male populations. Critically male team sport talent development environments (TDEs) and TD processes that are available in the literature cannot be superimposed to female team sports without exploring this specific context. Therefore to examine the gaps within TD research Chapter 1 searched relevant studies between 1999-2019 and highlighted the dearth of TD literature (<10%) that relate to female only populations.

Therefore to fill this gender data gap Chapter 4 sought to explore the TDE of a female national team sport, through using the TDEQ-5, to better understand this complex TDE. The complexity in the TDE is reflective of the multiple contexts players co-inhabit. Chapter 5 was a follow up study including semi structured focus groups to provide richer insights regarding the lack of coherence and joint up systematic development of athletes found in the TDE. Results indicated coaches are working in silos, off their own agenda, with little direction provided by the NGB. Accordingly it was important to better understand the TD processes in the female team sport TDE. Therefore Chapter 6 used the Psychological Characteristics of Developing Excellence Questionnaire Version 2 (PCDEQ2) to investigate the psycho-behavioural skills evident in the national TD pathway. Results indicated differences between the playing groups and also depicted the lack of systematic development of these skills. Chapter 7 and 8 analysed game locomotor data using GPS metrics to better understand a young high potential athletes physical preparedness to transition vertically through the latter end of the pathway towards the senior elite level and horizontally towards the national TD pathway. The between game variability data in Chapter 7 was greater for higher speed compared to lower speed movements. This data can be interpreted to inform a threshold value to assist practitioners in determining a real change in performance over time for each locomotor metric. Results form Chapter 8 indicated the between game variability was higher at the club level compared to national level and the within game variability was lower in comparison to the national level, highlighting a contrast in the locomotor demands experienced at each playing level. This suggests the club level competition is not preparing players for the physical locomotor demands they are likely to experience at national level. Overall, the results throughout the thesis reflect a complex female team sport TDE providing practical guidelines to assist practitioners in other female team sport settings.

Chapter 1: Introduction

Talent development (TD) in sport has become a big global business. Achieving success on the world stage, and winning medals at major world sporting events such as the Olympic Games and World Championships is regarded as the pinnacle of elite sport. To achieve these goals, national sports organisations are committed to supporting their national governing bodies (NGBs) to develop TD pathways that are specific to their sport and conducive to developing athletes capable of achieving success at the top level (Sotiriadou et al., 2016; Harwood & Johnston, 2016). In recent years, there has been increased funding for high performance sport TD pathways with a return on investment seen in world-stage medal achievement (Sport Ireland, 2020). These TD pathways are national level sports programmes that incorporate TD systems or processes aimed at holistically supporting athletes in their physical and sporting development towards elite senior national representation. The TD systems are developmentally specific to the training age and stage of the athlete as they progress along the TD pathway. NGBs are encouraged to create TD pathways with TD systems that produce a conveyor belt of success for their respective sport, showcasing their countries' talent and success on the global stage (Sport England, 2018).

1.1 Talent development in sport

The development of TD pathways in any sport is going to be influenced by the nuances of that sport, the system that underpins the pathway as well as the culture and context of the sport. This understanding of TD as something that encompasses all aspects of the coaching environment, and therefore the multiple contexts that an athlete is involved with (Martindale et al., 2005), is important as it recognises the importance of understanding the coherence of the development experience across multiple contexts. In this regard, the importance of contextually influenced talent development environments (TDEs) that support the

identification, selection, and then subsequent development of talent by providing opportunities (i.e., TD pathways) for high potential young athletes to progress their talent is critical (Harwood & Johnston, 2016). Crucially, this will require attention focused on the coherence of the experience from the athlete's perspective as well as strategic integration of the multiple inputs at different developmental stages and in different contexts (Taylor & Collins, 2022).

The design of a TDE is ultimately contingent on resource allocation within the NGB as well as the outcome measures of the TD pathway. From a talent identification perspective, there is growing recognition that the vast majority of athletes who enter a TD pathway at a young age are unlikely to progress to elite senior levels of performance (Barreiros et al., 2014; Boccia et al., 2020; 2020a; Brustio, Boccia et al., 2021; Herrebrøden & Bjørndal, 2022). This is reflective of the limited 'spots' and opportunities available at the highest level of sport and the pyramid design that is typical of TD pathways (Green, 2005). In fact, judging the quality of the TD pathway, or indeed the nature of the athlete's experience on the pathway, based on this outcome measure alone is too simplistic a measure. Reflecting this, as well as current agendas driving both elite and development sport (De Bosscher & van Bottenburg, 2011; Hanstad & Skille, 2010), the success of the TD pathway is increasingly viewed in terms of not only elite performance but also more participatory motives (Collins et al., 2012). This point will be returned to later in the thesis but suggest that, at least from a talent system design perspective, understanding and then operationalising the outcome of the system will have implications at all levels of the pathway. For example, Tucker and Collins (2012) note that many decisions in TD are driven by resource allocation constraints. As such, it is important to understand the implications of how to allocate (already scarce) resources on the TD pathway;

as one example, the relative merits of supporting a deep pool of players or selecting and then resourcing a smaller group of players at different stages of development.

The process of TD can therefore be understood as involving resources and systematic decisions to assist promising athletes to realise their potential (Harwood & Johnston, 2016). NGBs are responsible for the development of their sport from grassroots through to high performance levels, and therefore have responsibility for both performance and participation goals (Collins, MacNamara & Cruickshank, 2019), with both goals a feature of multiple and co-existing contexts (e.g., school, club, regional/provincial, national). TD is complex, multidimensional, and non-linear in nature. Although the TD pathway is typically presented as linear progression (e.g., Sport England, 2018, pp. 7), the reality is that successful progression often involves multiple entries, exit and re-entry of athletes as they navigate their pathway (Abbott et al., 2005; Sweeney et al., 2021). The progression of youth athletes along the TD pathway results from a combination of factors including environmental and intrapersonal catalysts and the coordinated efforts of various stakeholders supporting athletes during their journey to high performance; ultimately the foundations of the TDE (Gagné, 2000; 2004). Critically, although the NGB can be viewed as the system coordinator, in reality, power is dissolved with different stages of the pathway working autonomously and independently from the NGB.

1.2 Establishing Context

1.2.1 TD research growth

The last 20 years has seen significant attention in the literature on the TDE (see Chapter 3) and different TDE models exist in the literature (Martindale et al., 2007; Martindale et al., 2005; Henriksen et al., 2010; 2010a; 2011). Martindale et al. (2007; 2005)'s work marks a move away from prescriptive models of TD by providing insights into the key features of

effective TDEs suggesting they are characterised by: long term aims and methods; include wide ranging coherent messages and support; emphasise development before success; are individualised as well as holistically and systematically integrated across the athlete's environment (see Figure 1.1). Martindale et al's work (2007; 2005) could be applied to many different settings. The model suggests that if the key features outlined above are present in the TDE, when considered and applied within the nuances of the specific context, this will lead to an effective TDE.

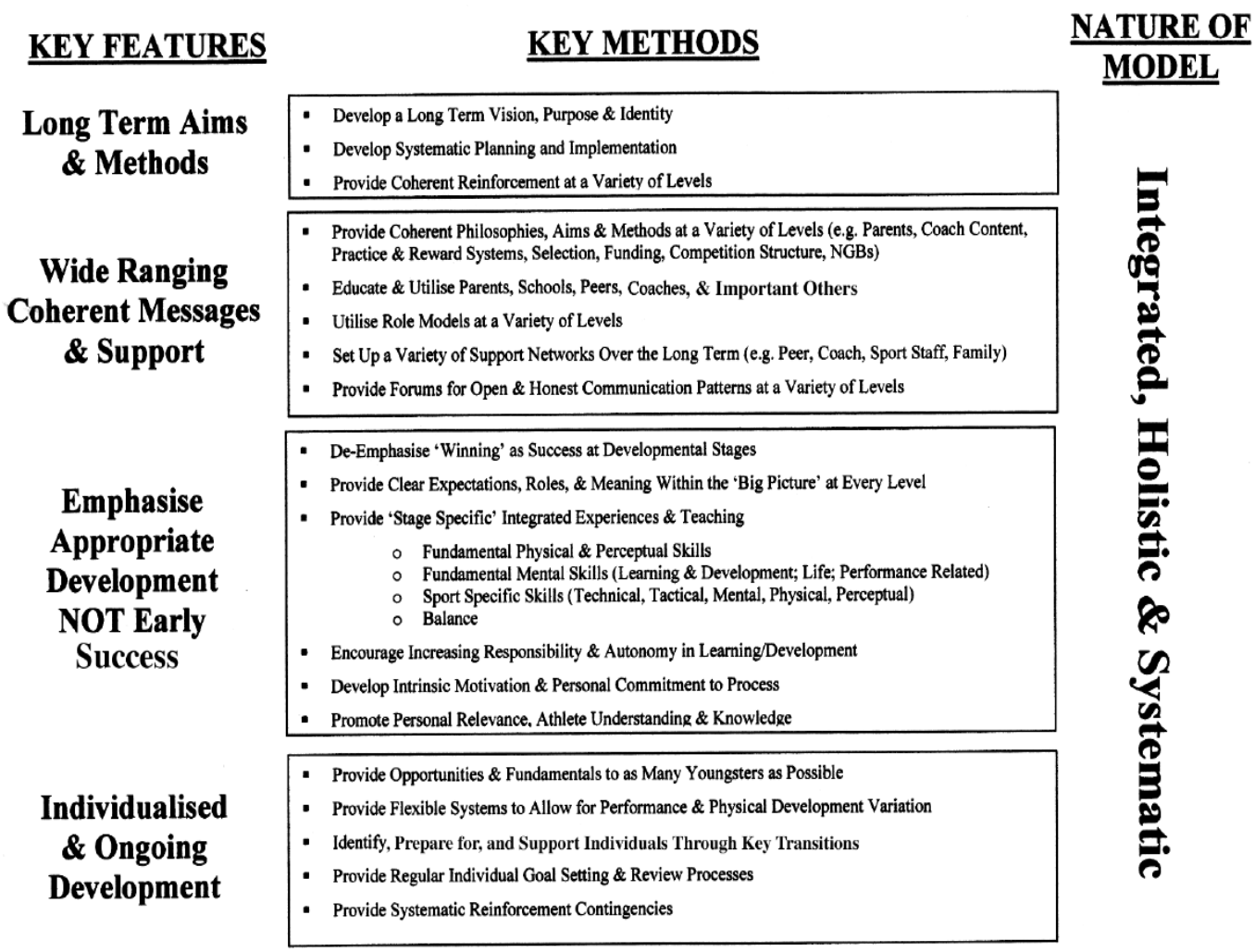

Figure 1.1

The model of effective talent identification and development procedures (see Martindale et al., 2005, p. 368).

Similarly, Henriksen and colleagues (2010; 2010a; 2011) provide examples of successful TDEs. Using a holistic ecological approach, they investigated successful sports clubs and environments that were characterised by a long term focus with cohesion, collaboration and a strong sense of belonging at the core of the TDE (Henriksen et al., 2010; 2010a; 2011). Links to the wider socio-cultural context and multiple worlds athletes inhabit are also evident in their work using two models, the athletic talent development environment (ATDE) working model (see Figure 1.2) and the environment success factors (ESF) working model (see Figure 1.3). These models detail the interactions between athletes' preconditions, the TD process, and the organisation's culture (Henriksen, et al., 2010; 2010a; 2011). This literature is explored in more depth throughout Chapter 2 (Section 2.1.3 and 2.1.4) but, for now, the importance of transferability and application to practice should be emphasised.

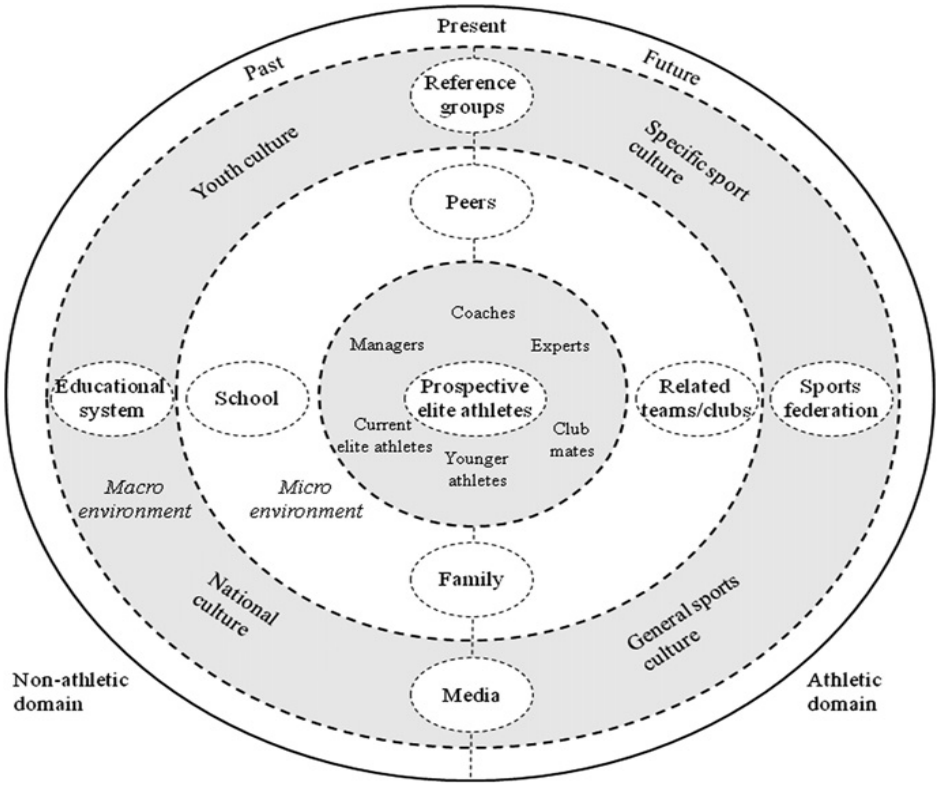

Figure 1.2

The athletic talent development environment (ATDE) working model (see Henriksen et al., 2010, p. 213).

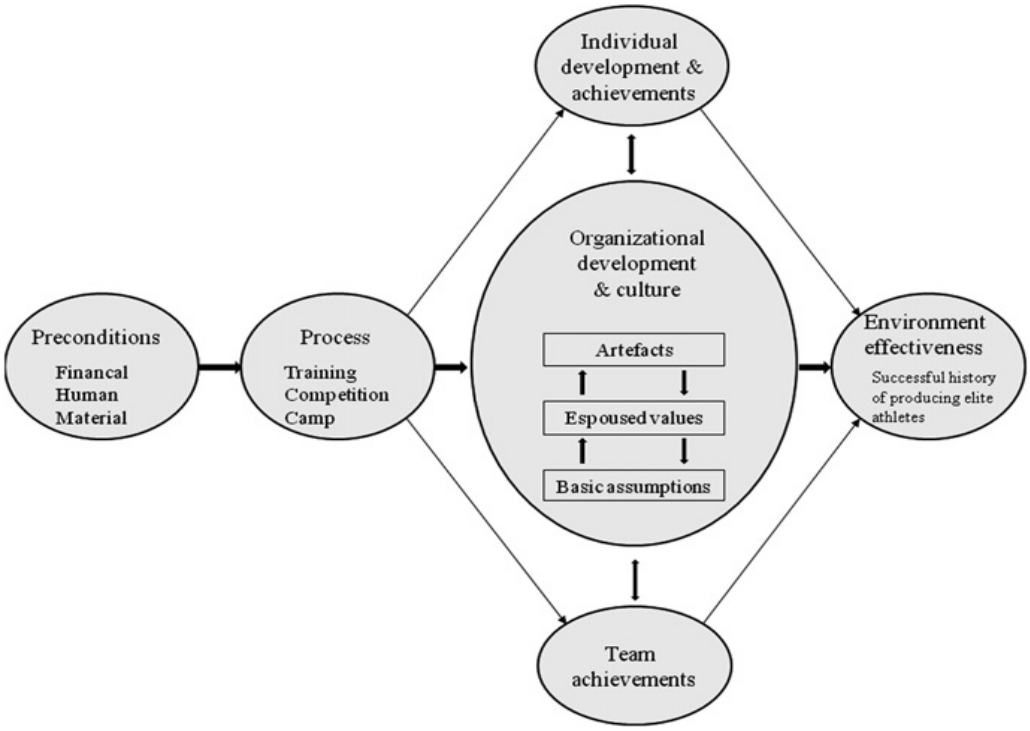

Figure 1.3

The environment success factors (ESF) working model (see Henriksen et al., 2010, p. 214).

It is currently accepted that TD is multidimensional (Baker et el., 2019; Collins & MacNamara, 2022) and that TDEs must be holistic and coherent in nature and pay attention to individual long-term development, encompassing psycho-behavioural and physical variables (Collins & MacNamara, 2022). However, early literature indicates that traditional approaches to selection and identification were based on a uni-dimensional and static concept of talent that most likely led to the premature de-selection of talented children (Abbott & Collins, 2002). Initial identification and then selection, certainly at early stages of the TD pathway, have been dominated by physical (e.g., a variable influenced by maturation, (Howard et al., 2016)) and performance (a variable that has been suggested to be influenced by a range of psycho-social measures, (Holt & Dunn, 2004) measurements. This approach tends to select young athletes who are performing well at the time of selection on variables that are perceived to be requisites for success within a given sport.

The importance of differentiating between performance and development factors is well understood (Abbott et al., 2005; Abbott & Collins, 2002), especially against the literature and evidence highlighting the small relationship between junior and senior success (e.g., Boccia et al., 2020; 2020a). As one example, Holt and Dunn (2004) suggest that technical ability does not seem to predict selection to professional adult soccer but instead the possession of certain psychological competencies is more likely to lead to professional adult soccer selection. Reflecting this, the importance of biopsychosocial competencies within TD pathways that best support athletes in reaching their potential (Collins & MacNamara, 2017; Holt & Dunn, 2004; Martindale et al., 2005) have begun to receive considerable attention, especially against the dual outcomes of the pathway (i.e., participation and performance). Despite this, considerable research still tends to look at the process through a uni-disciplinary lens, identifying single variables related to TD (e.g., physical), without considering the effects

that may have on, or be affected by, other important influences on the TD process. Given that TD is multidimensional and should incorporate holistic and coherent efforts, from a pathway and TD system perspective there is a need to consider multiple variables and make references to and links between these, i.e., environmental and intrapersonal (Gagné 2000; 2004). The multidimensional and holistic nature of TD is explored more throughout Chapter 2 and is of particular importance and relevance throughout this PhD thesis.

1.2.2 Female sport – a new level of interest

The visibility of female athletes in sport is continuously growing. In Ireland, the '20x20 campaign' began a conversation regarding the visibility of female sports stars in the media and on our television screens, with the slogan "*if she can't see it, she can't be it*" becoming a common phrase used throughout (Irish Sport, 2020). The campaign was successful in achieving the goal to increase media coverage, attendance at key events and participation in women's sport each by 20% by the end of 2020 (Irish Sport, 2020). Prior to achieving this references were made to the ignorance in public of the successes of female sports teams and individual athletes alike. There was wide recognition and celebration for the Dublin senior men's Gaelic Football team when they won their sixth All-Ireland title in a row in 2020, a feat already achieved by the Cork senior Ladies' Gaelic Football team yet not celebrated to the same scale. Similarly, Henry Shefflin (male Hurling star) is often referenced as the greatest of all time having won 10 All-Ireland medals, yet much rarer reference is made to Rena Buckley (Ladies' Gaelic Football and Camogie star) though she won 8 more All-Ireland medals during her career (Duffy, 2021).

More positively, recent months have seen growth and professionalism in female sports across the world. In line with the growing number of teams playing in the Women's Australian Football League (AFLW) competition, attendance at games has increased year on

year and in the last year alone television viewing has increased by up to 30% (Women's AFL, 2022). The AFLW athletes have moved from semi-professional contracts to professional contracts with a pay increase of up to 94% (RTE, 2022b). The professionalism appears to have become a draw as more and more Ladies Gaelic Football players are making the move from Ireland to Australia to seek a career as a professional athlete in the AFLW which cannot be achieved to the same standard of living in Ireland. Closer to home, in 2022 Irish Rugby introduced professional contracts for its women's fifteens programme for the first time (Irish Rugby, 2022). Though these contracts are of much lower value than the men's rugby contracts or the AFLW, they are a step in the right direction.

The increased interest in female sport globally has resulted in increased impact and inspiration for females, particularly young aspiring female athletes. Recently the English women's soccer team, the Lionesses, achieved great success by winning the 2022 Euros. Throughout the tournament the nation was invested and inspired by their journey through the competition. The increased interest was evident in the record-breaking game attendance, television viewing and subsequent increased female participation in the sport (BBC, 2022). Additionally, there were constant interviews with the public describing the inspiring influence the Lionesses had on young female soccer players and non-players alike (BBC, 2022). Similarly, the Ireland Women's Hockey team's silver medal success at the 2018 International Hockey Federation (FIH) World Cup and subsequent qualification for the Tokyo Olympics on home soil influenced a growth in female hockey participation in Ireland (Hockey Ireland, 2021). The increased participation and interest in female team sports see a parallel interest from NGBs to focus attention on creating TD pathways specific to female team sports (soccer: The FA, 2017; FAI, 2021; field hockey: Field Hockey Canada, 2022). Critically, the question now is whether the available literature is keeping up with this increased attention and interest in

female sport? Are these TD pathways evidence informed and reflective of female athlete experiences?

1.2.3 Female Underrepresentation

The research available pertaining to effective TDEs outlines factors associated with successfully assisting young high potential athletes to move through the TD pathway. Particularly, TD research alludes to the challenges associated with concurrent transitions in sport and life and how best to equip young athletes with the skills to negotiate the route to the top (Collins & MacNamara, 2012; Martindale et al., 2007). However, this research has primarily focused on male sporting environments with female athletes significantly under-represented in the literature (Gledhill & Harwood, 2015). This is despite the fact there is continued growth worldwide in female sport, with sports participation amongst girls and women at an all-time high (Fink, 2015). From a physiological perspective, research suggests there are differences in the aerobic and anaerobic development of males and females (Batterham & Birch, 1996; Cramer et al., 2002; Weber et al., 2006) and common speed thresholds used to analyse physical locomotor activity in male athletes underestimate the high speed running distances of their female counterparts (Bradley et al., 2014). Likewise, the literature reports coping mechanisms within sport differ between genders (Crocker & Graham, 1995; Phillipe & Seiler, 2005) and females tend to perceive their environment as a more task oriented climate (Murcia et al., 2008) supporting the assertion that there is a need for caution when referring to the literature to make inferences about female athletes from male dominated research. Simply, the established research pertaining to male athletes cannot be *assumed* to relate to female athletes (Gledhill & Harwood, 2015). There is a need for research specific to females in sport and in particular TD to be more visible to allow for evidence informed decisions to be made in female sport environments.

1.2.4 My Context and Biographical Positioning

During the early part of this PhD I was a practitioner at the latter end of the TD pathway part of a complex female team sport TDE. My role related to the athletic development of the under 21 year old (U21) female athletes, leading the physical development of these players to withstand the training and competition demands of the final transition to the elite senior level. As players transitioned to the senior level, for either short duration 'trial' periods, or for longer term selection purposes my role was integral in communicating and collaborating with the senior team's athletic performance coach. This regarded the management and progression of the transitioning athlete's training volume and load in efforts to avoid over training, to support the transition to the increased training intensity and assist with balancing and managing training and academic demands through the week. My role also involved the physical preparation of the U21 national team athletes for their European tournaments, ensuring the development of strength, power, speed, agility, endurance etc., to cope with international competition demands and to peak on time for crucial tournaments during the season.

Parallel to the physical preparation of these players, it was crucial we paid heed to the emotional and psychological load encountered throughout the year where these young high potential athletes were balancing academic, social and sporting lives. Many were involved in multiple teams, some progressing to the higher playing levels, i.e., senior national representation and most players respected as high achievers in more than one life domain. The ability to cope with the rollercoaster of highs and lows experienced in a high performance environment, to deal with setbacks, failures and underperformance as well as contending with potential opportunities to move towards senior national representation was important to consider and nurture in this group of players in tandem with their physical preparation. Of

particular importance to this thesis and my time working with this cohort of players, the dearth of female specific literature within TD research created difficulty in making evidence informed decisions to appropriately support young high potential female athletes in their pursuit of development towards the elite senior level.

I was interested in exploring a complex female team sport TDE, to create a better understanding and awareness of the TD systems and processes and where they sit against research best practice suggestions. Consequently, the Irish Hockey female TD pathway and TDE was a particularly relevant setting to explore the complexity of the TD process in a female team sport and provided the stage setting for the studies in this thesis. My research was therefore underpinned by a pragmatic philosophy, and I was motivated to contribute to the literature so NGBs and pathway practitioners can lean on research to inform practice and decision making in TDEs

1.2.5 Complex female team sport TDE

The TDE within which I was an applied practitioner, Hockey Ireland, provides a multi-context TDE, outlined in Figure 1.4. Hockey Ireland comprises of four affiliate branches that govern the domestic competition regionally where the organisation has experienced unprecedented growth at grassroots, with new clubs forming and over 32,000 members across the island of Ireland. This has resulted from the important qualification, success and media coverage of the senior men's and women's teams at Olympic Games and World Cups over the last four years. Hockey Ireland is comprised of 154 clubs and 280 schools participating nationwide which supports preparation and competition for national junior age grade (NJAG) representation (Hockey Ireland, 2021). Though there has been growth in female hockey participation across Ireland, the talent pool available in Hockey Ireland pales in comparison to other female team sport organisations in Ireland. For example, Ladies Gaelic

Football in 2018 reported 188,000 members (LGFA, 2018) and Camogie in 2022 had 100,000 people playing the game (The Camogie Association, 2022). The lower participation rates and shallow talent pool for Hockey Ireland requires an effective TDE be in place to support the young athletes that aspire to reach the elite senior level by developing them concurrently through school, club and provincial (regional) teams as well as providing opportunities for junior age grade national team representation. Due to the multiple simultaneous contexts and low participation rates, this is a complex TDE and TD pathway, with multiple coaches, teams, stakeholders etc. and with possible opportunities for exit and re-entry points as young high potential athletes navigate the challenges on the route to the top.

The literature in TD has primarily been conducted in individual clubs or professional pathways; however, a national pathway may have different (both qualitative and quantitative) constraints, stressors and opportunities. As such, the aforementioned research cannot be simply transferred to a national amateur sport organisation comprising contrasting contexts. There is a need for female specific research within an amateur national organisations TDE therefore to provide evidence informed knowledge that supports the NGB in making decisions and providing appropriate experiences for the development of high potential young athletes towards senior national team representation. Furthermore, interest in female hockey in Ireland is greater than ever due to the aforementioned successes of the senior international women's hockey team. To continue this success on the world stage it is important that Hockey Ireland as the NGB optimally prepares young female hockey players in an evidence informed holistic and systematic manner towards senior representation.

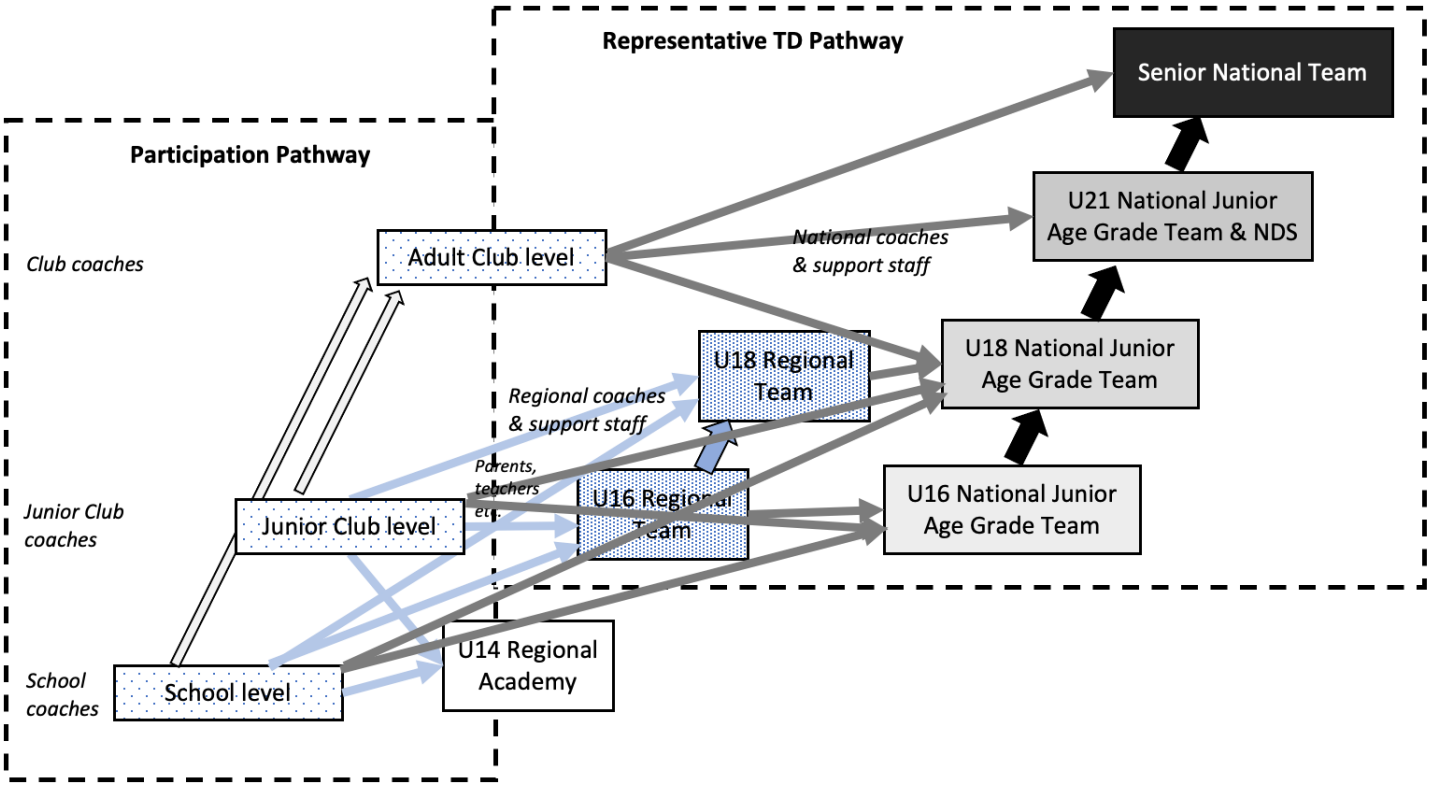

Figure 1.4

The national representative TD pathway – a complex talent development environment

1.3 Philosophical Underpinnings

As a scientific practitioner aiming to generate practical meaningful knowledge from research, this PhD is underpinned by a pragmatic research philosophy (Giacobbi et al., 2005). Using the theory of pragmatism, this PhD was driven by an approach to use research to answer practical questions which can be applied to the improvement of a TD context (Feilzer, 2010). Instead of using other paradigms where matters of ontology and epistemology are likely to dictate the research process, pragmatism is driven by practical questions and methods by which they can be aptly measured (Sparkes, 2015). While positivists and constructivists have dichotomous epistemological views, pragmatism argues that a continuum exists between objective and subjective viewpoints and this viewpoint depends on the research question (Giacobbi et al., 2005). Throughout this PhD I continually worked

towards practicality in the research, while anchored in the process of inquiry to place emphasis on actionable knowledge, recognising the interconnectedness between experience, knowing, and acting (Kelly & Cordeiro, 2020). As such, this PhD attempts to generate useful knowledge to inform practice in female TD pathways through a multiple methods approach. This approach aims to include both quantitative and qualitative methods, with each chapter/study reflecting the method(s) deemed most appropriate to each specific chapter/study context and research inquiry.

Throughout the research I considered myself a co-constructor of knowledge and ultimately aimed to identify tangible artefacts rather than generalised truths or purely subjective constructions (Giacobbi et al., 2005). To this extent, this PhD is supported and guided by my experiences within the sport in question and therefore the knowledge of the participants' sporting environment, pathway and an awareness of the issues being researched. Therefore, considering the research gap and the current rise of interest in female sport, the purpose of this research was to understand current practices in a complex female team sport TDE, gaining valuable insight into both positive and negative characteristics that may be present. The research knowledge outputs should assist NGBs consisting of female team sport and pathway practitioners in understanding their TDE with the goal to improve their TD processes towards a more evidence informed holistic, coherent and systematic manner. My PhD work was engaged in a mutually beneficial process of the application of this knowledge to the TDE and TD programme.

1.4 Aims and Objectives of the Thesis

This thesis aimed to gain practical and meaningful knowledge of the TDE and TD processes in a complex female team sport TD pathway. Additionally, the thesis aimed to examine the availability of current TD research relating to female athletes and thereafter add

relevant and practical research in female TD to the literature. The thesis aims and objectives can be summarised as the following:

1) **Aim:** To examine gaps within TD research, specifically the lack of research relating to female athletes

   Objectives:

   a) Identify the key research areas within TD literature between 1999 and 2019
   b) Understand the number of studies that relate to female only populations
   c) Analyse the number of female only studies in comparison to male only studies

2) **Aim:** To explore the complex Talent Development Environment (TDE) of a national female team sport and the coherence, or lack of across the school, club, provincial and national contexts from an athlete and coaching perspective

   Objectives:

   a) Analyse quantitative data through the 5 factor Talent Development Environment Questionnaire (TDEQ-5) of young female team sport athletes part of the same TD pathway
   b) Analyse qualitative data through semi-structured focus groups of young female team sport athletes and additionally coaches and pathway staff members part of the same TD pathway and TDE, based on the themes presented in the TDEQ-5
   c) Identify and understand areas of the TDE requiring attention that could be improved upon

3) **Aim:** To investigate the Psychological Characteristics for Developing Excellence (PCDEs) in a national female team sport TDE across playing groups (U16, U18, U21 senior level), and compare the results between groups and to the 'ideal score'

   Objectives:

   a) Analyse quantitative data through the Psychological Characteristics for Developing Excellence Questionnaire Version 2 (PCDEQ2) of female team sport athletes, representing elite senior international and also national junior age grade (NJAG) level

   b) Understand any differences or gaps between the NJAG athletes and the senior elite athletes

4) **Aim:** To estimate between- and within-athlete variability data to form threshold values for the interpretation of changes in physical game locomotor activity over time in a female team sport using a junior national age grade team to represent the national context, and the same players representing data in a club level context

   Objectives:

   a) Analyse the game-to-game variability data using Global Positioning System (GPS) locomotor activity metrics from junior international hockey games to better inform decision making around physical preparedness to transition to the elite senior international level (vertically on the TD pathway)

   b) Estimate the degree of quarter-to-quarter variability for an athlete, on average within the three primary positional units (defender, midfielder

and forward), to inform practitioners of the inherent fluctuations in locomotor activity throughout a game in a development cohort

c) Understand comparisons between the variability data from international and club level games to better inform the physical preparedness of players to transition towards the increased physical game locomotor demands of international competition (horizontally across the pathway).

1.5 Programme of work

Chapter 2 maps the background and literature surrounding the TD process and TDEs. The chapter also provides an overview of TD pathways, exploring the vertical and horizontal system of development, highlighting the need for coherence across TDEs and recognising the challenging final step in the transition to elite senior team representation.

Though Chapter 2 explores a breadth of literature relating to TD and TDEs it became clear that much of the available literature relates to male populations. As such, Chapter 3 set out to illustrate the underrepresentation of females in TD research. This involved desktop research into the landscape of available literature and resulted in a published study highlighting the need for an increase in female specific research in the TD field. Reflecting the under-representation of females in the TD literature and the pragmatic research philosophy of this thesis, the remaining chapters included aims to provide female specific practically meaningful study inquiries, providing evidence informed knowledge to support improvements or changes in practice in female team sport TDEs.

Building on the broad knowledge base explored through Chapter 2 and the need for female specific research highlighted in Chapter 3, Chapters 4 and 5 explored the TDE of a national female team sport organisation, to understand the female TD pathway and other working contexts. This study employed both quantitative and qualitative research methods

and was split into two parts resulting in a two-part published study to gain a rich understanding of the TDE and allow practical knowledge to be applied. Chapter 4 employed a quantitative questionnaire, the 5 factor Talent Development Environment Questionnaire (TDEQ-5), to explore the effectiveness of the TDE. The results of the questionnaire allowed insight into the positive features of the TDE and shed some light on the possible gaps and derailers within and across the TDE. This investigation however required more information and therefore provided a platform for further qualitative inquiry in Chapter 5. The pragmatic approach undertaken throughout this PhD is particularly evident in Chapter 5, where semi structured focus groups and thematic analysis is used to create deeper insights into the systematic workings of the TDE from both the player's and coach's viewpoint. The results from this qualitative inquiry, added to the results from Chapter 4, allowed me to view the TDE from a wider lens, reaching consensus on the positive features and indeed the areas needing improvement, particularly a shortcoming in systematic coherence and attention to psychological skills within and across the TD pathway.

Following the studies in Chapters 4 and 5, with evidence pointing to a lack of psychological skill development included throughout the TD pathway, Chapter 6 set out to gain insight into what level of psychological skill development potentially exists at each point along the TD pathway, i.e., in each junior age grade team. Additionally, this chapter investigated the psychological skills and characteristics currently evident in the senior national team, outlining the skills and characteristics beneficial for athletes that have navigated the TD pathway. This chapter used a quantitative questionnaire. The version two of the psychological characteristics of developing excellence questionnaire (PCDEQ2) was used to assess the presence of psychological characteristics of developing excellence (PCDEs) at the elite senior national level and along the pathway age grades. The results of the

questionnaire create an overview of the possible PCDEs beneficial to the athletes that progressed to the senior national level in this TDE and the current PCDEs represented at each junior age grade, highlighting the PCDEs not yet embedded in the pathway programme, naturally or otherwise.

Appreciating the need to include physical development in addition to the psycho-behavioural needs of athletes at the different stages of the pathway (Collins & MacNamara, 2022), Chapters 7 and 8 estimated the physical game locomotor activity demands of the junior female hockey players in the TDE and the potential variability between and within games. Since this is a complex TDE, and findings from Chapters 4 and 5 indicate a need for better coherence both vertically and horizontally in the TDE, Chapters 7 and 8 investigated the variability between and within games at international and domestic club level respectively. This resulted in a published study, setting out a framework to interpret the game locomotor data providing a better understanding of a young high potential athlete's ability to handle an increase in physical locomotor demands, and providing an original contribution to the literature. Accordingly, practitioners can interpret the data to practically inform decisions regarding the athlete's physical readiness to transition to higher playing levels. Quantitative data analysis was applied in these studies with the method of data collection and analysis outlined in the chapters.

This thesis and its encompassing chapters are intended to provide new insights and practical applications in female TDEs by contributing to an understanding of complex team sport TDEs, interpretation of physical readiness to transition through the TD pathway, and the PCDEs required in this context to assist progress to the senior national level. However, the findings of this thesis relate to this specific context and cannot necessarily be superimposed to another amateur sport or female team sport context because it always

depends on the specific nuances of the particular context, which drives the inquiry and ultimately the findings. It is hoped that readers, coaches and pathway practitioners can certainly take some learnings from the findings in this thesis to support evidence informed practice in their contexts.

As the body of research in this thesis is underpinned by providing solutions to practical problems and informing applied practice, Chapter 9 is a general discussion which reviews the findings of the thesis. This final chapter discusses the possible applied suggestions for the TDE derived from the evidence informed knowledge developed throughout this research as well as possible key findings and recommendations that can be considered for other similar contexts. Additionally, Chapter 9 considers future research directions, alongside the associated strengths and limitations of this thesis.

1.6 Delimitations

Notably, Chapters 4 to 8 incorporate research studies focused solely on one specific TDE and the athletes involved in the national TD pathway. While conducting this research, my role as described earlier in this chapter (Section 1.2.4), allowed me to be embedded in the considered TDE, providing a great opportunity to gather information, data and insights into the TD pathway and the social and cultural context in which it exists. This provided an opportunity to triangulate information by being embedded in the athletes' support system and TDE. The TDE researched reflects an amateur sporting organisation in an Irish sport context and is a specific example of a sport system within this wider context, yet is not representative of Irish sport culture as a whole. Though the pragmatic research approach to each study in this PhD aims to generate practical and meaningful evidence informed knowledge that can be applied to female team sport TD settings it must be noted that the findings of each study are limited to the sport organisation which the research has been

conducted and caution must be taken when inferring the practical applications of this research to other contexts. Indeed, NGBs, sport organisations, coaches etc. can benefit from the research findings of each study by understanding the pragmatic approach to the research undertaken and carefully considering how it might apply to similar settings, contexts, and populations or how the framework and approach taken might transfer to a similar level of inquiry in another sport setting.

Chapter 2: Talent Development and Talent Development Environments

2.1 The importance of the talent development environment (TDE)

2.1.1 What is talent development (TD)?

To appreciate the important role the environment plays in TD we need to acknowledge that the process of developing talent in sport is complex where many variables interplay when supporting athletes to reach the goal of elite level representation. Elite team sport demands athletes to perform skills under pressure, in chaotic situations often at speed and with heightened physicality while trying to overcome disruption from the opposition vying for the same outcome (Baker, Wattie & Schorer, 2019). The nature versus nurture argument is a constant in TD research; however, recent literature conceptualised talent as representing innate qualities and is emergenic, multidimensional, dynamic and symbiotic (Baker et al., 2019; Simonton, 2001). This concept maintains talent is not static, rather innate qualities in humans have massive variation that interplay with the surrounding environment to influence the full expression of these qualities (Baker et al., 2019; Gagné, 1993).

Three decades ago, Gagné's Differentiated Model of Giftedness and Talent (DMGT; 1993), outlined in Figure 2.1 (see Gagné, 2000) suggests talent is developed from natural abilities. In this model Gagné suggests that giftedness refers to potential, untrained natural abilities and talent refers to higher performance or superior mastery attained as a result of a systematic programme of training and practice. While still a current concept in TD the DMGT suggests that natural abilities (gifts or aptitudes) may appear early in life, yet adult accomplishments result from the systematic training and practice of these natural abilities in specific and restricted contexts. Importantly intrapersonal and environmental catalysts interplay in this process, reflecting the multidimensional, dynamic, and emergenic nature of

TD (Baker et el., 2019; Collins & MacNamara, 2022; Gagné, 1995; 1993). It is important talent identification and development programmes acknowledge the interaction of natural abilities with the intrapersonal and environmental catalysts.

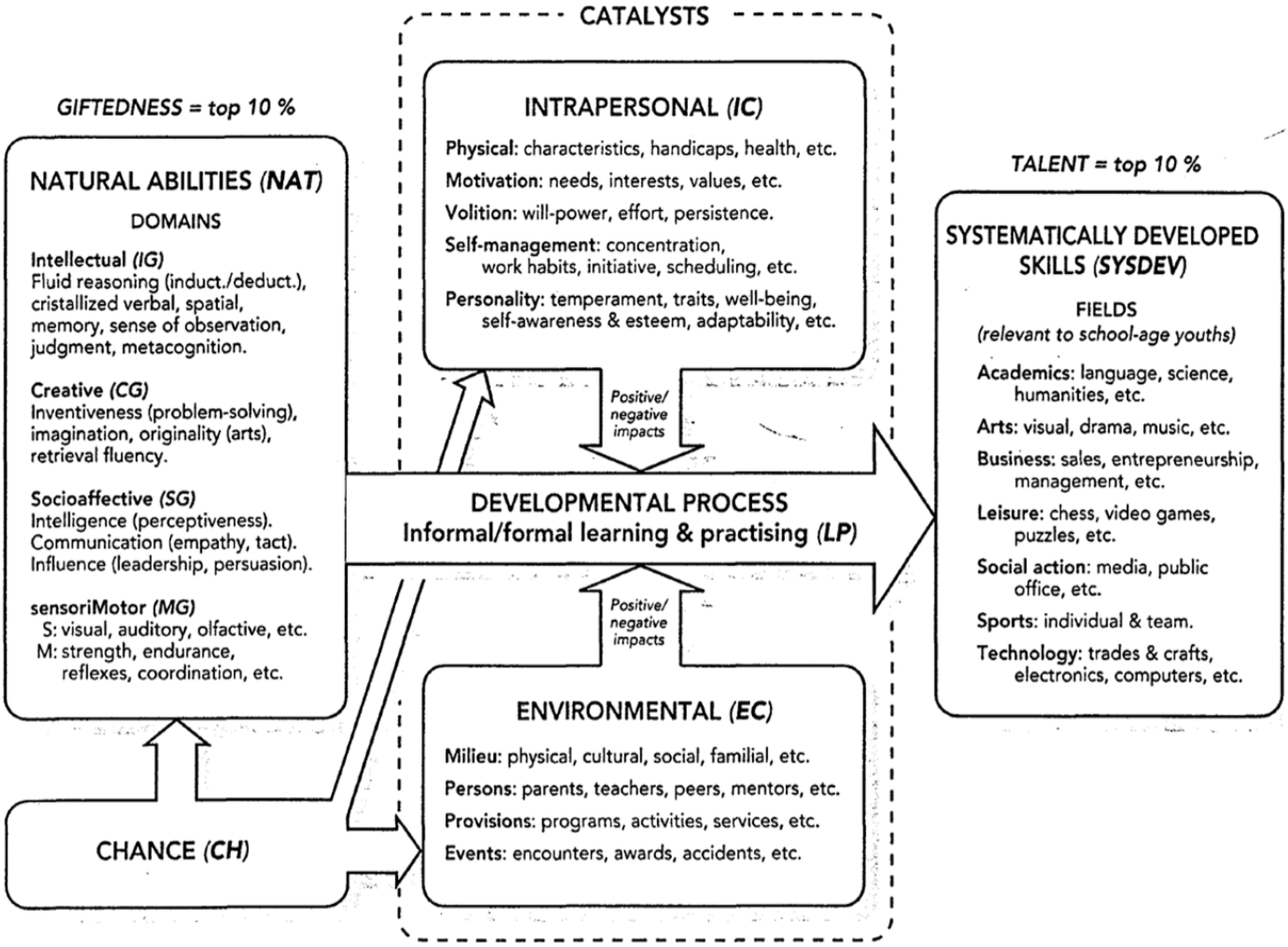

Figure 2.1

Gagnés Differentiated Model of Giftedness and Talent, (DMGT) (see Gagné, 2000).

As discussed in Chapter 1, talent selection and identification is a key feature of almost all TD pathways. Interestingly, the lack of correlation between talent identification and ultimate senior level representation and subsequent performance (Barreiros et al., 2014; Boccia et al., 2020; 2020a; Brustio, Boccia et al., 2021; Herrebrøden & Bjørndal, 2022) suggests the initial selection is more performance (at the time of selection) than the

identification of the factors associated with the development of ultimate elite performance (Barreiros et al., 2014). While the highest potential young athletes may ultimately progress to elite status the DMGT pertains that it is possible for well above average natural abilities to remain simply as gifts and not be further developed due to the absence of the important intrapersonal and environmental catalysts (Gagné, 1995; 1993). The intrapersonal catalysts include both physical and psycho-behavioural characteristics though it is argued there has traditionally been a lack of emphasis on the latter as a key component of the TD pathway (Abbott & Collins, 2004). Preparing high potential young athletes to cope with the increases in physical intensity as they progress through the pathway is essential (Lundqvist et al., 2022).

The progression in physical performance can be tracked using Global Positioning System (GPS) data measures which are commonplace in high performance sport (Buchheitt et al., 2014). Studies reflecting mean game locomotor GPS measures provide a basis for practitioners to apply a research informed approach to decision making regarding athletes' physical preparation and performance, which is discussed further in Section 2.3. Reflecting the need to provide an evidence informed approach to TD practice as outlined in Chapter 1, Chapters 7 and 8 discuss a framework to analyse game locomotor GPS metrics to better understand a physical readiness to progress to higher playing levels. While it is crucial to understand how best to develop young athletes physically to cope with the demands of their sport, TDEs must also consider psycho-behavioural skill development. Though generally lacking emphasis in TD pathways (Abbott & Collins, 2004), incorporating psycho-behavioural skill development in pathway programmes is important to enable athletes to maximise their performance potential (Abbott et al., 2005; Andronikos et al., 2021; MacNamara et al., 2010a). Psychological skills and behaviours have been linked to an individual’s capacity for development (Abbot & Collins, 2002), noting physical performance alone does not determine

future potential. Psychological skills and behaviours such as motivation, self-regulation, goal-setting, and commitment can influence a young high potential athlete's ability to interact positively with their environment and possible development opportunities afforded to them (Abbott et al., 2005; Abbott & Collins 2002, 2004; Baker et al., 2019). The influence of psychological skills and behaviours in supporting athletes to navigate the *rocky* route to the elite level is explored in greater detail later (Section 2.4).

Social and cultural factors can also support and stimulate or slow down and block the TD process (Bailey, 2007; Gagné, 2000). Thus, features of the athlete's environment can influence athlete development in many ways, such as geographical location (Woolcock & Burke, 2013) which may impact opportunities afforded to individuals, and more microscopically via parenting style (Holt & Black, 2007) and socioeconomic status (Kay, 2000). Additionally, significant persons (e.g., teachers, peers, parents, siblings) and significant events (e.g., an injury, winning an award, non-selection) can have a lasting impact on the TD process (Bailey, 2007; Gagné, 2004).

Finally, among the aforementioned influences on TD is chance (Bailey, 2007; Gagné & Schader, 2006). Chance sits within the already identified influences on TD i.e., the chance of being born into a certain family, the chance of the school having accommodating TD programmes towards the individual's abilities, the chance of an injury or illness (Gagné, 2004; Gagné & Schader, 2006). A more recent portrayal of the TD process (Figure 2.2) builds on Gagnés DMGT to highlight the process of TD; how a talent pathway can develop an individual's natural abilities (inputs to TD) in the presence and interplay of intrapersonal and environmental catalysts resulting in systematically developed skills (outputs of TD) (Collins & MacNamara, 2022).

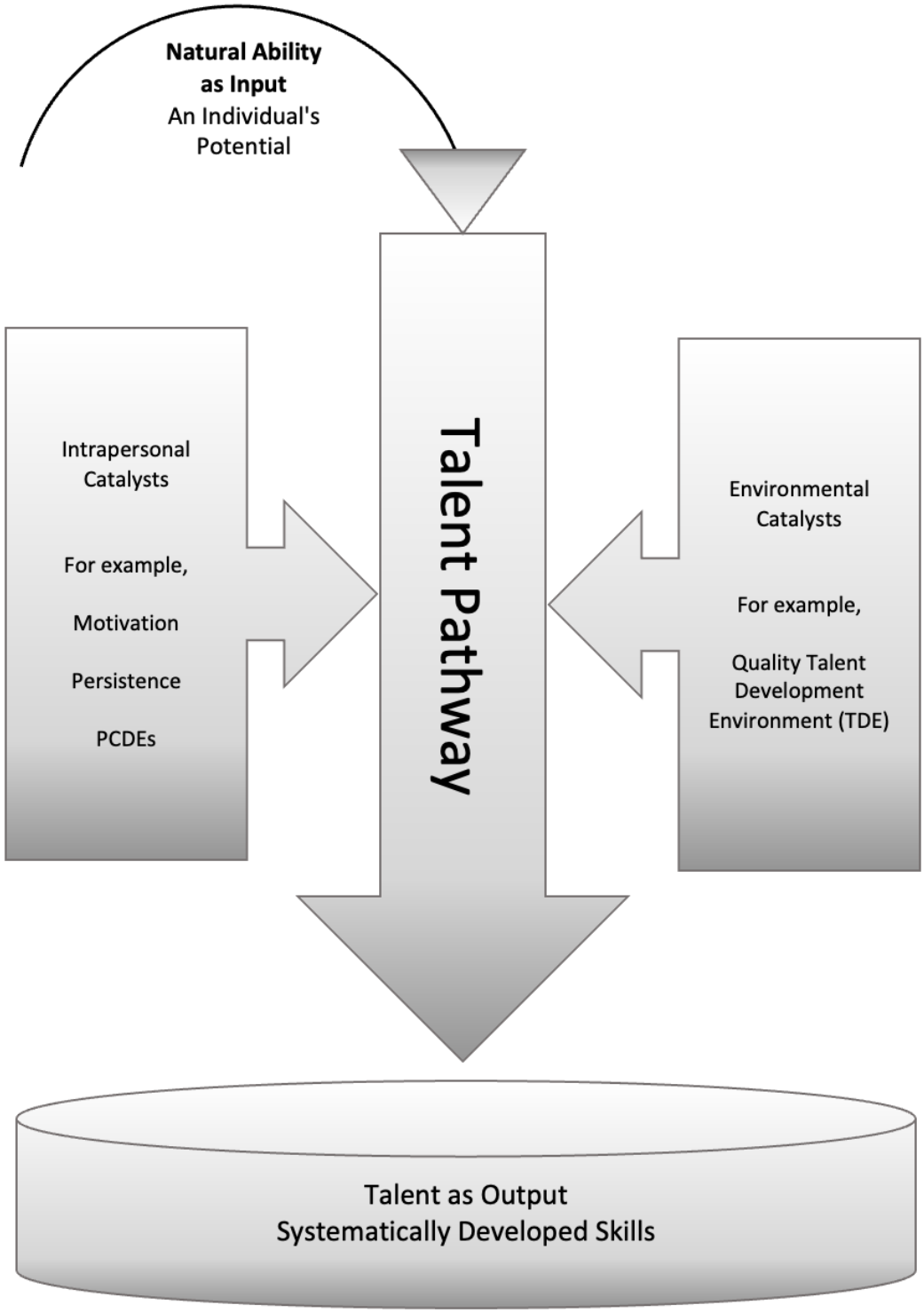

Figure 2.2

Inputs and outputs on the TD pathway (see Collins & MacNamara, 2022, p. 5).

2.1.2 The TDE

The success of senior elite sports teams globally relies on the quality of the athlete/s within its organisation (Flatgard et al., 2020; Martindale et al., 2007). Sporting organisations or NGBs seek to produce talented athletes through the development and implementation of effective TDEs that encompass TD pathways. This is especially important at a national level where there is not the opportunity to 'buy' players in to 'plug gaps' in the system. Therefore, given the economical and performance currency associated with developing young players, in order to develop enough players to be competitive at the senior level, TDEs must nurture young athletes and develop them through TD pathways towards a successful transition to the senior elite level (Martindale, et al., 2007; 2005).

As discussed in Chapter 1, talent identification and selection is a feature of all NGB TD pathways. As such, young athletes enter the NGBs TD pathway with above average skills compared to unselected peers and with *potential* for growth. In line with Figures 2.1 and 2.2 the TDE and thus the TD pathway should aim to systematically develop athletes to become proficient in their specific sport through appropriate training and learning experiences (Collins & MacNamara, 2022; Gagné, 2000). Within the broad TDE, this process involves a programme of support delivered by a range of stakeholders including a range of activities, events, and learning opportunities (Li, Wang & Pyun, 2014). NGBs generally set clear areas and key performance indicators for each pathway stage with many pathways having Individual Development Plans as part of their development processes. However, given the broad nature of the TDE these processes may be further complicated by a range of different performance outcome emphases and goals at different stages of the pathway. For example, an emphasis on winning as an outcome measure at the junior level has been shown to have a significant impact on process (Sweeney, Horan & MacNamara, 2021), and outcome measures on the

pathway (Hauser et al., 2022). Given the multiple factors that input TD, the nature of the TDE is key to ensuring the multidimensional and dynamic nature of TD is holistic, coordinated and stage appropriate if potential is to be maximised. Collins and colleagues (2019) have proposed the POP principle (Performance-Outcome-Process) as a practical means of outlining the desirable *performance* goals within and across TD pathway stages; the *outcome* variables selected to assist with achieving these; and the *processes* deemed appropriate for effective development at that particular TD pathway stage (Collins, MacNamara & Cruickshank, 2019).

Given team sport's high potential young athletes will invariably experience a range of different playing contexts, often simultaneously across the TDE, it is important to consider the nature of that experience. With this in mind, Webb and colleagues (2016) describe the need for an aligned and systematically planned TDE that allows athletes to experience a bandwidth of varying developmental experiences between and within developmental stages in the TD pathway. Here, the POP principle could effectively support NGBs to outline the pathway stage-based performance goals (Collins et al., 2019), forcing NGBs to critically assess what success may look like at each pathway stage while detailing the requirement for success now or later. The preferred outcomes are subsequently set to achieve the desired performance goals. This may include sport specific, physical, psycho-behavioural etc., and thereafter the process part of the POP principle becomes important to facilitate athletes making the most of development opportunities afforded to them across the entire TDE.

The literature outlines the key concepts and characteristics of successful or effective TDEs. Similar to Gagne's DMGT, research by Martindale and colleagues (2005) provides the five key features of an effective TDE, while Henriksen and colleagues (2010; 2010a; 2011) suggest a holistic ecological approach in understanding the intricacies of successful TDEs using specific examples of clubs or teams. Classification of the environmental factors that are crucial

for effective TD, notably those presented by Martindale et al. and Henriksen et al. have been outlined in a review study by Li, Wang & Pyun (2014). Additionally, Hauser et al. (2022) proposed functional and dysfunctional features of TDEs in a review of studies that reflect the models presented by Martindale et al. (2005) and Henriksen et al. (2010).

2.1.3 Key features of an effective TDE

Martindale and colleagues (2007; 2005) through their model of effective talent identification and development propose key features of effective TDEs. Effective TDEs are characterised by i) long term aims and methods, ii) wide ranging coherent messages and support, iii) emphasis on appropriate development not early success, iv) individualised and ongoing development that are v) holistically and systematically integrated across the athletes environment (see Figure 1.1, Martindale et al., 2005). The poor predictive ability of junior athlete performance in determining future success (Barreiros et al., 2014; Kearney & Hayes, 2018; Taylor & Collins, 2019) highlights that a long term approach to TD should be embedded in the TDE. The interplay of a systematic development approach and inclusion of the aforementioned key features of the TDE will assist athletes in successfully navigating through the pathway journey towards the senior elite level. Martindale and colleagues (2005; 2007) suggested the processes required for long term development should be systematic, organised and wide ranging with an individual focus that recognises the range of skills, behaviours and experiences that will support development within sport and beyond the sport specific domain (Hauser et al., 2022).

In line with the key features for effective TDEs outlined by Martindale et al. (2005), Ivarsson and colleagues (2015) indicated that players who perceive their TDE as being focused on long-term development, have individual coaching experiences as well as an established supporting environment, seem to be less stressed and experience higher well-being than

those players who do not. Given the current focus within TD and performance sport on well-being, mental health and culture (Hauser et al., 2022), this has important implications for the design of the TD pathway. Therefore, in addition to facilitating sport-specific development and performance progression among development athletes, high quality TDEs positively impact athletes' general well-being (Ivarsson, et al., 2015) as well as being facilitative of development and performance in other domains (Williams & MacNamara, 2020). The highest potential young athletes tend to accumulate a growing number of significant others as they progress in their sport (e.g. coaches, parents, peers, other athletes) and interact with these in multiple settings (school, club, home, etc.). As such, and perhaps even more importantly in a development rather than performance environment, a shared, integrated and coherent understanding amongst the various stakeholders involved in young athletes' development is a critical factor in enhancing the progression of talented young athletes to senior elite levels (Bjorndal & Ronglan, 2018; Martindale et al., 2007; 2005; Morley et al., 2022; Webb, et al., 2016). This encompasses coherence regarding sport specific development, physical development, lifestyle and commitment balance, the inclusion of psycho-behavioural skills as well as prioritising long term development over short term success (Bjorndal et al., 2017; Martindale et al., 2007; Taylor, Ashford & Collins., 2022; Webb, et al., 2016). The need for a coherent approach and what is involved is discussed in more detail later in this chapter (Sections 2.1.6 and 2.1.7).

2.1.4 The holistic ecological approach

Henriksen and colleagues provided insight into successful TDEs in varied sports settings such as kayaking in Norway, track and field in Sweden and sailing in Denmark (Henriksen et al., 2011; 2010; 2010a). This research introduced a holistic ecological approach to TD focused on the broader environment and encapsulated a young athlete's social

relations both inside and outside their sporting context. Whilst these social relations have a sports club or team as their core, they also include the larger context in which the club/team is ingrained, i.e., the sporting organisation, the wider socio-culture (Henriksen et al., 2011; 2010; 2010a). Similarities are evident in the culture of these three sport settings. Though the studies include single club environments with few resources, the cultures clearly reflect cohesion with the NGB and horizontally across schools and clubs that form the TDE, in addition to national senior team coaches and athletes (Henriksen et al., 2011; 2010; 2010a). This should be the aim of all complex NGB TD pathways and environments.

In these environments, top level elite athletes were also found to regularly interact and often train with the prospective talents suggesting that vertical alignment was a feature of the pathway. This in turn encouraged the young talented athletes to work and train closely with even younger athletes within the system further extending the vertical alignment of the TDE. Embedded within this culture is an openness to sharing between both athletes and coaches, exchanging information regarding cultural values, tricks of the trade and important high performance attitudes. Further, the young talented athletes are encouraged to be self-organised, developing early self-regulatory skills, a high work ethic and can see what it takes at the top, both physically and psycho-behaviourally. These are two important cogs for longevity in TD (Li, Wang & Pyun, 2014; Lundqvist et al., 2022; Williams & MacNamara, 2022) and I will return to these ideas later in the chapter (Sections 2.3 and 2.4, respectively).

Drawing upon the two TD working models mentioned in Chapter 1, the ATDE working model (see Figure 1.2) and the ESF working model (see Figure 1.3), Henriksen and colleagues outlined a view where the individual athlete/team interact with the athletes' preconditions (e.g., behavioural characteristics, financial, material), the process (e.g., training, competitions) and the organisation's culture (including its basic assumptions and artefacts)

to influence the effectiveness of the progression towards the senior elite level (Henriksen et al., 2011; 2010; 2010a). This holistic ecological approach outlined common characteristics which exist in successful TDEs. These are i) a sense of belonging, ii) psychological well-being and iii) a strong degree of cohesion and connection within the sporting organisation's wider context. These characteristics are consistent with findings in other real world settings such as football clubs and academies across Norway, Sweden, Denmark, Belgium and England (Aalberg & Saether, 2016; Flatgard et al., 2020; Ivarsson et al., 2015; Larsen et al., 2013; Mills et al., 2014; Ryom et al., 2020).

It should be noted, however, that this research, though insightful and informative, relates to single club or single team contexts. It does not accurately reflect a TDE that exists across team sport NGBs (see Figure 1.4), a complex jigsaw consisting of multiple teams, clubs, playing levels and stakeholders. Reflecting my pragmatic underpinnings, it is important there is research pertaining to national team sport settings to provide information allowing evidence informed systems and practices to be embedded across such TDEs.

2.1.5 Team sport TDEs; the complex jigsaw

It is widely accepted that success at junior level does not predict success at senior level (Abbot & Collins, 2004; Boccia et al., 2020; 2020a; Brustio, Boccia et al., 2021). TDEs capable of progressing athletes efficiently and effectively through the TD pathway from youth to senior level can help sporting bodies enhance the quality and sustainability of their elite level teams (Martindale et al., 2007; 2005). However, it is clear that the process is complex and multifaceted. Pathway athletes frequently inhabit various worlds, balancing their sport development with school, work, family and social lives (Stambulova et al., 2017). The complexity extends further because various teams, organisations and pathways (e.g., school, club, regional, national) as well as a variety of stakeholders (e.g., coaches) and demands (e.g.,

outcome measures) encompass a national team sport TDE. Given the complexity that young athletes inhabit multiple contexts it is important there is an understanding of the aforementioned process markers ensuring support is consistent for effective development, for example psychological, physical etc. (Collins et al., 2019). This complexity extends further when we consider athletes are transitioning concurrently in athletic, academic/vocational, individual and psycho-social levels as depicted in Wylleman and Lavellee's developmental model (2004). Therefore it is important we understand how the various pathway components should operate across a complex national sport TDE to support athletes through these simultaneously occurring transitions (MacNamara, et al., 2010a). This is particularly so for national *team* sport settings considering much of the research pertaining to successful TDEs reflects individual sports or single team settings.

How athletes navigate and deal with the complexity encountered in real world settings, balancing the multiple contexts while catering towards the multidimensional nature of TD is not wholly accounted for in the literature (Johnston et al., 2018). There seems to be an over emphasis on unidimensional studies focused on a single area, e.g., physical variables without creating links to other variables of performance or TD. It is perhaps not surprising that this is more profound when considering the gender data gap within TD research specifically (Johnston et al., 2018). It is important that TD research include a multidimensional approach, using multiple methods and reflecting real world settings that are currently underrepresented in the literature. Subsequent chapters in this thesis seek to fill this gap, exploring the TDE in a real team sport setting, using a female national hockey organisation as the avenue to represent a complex female TD pathway across a national team sport TDE (see Figure 1.4).

What we do know from the literature is that TDEs should strive for long term, stage appropriate development with a focus on athletes' individual needs and without over emphasising external factors for success such as short-term success or achieving contracts (Mills et al., 2014). Of course, and cognisant of a pragmatic stance, these factors cannot be ignored since the reality is that these measures are characteristic of TD pathways and therefore drive practice and decision making within the TDE. The increased pressure placed on development coaches from the NGB hierarchy to be successful during competition, a need to win mentality and a culture of premature professionalism however can skew and hinder the development experience for youth athletes (Mills et al., 2014; Sweeney et al., 2021).

The multidimensional, dynamic and emergenic nature of TD requires development to include, in addition to sport specific elements, physical and psycho-behavioural characteristic development (Gagné, 1995; 2000). It should also cater for interactions with 'significant others' across multiple contexts where a network of TD systems interplay in the TDE to influence the athlete's development (Coutinho et al., 2016; Morley et al., 2022). Personal factors such as psycho-behavioural characteristics or prior learnings constantly interact with environmental factors such as coaches, training opportunities etc. to determine the individual athlete's trajectory where this development journey spans across a variety of development experiences and contexts such as school and club systems (Henriksen et al., 2010; 2010a; 2011; Martindale et al., 2007). Henriksen and colleagues recent study, not unlike their earlier work, has introduced a collaboration success factor (CSF) model (Mathorne et al., 2020). This study explores a real world Danish setting where the CSF points to successful collaboration between and within the micro and macro environments which resulted in positive influences on TD effectiveness. This further highlights the importance of coherence in the TD process (Mathorne et al., 2020).

Considerable research has described the non-linearity of TD, illustrating the multiple entry and exit routes that athletes negotiate as they progress (Abbott et al., 2005; Sweeney et al., 2021). In fact, a degree of what Webb and colleagues (2016, p. 1801) call 'ping-ponging' on the pathway is thought to be facilitative of development by providing a blend of developmental experiences supportive of long term development. However, from a system design perspective, the degree to which the TDE and TD pathway accommodates the entry and re-entry of individuals at different times is less understood, perhaps reflective of the stage-design of talent pathways (Green, 2005). In reality, and reflective of the importance of individualisation, some athletes might benefit from leaving the pathway to train at a lower playing level or in a different context to receive more developmentally appropriate psycho-social and sport specific skill learning (Sweeney et al., 2021). Similarly, if individual athletes show technical or physical potential, they may be afforded premature opportunities to train or compete at higher levels (though this premature acceleration to higher levels is most appropriate when accompanied by a developmental agenda and a relatively robust set of psychological skills and social support to cope with the challenge) (Flatgard et al., 2020; Mills et al., 2014).

In this regard, decisions on the pathway require key stakeholders to share wide ranging and coherent messages, with collaboration across contexts within the TDE (Lundqvist et al., 2022; Martindale et al., 2007; 2005). Of course, the multiple contexts across national team sport TDEs are qualitatively different (e.g., school, club, regional, national) and therefore require different behaviours, actions and support. Some contexts may even have contradictory outcome measures (e.g., win now or later), yet co-inhabitation can be facilitated if the process and core teachings can be reflective, shared and coherent (Webb et al., 2016). Chapters 4 and 5 explore this concept across multiple contexts in a national hockey

TDE, reflecting a typical national team sport TDE setting and providing a real world platform to examine the level of coherence within and between important stakeholders.

2.1.6 Coherence in national team sport TDEs

A growing appreciation that TD is not the responsibility of a single person within an environment has emerged within the research and is the collective responsibility of the environment or organisation itself, i.e., where stakeholders at all levels should communicate, share knowledge, and work together towards the ongoing development of young athletes (Bjørndal & Ronglan, 2018; Gledhill et al., 2017; Mathorne et al., 2020). Many national team sport TDEs are complex with NGBs comprising ecosystems where multiple contexts (school, club, regional, national) operate simultaneously on the TD pathway. Such ecosystems require both horizontal (e.g. across multiple contexts), and vertical (e.g. between stages of development) cooperation and alignment along the national TD pathway (Bjørndal & Ronglan 2018; Bjørndal et al., 2017; Taylor & Collins, 2021). The emphasis on horizontal alignment in the TDE requires an associated emphasis on the extent to which the multiple stakeholders within an athlete's pathway operate in a coherent manner (Mathorne et al., 2020; Taylor, Ashford & Collins, 2022; Taylor et al., 2021; Webb et al., 2016). The emphasis on coherence resembles the concept of a shared mental model (SMM), where shared knowledge, information, and expectations across a broad team allow greater efficiency and effectiveness in the TD process (Gershgoren et al., 2013; Mathieu et al., 2000; Taylor & Collins, 2022).

In a complex national team sport's TDE, the concept of a SMM should aid alignment across stakeholders (Taylor, MacNamara & Taylor, 2022). Of course, the efficiency of the TD pathway is judged on both the quantity of players who convert to senior status and the efficiency of the process. This requires a careful balance between expediting the process (i.e., getting the athletes to senior status as quickly as possible) and ensuring athletes develop the

adaptability, independence and resilience required for senior success (Webb et al., 2016). Building on the descriptive literature that illustrates the inefficiency of TD pathways in converting successful junior athletes into senior champions there is a growing need to outline the mechanisms of this process (Herrebrøden & Bjørndal, 2022; Morley et al., 2022). For example, coaches who create positive facilitation rather than a directive style are more effective in converting young potential into senior success (Collins, MacNamara & McCarthy, 2016).

TD coaches require a different mindset, approach, community, and overall organisational structure than coaches working at the senior elite level (Collins et al., 2019; UK Sport & English Institute of Sport, 2020). The international level development coaches' raison d'etre is therefore to support the transition of high potential junior athletes into senior internationals, with age-grade success a secondary outcome. Even within a team sport context, this requires coaches to focus on the *individual* athlete given only a small percentage of junior athletes will make a successful transition to senior representation (Barreiros et al., 2014; Herrebrøden & Bjørndal, 2022).

2.1.7 Remember it is complex; using Performance-Outcome-Process (POP) in the TDE

In a complex TDE which exists in many team sports, the NGB can act as the system controller or orchestrator whilst still encouraging freedom within a philosophical bandwidth that is understood and followed by coaches at all pathway stages (Bjørndal & Ronglan, 2018; Webb et al., 2016). All contexts in the TDE simply align to the system's objectives for each development phase ensuring coaches and players work towards a shared goal. However, the pathway should also allow for the "ping-pong" variation (Webb et al., 2016, p. 1801) athletes encounter and is welcomed through various coaching styles, challenges and developmental experiences across the TDE contexts, again reflecting a blend of experiences for the high

potential young athletes. Implementing the POP principle (introduced in Section 2.1.2) whilst following a SMM approach would require the NGB to gain and coordinate 'buy in' from all stakeholders (i.e., horizontally across school, club, regional and vertically along the national pathway). This requires coaches across contexts to work in tandem towards the *performance* targets set at each pathway stage and the *outcomes* deemed most favourable towards achieving these goals. Considering the multiple contexts and coaches working as part of the SMM concept, the *processes* involved could be outlined yet afford a level of independence whereby the processes fall within a bandwidth which coaches across horizontal and parallel contexts apply to their own coaching style and philosophy (Bjørndal & Ronglan, 2018; Webb et al., 2016) with opportunity for bi-directional open communication (Taylor, MacNamara & Taylor, 2022). This model has the potential to offer high potential athletes a blend of experiences while still tailored towards common goals (Bjørndal & Ronglan, 2018; Webb et al., 2016).

The coordinated and coherent efforts of the various stakeholders are key in the TDE process. A lack of shared consensus vertically on TD pathways regarding the performance goal (e.g., performance now or succeeding later) can drive a gap and mismatch in coaching, selection, and TD decisions among stakeholders operating at differing stages of the pathway (Collins et al., 2019). Additionally, given the variation in approaches and perceptions of stakeholders that is an inevitable (and potentially positive) feature of team sport TDEs, careful consideration must be given to the trade-offs (perceived or real) required in the different contexts operating horizontally across the TDE, i.e., a focus on winning may be inevitable in one context, e.g., school. While the TDE could view this as an avenue to educate young athletes about motivation and determination it may however be less appropriate in other

contexts where individual growth, self-drive and self-regulation are prioritised e.g., national junior age grade (Bjørndal & Ronglan, 2018; Collins et al., 2019).

As a potential way forward, team sport TDEs should place emphasis on the horizontal coherence between contexts while encouraging interaction and flexible adaptation to support the athlete to navigate the TD pathway (Bjørndal, et al., 2017; Taylor, MacNamara & Taylor, 2022). Successful examples of this concept are available in the literature. For example, Mathorne et al's case study in a Danish swimming TDE highlights the successful collaboration of TD coordinators within the micro and macro environments to provide a context specific effective development environment for the participants (Mathorne et al., 2020). This TDE incorporated effective communication across different contexts, the sharing of training opportunities along with better training and educational balance to best support the youth athlete's development (Mathorne et al., 2020). As another example in Costello et al's study, prior collaboration, and coherence both vertically and horizontally within a professional rugby union TDE allowed for the subsequent success of the senior team in a challenging situation when COVID-19 ruled out many of the senior players (Costello et al., 2022). In this specific case study where development athletes were prematurely and temporarily promoted to senior level, the successful outcome highlights the benefits of the preceding coherent efforts both vertically and horizontally in the TDE (Costello et al., 2022).

2.2 The final transition; approaching senior elite level

There are major developmental changes and challenges outside of the sporting context associated with the period of adolescence. It is during this period that adolescents acquire the competencies, attitudes, values and social relations necessary to make the transition to adulthood (Zarrett & Eccles, 2006). For high potential young athletes, late

adolescence generally involves parallel transitions occurring in both the athletic level and in other non-sporting domains of their lives. A constant need for balance between academic, athletic and social roles is necessary to allow young athletes to develop their athletic careers while simultaneously pursuing education and/or work and instantaneously navigating social relations and demands (Ryba et al., 2015; Stambulova et al., 2012; Tekavc et al., 2015).

Adequate social support from coaches, teammates and families is the most cited external resource for junior athletes who experience high expectations and pressures among the barriers in the transition to senior representation (Stambulova et al., 2017). Research relating to specific examples of athletes who navigate the final transition to senior level emphasises the challenging nature of this time. Morris and colleagues (2017), for example, describe how soccer players who made the transition to first-team football reported significant performance pressures from stakeholders including coaches, parents and support staff and their inability to cope negatively affected their development trajectory. In this case, even though the players perceived they had the technical and physical capabilities required to perform and match the higher playing standard, they felt inadequately prepared to cope with the increased pressure and greater challenges during the transition.

Subijana et al. (2015) also reported time management as a significant transitional barrier. Managing both academic/work with athletic careers has been found to be problematic, particularly when it incorporated study with training and competition schedules, dealing with fatigue, financial concerns, sometimes the move away from home as well as regularly being forced to make personal sacrifices (Tekavc et al., 2015). Females specifically have a tendency to place more importance on their social relations, creating a likelihood to fall short of the competencies to adapt to the lifestyle changes required to navigate the transition to the senior elite level (Geldhill & Harwood, 2015). TDEs should operate to educate

athletes to lead a balanced lifestyle, managing overlapping demands that over time become less coordinated by their support network with increased responsibility and autonomy placed on athletes (Hauser et al., 2022; Henriksen et al., 2020; Nikander et al., 2020).

2.2.1 Helping to bridge the gap; holistic quality preparation

Effective holistic quality preparation can be difficult to coordinate. For young athletes balancing high performance sport and the transition from either secondary to higher education or education to work is difficult (Stambulova et al., 2015; Subijana et al., 2015). This process becomes more complex when one considers the various coaches which exist across the multiple contexts these athletes are part of given it is likely some operate off their own agenda (Collins et al., 2019; Webb et al., 2016). Resultantly these young athletes will interact with coaches working in silos, offering possible contradictory messages or advice. They must also balance interactions with teachers or work colleagues in addition to parental and peer influence. For individual athletes navigating this complex web of interactions can be difficult and potentially heighten the perceived external pressures the athletes experience from coaches, teachers, parents etc. (Stambulova & Wylleman, 2019).

Coordination, communication and combined efforts of the athletes' support network are pivotal (Henriksen et al., 2020). Using the SMM concept introduced earlier (Section 2.1.6) NGBs could facilitate coaches, parents, other support staff etc., to become aware of each other with good communication and adaption to the demands of other domains assisting the transition from youth to senior elite level (Ryba et al., 2015; Stambulova et al., 2015; Subijana et al., 2015). It is critical to bear in mind that this is a process, rather than an event and will likely occur at times specific to individuals rather than at a certain calendar date or age. Further complexity in the process is apparent considering multiple young team sport athletes might transition towards the senior level at the same time, yet simultaneously enter the

senior level with various levels of development experience, some at 17 years, others at 20 years (Lundqvist et al., 2022). Others may enter the senior level at a young age yet exit and re-enter it. Resultantly the transition to the senior elite level is considered a difficult process in the TDE where young athletes of various experience levels are concurrently faced with similar and plenty of challenges (Collins & MacNamara, 2022; Gledhill et al., 2017).

Individually, young high potential athletes transitioning from youth level to senior elite level concurrently experience increased pressures in athletic and non-athletic domains (Gledhill et al., 2017; Stambulova et al., 2017; Wylleman & Lavellee, 2004). The step up to senior elite representation is accompanied by increases in competition physical intensities (Brewer et al., 2010; Burgess et al., 2012), heightened perceived pressure and emotional disturbances (Taylor & Collins, 2021b; Williams & MacNamara, 2022). Given two important cogs for longevity in TD are physical and psycho-behavioural development (Collins & MacNamara, 2022; Li et al., 2014) and the complexity of the transition to the highest playing level, NGBs should encourage coherent efforts in the TDE to provide aligned holistic development that also support athletes physical and psycho-behavioural development.

2.3 The step up in physical demands during the junior to senior transition

Young athletes at the latter end of the pathway experience increased training and competition demands as they edge closer to the senior elite level (Lundqvist et al., 2022; Morley et al., 2022). Game locomotor demands can often differentiate the physical requirements between junior and senior level athletes (Burgess et al., 2012; Vescovi, 2016). TD pathways and systems aim to prepare young athletes to handle heightened or more challenging training intensities to assist them with their transition to the next performance level where increased playing demands are inevitable (Burgess et al., 2012; Vescovi, 2016;

Vescovi, 2014). The most common method for determining the physical game locomotor demands and the ability of young athletes to meet these demands is using GPS tracking. Research displays mean game locomotor demands for junior as well as senior level and allows conditioning practitioners to best prepare athletes for the transition to higher level representation (Brewer et al., 2010; Vescovi, 2016; Vescovi, 2014).

It is generally accepted that if a TD athlete is consistently performing at or above the mean game locomotor demands in a specific sport, often found in the literature (Vescovi, 2016; Vescovi, 2014), it could be determined that the athlete is ready to handle a transition to higher playing demands. Critically, this raises the question if knowledge of mean game locomotor demands provides an effective process marker for informing performance progression decisions. A concept explored further in the next section and in Chapters 7 and 8 concerns using GPS metrics to instead create a framework to better understand the changes in performance over time. This framework could act as a practical developmental marker for assessing the readiness of young team sport athletes to cope physically with a transition to increased competition intensities experienced at higher playing levels (Brewer et al., 2010).

2.3.1 Differences in game locomotor demands vertically on the pathway

Akin to most other team sports, hockey is intermittent in nature consisting primarily of low to moderate intensity running interspersed with frequent bouts of intense activity. This includes high velocity locomotor activity, accelerations, decelerations and numerous changes of direction (FIH, 2019; Gabbett, 2010; McGuinness, Malone, Petrakos et al., 2019). Research on elite-level female hockey has used GPS software to quantify the locomotor demands by game (McGuinness, Malone, Petrakos et al., 2019), quarter (McGuinness, Malone, Hughes et al., 2019), position (Macutkiewicz & Sunderland, 2011), and playing level (Vescovi, 2016), with most studies focusing on the mean game demands of senior international game play.

Along the national TD pathway it is clear there are differences in locomotor demands between playing levels (Vescovi, 2016). Vescovi (2016) found large differences in game demands between U17 and U21 playing levels reporting differences in the mean game relative distance (U17=107 m.min^{-1}; U21=112 m.min^{-1}) and high speed running distance (>16.1km/h; U17=371m; U21=511m). Comparisons with other published studies show that these game demands are also lower than what has been estimated for senior playing populations (126 m.min^{-1}, 587m >16km/h) (Macutkiewicz & Sunderland, 2011; McGuinness, Malone, Petrakos et al., 2019), similar to findings in other sports (Burgess et al., 2012; Vescovi, 2014). This difference is supported by other documented differences in physical capacities between senior and junior international female hockey players (Watts, 2014). Watts (2014) found that senior international players performed better than development players across physical performance assessments (e.g., 10m and 40 speed time, the multistage fitness test, upper and lower rep max strength tests) where the participant development players had all been identified as *potential* future senior international team players.

Differences in physical capacities and game locomotor demands between playing levels highlight the need for appropriate monitoring of performance so that athletes can be physically prepared to transition through the TD pathway. From a talent and long term athlete development perspective, it is also critical in addition to tracking mean game locomotor demands in junior playing levels, to consider the variability in game-to-game or within-game (across a whole game) locomotor activity (Doncaster & Unnithan, 2019). Knowledge of between-game variability data could assist practitioners to better understand and interpret game locomotor activity and analyse if desired changes in performance have occurred (Doncaster & Unnithan, 2019). This information is particularly important to ensure junior players are supported to transition to higher playing levels at times when they can withstand

the increased locomotor demands, ultimately leading to suitable preparation for senior level (Doncaster & Unnithan, 2019; Vescovi, 2016). There is limited knowledge in the literature about game-to-game or quarter-to-quarter variabilities for junior team sport athletes, particularly females. Early work by Espenchade (1936) on female, club level hockey players recorded intra-game activity (distance covered and speeds achieved) in 3-minute intervals and observed larger variabilities for midfield (halfback) positions in comparison to defenders (fullback). Although these data (c. 1936) long predate the use of GPS monitoring in sport, Espenchade's work provides an initial rigorous empirical basis from which to continue the study of intra-game variabilities in female hockey (Espenchade, 1936).

From a coaching perspective, knowledge of game-to-game and within-game variability would be beneficial when working with a development group. Practically, if the magnitudes of between- and within-athlete sources of variability are known, then junior athlete game locomotor data (measured by GPS) can be more accurately interpreted to support coaches' understanding of the demands of competition and the relative smallest worthwhile change (SWC) required in determining if real physical performance progression has occurred over time (Dalton-Barron et al., 2021; Gregson et al., 2010; Kempton et al., 2014; McLaren et al., 2016; Paul et al., 2015). Consequently, practitioners would be better equipped to determine an athlete's readiness to progress from the final stages of the pathway to senior level based on their capacity to repeatedly perform in specific game GPS metrics beyond the relevant variability range over a time. This would seem preferable to comparisons of a one-off performance snapshot in a single game or mean game data before making the transition from junior to senior elite level. Between-game variability however cannot always be generalised, and the literature recommends different contexts to quantify their own game-to-game variability (Carling et al., 2016).

2.3.2 Differences in game locomotor demands horizontally across the TDE

The development and progression of team sport athletes on the national TD pathway is not the sole responsibility of the international age grade coach, but rather the coherent effort of all coaches at each level across each context especially in complex TD systems. The multiple settings young pathway athletes must navigate creates complexity and often leads to a hectic schedule, forcing the young athlete to balance multiple and varied coaching demands, game tactics etc. (Phibbs et al., 2018). The lower domestic playing levels are an integral part of the development process, however, research in female hockey suggests a potential performance gap exists between domestic and international playing levels (Gabbett, 2010; Vescovi & Frayne, 2015). For example, domestic level collegiate (Vescovi & Frayne, 2015) and senior club level (Gabbett, 2010) female hockey players cover more total distance (collegiate, 6062-6765m; senior club, 6154-6931m) than senior international level females (5369-5696m, McGuinness, Malone, Petrakos et al., 2019). The collegiate level players covered similar high intensity running distances (664-816m >16.1kmh, Vescovi & Frayne, 2015) when compared to senior international (572-810m >16kmh, McGuinness, Malone, Petrakos et al., 2019), though it is important to note that the collegiate level competition usually has up to twenty minutes extra playing time than international games (Vescovi & Frayne, 2015). Subsequently, the relative distance covered by the collegiate playing group (108-110 $m.min^{-1}$, Vescovi & Frayne, 2015) was lower than senior international level (127 $m.min^{-1}$, McGuinness, Malone, Petrakos et al., 2019), yet was comparable with age-matched U21 international data (112 $m.min^{-1}$, Vescovi, 2016).

Similar findings were reported in male hockey (Jennings et al., 2012), female soccer (Andersson et al., 2010) and Australian Football League (AFL) (Brewer et al., 2010) illustrating a disparity between game locomotor demands based on competition level. These studies

found when the same players competed across two competitions, one elite and one sub-elite, they performed greater high intensity activities during elite than sub-elite games. Further research showed a gap also exists between different domestic or sub-elite competition standards where athletes competing at the highest standard perform greater high intensity running distances during a game than at the lower level competitions (Mohr et al., 2008). The increase in competition demands from youth to senior level and from domestic or lower level competition through to higher level competition suggests the need for players to be able to perform at a greater pace and intensity when progressing to higher standards of play, not only from junior to senior level (Jennings et al., 2012; Vescovi, 2016; Watt, 2014). Therefore, in addition to quantifying the game locomotor demands exposed along the national TD pathway, it is important to consider the lower domestic levels. This information would assist complex national development programmes to strategically and successfully support youth athlete development given their simultaneous involvement across multiple contexts.

Given knowledge of mean game locomotor demands are only part of the puzzle further insight can be sought from understanding the between- and within-game variability data mentioned earlier (Section 2.3.1). There is a paucity of research available pertaining to game variability data in sub-elite playing levels, however. One study in an adolescent rugby union population revealed high week-to-week variability in game and training loads for this group (Phibbs et al., 2018). Though this study used session rate of perceived exertion (sRPE) and not GPS metrics for their data collection, the authors highlight the importance of this knowledge due to the chaotic nature of this development group. The multiple teams, contexts, games, and varied coaching this population experiences could expose them to high risk yet suboptimal game and training loads (Phibbs et al., 2018).

Knowledge of the game-to-game or within-game variability at both domestic and national levels is important. This would create a better understanding of the differences in competition demands imposed on players who regularly transition between these multiple contexts and playing levels whilst part of national TD pathways. Understanding this information could assist in preparing young players appropriately for the game locomotor demands of international competition and a young high potential athlete's physical preparedness to progress to higher playing levels as they progress through the TD pathway. This is also particularly important given the need to cater for late developers, and the possible TD pathway entry and re-entry requirements described earlier in the chapter (Abbott et al., 2005; Mills et al., 2014; Sweeney et al., 2021). Such information would provide an understanding of the game locomotor demands athletes are exposed to when playing across multiple contexts and better inform performance improvements over time indicating a readiness to transition from lower to higher levels of competition.

In addition to preparing athletes to physically cope with the increased locomotor demands experienced as they progress to higher standards of play and through the national TD pathway (Burgess & Naughton, 2012), it is also important to consider the other intrapersonal catalyst that can influence how a young high potential athlete interacts with their environment and training or playing opportunities, i.e., psycho-behavioural development (Gagné, 1995; Williams & MacNamara, 2022).

2.4 The psycho-behavioural demands during the junior to senior transition

It is not surprising that research has indicated successful athletes or those who do 'make it' possess a host of psychological characteristics and behaviours conducive to reaching high levels of performance (Holt & Dunn, 2004; Martindale et al., 2005). On the other hand,

performers who do not make the final transition to senior elite level, or fail to reach their potential are often characterised by a smooth ride through the early stages of their development (Collins & MacNamara, 2012; Taylor & Collins, 2021b). The smooth ride often fails to equip athletes with the mental skills necessary to face the challenges and times of adversity (e.g., non-selection, injury, under performance, failures, losses) they are likely to meet when transitioning to more difficult levels of play (Saward et al., 2020; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2019).

Psychological skill development is important for high potential athletes given they require the commitment, resilience, self-efficacy and personal control that is inevitably challenged throughout their pathway journey, specifically at times when athletes face concurrent sport and life transitions (Collins & MacNamara, 2012; Stambulova & Wylleman, 2019). The development of psychological skills (for example Psychological Characteristics of Developing Excellence, PCDEs) cannot be left to chance within the TDE, rather they must be deliberately incorporated as part of the development process both horizontally and vertically on the pathway (Collins & MacNamara, 2017; Taylor, Ashford & Collins, 2022). Traditionally, the focus in TD generally, and coaching more specifically, has been on the sport specific skills and physical, performance and technical factors associated with successful development in that particular sport. This emphasis may be attributed to the ability to measure these performance pillars and an applied motivation for objectively measurable and tangible outcomes (Bjørndal & Ronglan, 2018; Dimundo et al., 2021). However, despite growing recognition of the role of psychological factors as determinants of both performance and development (e.g., MacNamara et al., 2010a; 2010b), less attention has been paid to the systematic development of psychological factors as a key element of the TDE. As before, the inclusion of psycho-behavioural skill development in the TDE, not unlike physical

development, requires an understanding and commitment from all coaches working in the TDE, both horizontally and vertically as well as other important stakeholders, i.e., parents, and other support staff.

2.4.1 Psychological Characteristics of Developing Excellence (PCDEs)

PCDEs are clear and observable behaviours, including attitudes, emotions and the commitment developing athletes require in order to reach their potential (Collins & MacNamara, 2022; MacNamara et al., 2010a, 2010b). Table 2.1 (p. 56) depicts examples of PCDEs referenced most often by athletes that have been successful in making it to and staying at the senior elite level (Collins & MacNamara, 2017). Considering the information presented in the previous section (2.4) highlights developing athletes will inevitably face challenges such as underperformance, failures, de-selection etc., through their development journey, (MacNamara et al., 2010a, 2010b; Saward et al., 2020; Taylor, Ashford & Collins, 2022) it is important these athletes learn to use PCDEs to assist them navigate such challenges. The research indicates athletes who progress through to the senior elite level approach challenge with an adaptive, progressive and planned approach, utilising psychological skills to cope with the challenge (Collins & MacNamara, 2017; 2012). Contrastingly, those who do not 'make it' tend to have a more reactive unprepared approach (Collins & MacNamara, 2017; 2012; Saward et al., 2017). Additionally athletes who are better equipped to cope with pressure, deal with setbacks etc., particularly during transitions toward higher paying levels are those who perform better when presented with such opportunities (Hill, et al., 2018; Saward et al., 2017; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2021b; Taylor et al., 2020).

Given that TD is multidimensional and complex, the POP principle (Section 2.1.2 and 2.1.7) could provide a means for the NGB to encourage the inclusion of psycho-behavioural skills in the TDE. Using the POP principle to outline the desired performance goals and the outcomes

conducive to achieving these should assist with gaining alignment towards the systematic development of psycho-behavioural skills simultaneously with other important domains e.g., physical (Collins et al., 2019). More specifically, if the pathway stage goal is performance based then the outcome might require physically robust, adaptable and resilient players being developed towards the latter end of the pathway. To meet these outcomes the process would encompass appropriate physical preparation, as explored earlier, in addition to the development of psycho-behavioural skills (i.e., PCDEs) that young athletes can apply to challenging experiences with confidence. The overall impact would improve their adaptability and develop resilient and self-driven athletes as a result (MacNamara et al., 2010a, 2010b).

PCDEs are psychological skills and behaviours that should be taught and developed in combinations and at varying time points. When these skills are applied to challenges along the pathway and effectively reviewed or reflected upon post challenge, it can lead to increased confidence in applying such skills (Collins & MacNamara, 2017). These skills can include, for example, assisting athletes with goal setting, imagery, understanding realistic performance evaluation and seeking and using social support; skills that when developed together can result in the development of resilience, grit, self-drive and a likely growth mindset (Collins & MacNamara, 2017; Collins et al., 2019; Dweck, 2006). Table 2.1 (see Section 2.4.4, p. 56) portrays an example of PCDEs (taken from Collins & MacNamara, 2017).

The inclusion of PCDEs within the TDE requires opportunities to be created to educate athletes, parents, and coaches across the TDE pathway about the psycho-behavioural skills likely to be desirable when approaching challenging times which may arise at varying time points along the TD journey (Collins & MacNamara, 2017; MacNamara, et al., 2010a, 2010b). Education of what PCDEs look like (i.e., commitment, focus and distraction control, realistic performance evaluations, self-awareness, coping with pressure, planning and self-

organisation, goal setting, effective imagery, actively seeking social support) and how these skills are beneficial to overcome challenges (i.e., increases in training demands, drop in performance, non-selection, injury etc.,) helps to create 'buy in' and a willingness to learn (MacNamara, et al., 2010a, 2010b). Including parents and other coaches from parallel contexts in this education brings greater opportunity for alignment and wider coherence to the messaging delivered to development athletes (Collins & MacNamara, 2017).

2.4.2 PCDE development; Teach-Test-Tweak-Repeat

Implementing the delivery of these skills in the TDE, like any skill development involves using a concept like the teach-test-tweak-repeat approach (Collins & MacNamara, 2022; Collins & MacNamara, 2017). This should assist athletes in developing the skills to enhance their "hand of cards" (Collins & MacNamara, 2017, p. 4) or toolbox of skills available when approaching any ups and downs met along their development trajectory. The research has determined it is not necessarily the challenge the athletes face but rather the challenging experience must be preceded by the opportunity to learn and develop the desired skills needed to then *bring to* and overcome a given challenge (either planned or natural). This should be accompanied by feedback, debriefing or reflection to grow from it (Collins & MacNamara, 2017, 2012; Mills et al., 2012; Savage et al., 2017; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2021b). This mix of learning, deployment of skills, reflection and debriefing provides the catalyst for athlete growth, to gain confidence in the use of the skills should a given, or similar challenge arise again and thereby more effectively translate potential into excellence (Taylor & Collins, 2021b).

For example, in Section 2.3 the need to prepare athletes physically to handle increases in training and competition demands could be an opportunity to educate and develop appropriate psychological skills and behaviours that may be beneficial in coping with the given

challenge. The psycho-behavioural skills might include commitment, an understanding that increased pressure is imminent and therefore a need to cope with such pressure as well as actively seeking social support to aid in preparation for the heightened physical intensity. Education of PCDEs within the TDE should develop an awareness of the type of psycho-behavioural skills athletes require, while the provision of support from other coaches, parents etc. should assist athletes throughout the challenge or test phase (Taylor & Collins, 2012b). Reflection and evaluation on the use of these skills following the period of physical intense training allow athletes to become self-aware and self-driven in how to approach the challenge if it were to repeat. Subsequently, the athlete grows from the experience developing a skillset to assist with other challenges that may arise during and following the transition to senior international level (Collins et al., 2017; Taylor & Collins, 2012b).

Different psycho-behavioural skills however will be suited to different challenges, and different ages or pathway stages will require a different skillset (Laureys et al., 2021). This emphasises the importance of systematically teaching and developing PCDEs through formal, informal, and procedural approaches. This should be reinforced through input from parents and other coaches across contexts and is especially relevant during early development years when younger athletes rely on parents for assistance with organising their training, lifestyle etc. As athletes progress into adolescence and through the TD pathway the reliance shifts towards coaches for assisting with goal setting, planning and organising etc. At the latter end of the pathway, the responsibility should shift towards the athlete drawing upon the PCDEs developed to assist with the progression of adaptable, autonomous, self-driven athletes with high self-regulatory skills (Hauser et al., 2022; Lundqvist et al., 2022; MacNamara et al., 2010b).

2.4.3 Consequences of omitting psychological skill development in the TDE

The literature suggests that high potential young athletes attribute their inability to reach their potential to a lack of, and an inability to effectively deploy, psychological skills and behaviours (Collins & MacNamara, 2017; Taylor & Collins, 2019). Critically, the absence of this skillset may only be felt when athletes reach the tail end of the pathway; as previously explored in Section 2.2 the transition from youth level to senior elite is considered one of the most difficult in high performance sport (Gledhill et al., 2017; Larsen et al., 2014; Stambulova et al., 2017; Taylor & Collins, 2021b). In their study, Taylor & Collins (2021b) identified the academy players given the repeated opportunities to play up with the senior team were those who compared to their peers, appeared to have a greater ability to cope with the pressures and emotional disturbance experienced in the transition.

If young athletes are mentally prepared to develop the appropriate psycho-behavioural skillset conducive to coping with high performance environments, i.e., PCDEs, they might interpret a situation as challenging, rather than threatening, and have a high perception of control and achievement (Li et al., 2019). TDEs should therefore facilitate and even encourage athletes to develop mental toughness, through teaching and encouraging the upskilling of PDEs, resulting in increased self-efficacy (Li et al., 2019).

2.4.4 PCDE measurement; Psychological Characteristics for Developing Excellence Questionnaire – Version 2

As with other sport skills the ability to measure the development of psychological skill progress against performance markers helps coaches monitor performance progression. However, the research has identified the use of anthropometric, physiological and technical testing as unpredictable in predicting adult performance capacity (Burgess & Naughton, 2010). Critically, the psychological and psycho-behavioural capacity of youths has been

identified as difficult to quantify and rarely tested (Burgess & Naughton, 2010; Pankhurst & Collins, 2013). MacNamara and Collins (2011), however, developed a formative assessment tool; the Psychological Characteristics for Developing Excellence Questionnaire (PCDEQ) to measure and monitor the development of psychological skills, characters and behaviours that support effective development. Version 2 of this questionnaire (PCDEQ2) was further developed by Hill and colleagues (2018) to extend the measures to include both adaptive and maladaptive psychological skills, characters and behaviours that support effective development (Hill, MacNamara & Collins, 2018).

Table 2.1

Psychological Characteristics for Developing Excellence (PCDEs) and PCDEQ2 associated factors (see Collins & MacNamara, 2017).

PCDE Skills	PCDEQ2 Factors
● Commitment ● Focus and distraction control ● Realistic performance evaluation ● Self-awareness ● Coping with pressure ● Planning and self-organisation ● Goal Setting ● Quality Practice ● Effective Imagery ● Actively seeking social support	1. Adverse response to failure (Fear of failure) 2. Imagery and active preparation 3. Self-directed control and management 4. Perfectionistic tendencies 5. Seeking and using social support 6. Active coping 7. Clinical indicators (e.g., eating disorders, anxiety, depression)

The PCDEQ2 does not replace the original PDCEQ (MacNamara & Collins, 2011), both of which assess factors that influence athlete development. However, psycho-behavioural characteristics such as perfectionistic tendencies for example can be adaptive and

maladaptive, both of which are captured in the 7 Factor PCDEQ2 (Table 2.1) and reflects the way PCDEs are deployed in the pathway. The PCDEQ2 informs psycho-behavioural interventions and identifies areas that require support to improve the effectiveness of TDEs (Hill, et al., 2018). It is not designed as a selection or deselection tool, but rather a lens to assess progress, highlighting strengths and weaknesses that may need to be addressed within the TDE (Laureys et al., 2021).

The PCDEQ2 has previously been used with a female field hockey national TD pathway in to examine the presence of PCDEs across the national TD programme (Edwards et al., 2022). Analysis of the results highlights some differences between junior and senior players, where junior players used imagery and active preparation more than senior players and more than non-selected junior players. Senior players showed a higher score regarding perfectionistic tendencies compared to junior players and non-selected players. There seems a difference in environments between junior and senior levels in this national TD pathway, those who make it to the senior level have high standards and strive towards perfection possibly reflecting a 'goldilocks' amount as too much reliance on perfectionism can lead to negative outcomes (Hill, Mallinson-Howard & Jowett, 2018).

Edwards and colleagues note that analysing the PCDEQ2 results at a group level provides insights into the general development of that group. This acts as a monitoring tool for a development curriculum though individual differences were found to exist within the group (Edwards et al., 2022). The PCDEQ2 can be effectively used as an assessment tool, regarded as one leg of the stool considering TD is multidimensional (Baker et al., 2019). Assessing the presence of PCDEs using the PCDEQ2 can inform TDE coordinators of possible skills, behaviours and characteristics that require attention at both a group and individual

level. Further assessment at the individual level could be used to assist coaches and practitioners support individual athletes that may be struggling psychologically in the current environment or in anticipation of future challenges (Edwards et al., 2022).

2.5 Informing practice in TDEs – a potential gender data gap?

The literature base, and data, from TDEs have become more extensive and include a range of empirical articles (Coutinho et al., 2015; Forsman et al., 2016), theory-driven papers (Davids et al., 2013; Phillips et al., 2010), and models of TD (Bailey & Morley, 2006; Gagné, 2004). The base of research is purported to enable researchers, practitioners, and policy makers to generate a clear understanding of what is 'known' in order to guide their practice and inform policy development and decisions. Indeed, across all sport science disciplines there is an understanding of the importance of evidence informed practice in determining the best outcomes for athletes and coaches. Reflecting the pragmatic philosophy underpinning my approach to this PhD thesis, evidence informed practice is the systematic reviewing of the best evidence in order to make informed choices about practice. The practical use of evidence based research is critical in a real world sport setting. Unfortunately Chapter 3 details, as elsewhere in a data-driven world, the data collected in TD is typically about male experiences, and not female experiences; a rather unfortunate omission given that approximately half of the population is made up of women (The World Bank, 2017)! The gender data gap (Criado-Perez, 2019) is an important consideration against the growth of women's and girls' sport in general and the subsequent implementation of female specific TD pathways (e.g., The Football Association Girls' England Talent Pathway; The FA, 2017). If data is used in the TD space to help drive decisions about resource allocation, pathway structures,

coaching, and competition about female sport, are we sure that it reflects the needs of specific populations? This body of research seeks to start to address this imbalance.

Sport and exercise medicine research has already been reported to significantly under-represent females in current literature, accounting for less than 40% of the total number of participants (Costello et al., 2014). The failure to account for the experiences of female athletes can therefore result in ineffective and inefficient TD systems and less than optimal experiences for female athletes. As such, closing the gender data gap requires the need to count female experiences explicitly in all fields.

2.5.1 The research is there; is it enough to inform practice in female team sport TDEs?

The last 20 years have seen a large volume of literature emerge exploring various aspects of TD (Bennett et al., 2019; Coutinho et al., 2016; Rongen et al., 2018). This research base has focused on a broad range of factors including identifying key aspects of the TDE (Gledhill & Harwood, 2019), the importance of psycho-behavioural factors (Erikstad et al., 2018a; Erikstad et al., 2018b; Höner & Feichtinger, 2016; Tedesqui & Young, 2018), physiological (Arazi et al., 2013; Fornasiero et al., 2018; Forsman et al., 2016; Jones et al., 2018), coaching (Peña-González et al., 2018; Romann et al., 2017), family (Domingues & Gonçalves, 2013; Elliott et al., 2018), and early experiences (Coutinho et al., 2015; Ford et al., 2009; Schorer et al., 2010) on the trajectory of young high potential athletes. Published literature such as journal articles presents the knowledge base of a given discipline and reflects the discipline's history, trends, and research norms. As such, before research findings can be applied with confidence to particular contexts, it is important to establish that the research reflects *that* context.

Funding and structures for women's sport have increased across the world with the establishment of professional leagues in, for example, soccer, hockey, and athletics. This has

given rise to TD pathways and academy structures for young female athletes developing in parallel. Often, the structures designed for female athletes have been 'borrowed' from their male counterparts, perhaps without due interrogation of the similarities and differences that may exist between the two cohorts. This chapter has explored much of the research to better understand the TDE, and TD pathways, the world team sport athletes inhabit and how best to develop them holistically towards senior elite representation. We cannot however assume findings and conclusions from the male dominated literature are applicable across contexts. This is not to say that we cannot do the same things with females or in female sporting environments, just that there currently is an absence of data (Curran et al., 2019; see Chapter 3). There is a need for evidence informed practice, using the best data available. The pragmatic nature of the body of work carried out in this PhD thesis reflects a desire to further enhance the knowledge base in female team sport TD settings, providing a more informed knowledge base for future use and further research in this space.

Chapter 3: What About The Girls? Exploring the Gender Data Gap in Talent Development

Curran, O., MacNamara, A., & Passmore, D. (2019). What about the girls? Exploring the gender data gap in talent development. *Frontiers in Sport and Active Living*, 1(3), pp. 1-7. Doi: 10.3389/fspor.2019.00003

3.1 Introduction

There has been much attention on the gender data gap across widely diverse domains such as medicine (Vitale et al., 2017), vehicle safety (Linder et al., 2011), and urban design (Carpio-Pinedo et al., 2019). Researchers simply appear to fail to collect data on women yet the results of the research are extrapolated to females without due consideration of the impact of that transfer (Criado-Perez, 2019). When women are underrepresented in data which underpins how decisions are made the results can be problematic. For example, women are more likely to be misdiagnosed with a heart attack as they experience different symptoms from men. However, heart failure trials generally use male participants leading to commonly known symptoms of heart failure to be those most experienced by males (Criado-Perez, 2019). Similarly, cars are designed around the body and physical profile of a male thus increasing the likelihood of injury to women in collisions (Bose et al., 2011).

The danger of not having, or using, robust data on females is far-reaching. Even when data on females *is* collected it is not always analysed appropriately (Criado-Perez, 2019). In some domains (e.g., medicine and transportation safety) the results of the data gap can be deadly (Bose et al., 2011; Linder et al., 2011; Vitale et al., 2017) whereas in TD there may not be the same catastrophic repercussions to the exclusion of data on females. Nonetheless, despite the worldwide growth and interest in female sport (Fink, 2015) and subsequent development of TD pathways focused on providing support to high potential female athletes

(e.g., The Football Association Girls' England Talent Pathway; The FA, 2017), Chapter 2 highlighted the underrepresentation of females across many research domains which includes sport and exercise medicine (Costello et al., 2014), with much of the TDE literature reflecting male experiences. Of course, some might interpret the available TDE research as informative and indeed applicable across varied sports, contexts, populations etc., since research can certainly be used to help inform decisions and practice. Critically, we must consider if we are to strive towards creating research informed TDEs we cannot assume that the experiences of a well-researched context using predominantly male athlete populations applies or mirrors the experiences of female athletes. To this end we need to explore female athlete experiences within a TDE. Indeed we need to know if young female athlete TD systems exist in the same manner as young male athletes? Until there is a greater body of research into female TDEs we cannot assume both genders have the same experiences of TD.

For some factors the differences are obvious. It is generally well accepted that male athletes have superior muscle strength and produce greater force than their female counterparts (Batterham & Birch, 1996; Cramer et al., 2002; Weber et al., 2006). Analysis of gender differences in elite soccer players demonstrated a clear difference between male and female game GPS locomotor metrics (Bradley & Vescovi, 2015). Similarly, Clarke et al. (2017) depict the most commonly used speed thresholds in elite male rugby populations underestimated the high intensity running distances covered by elite female rugby populations by up to 30%. This variation in match performance between genders is possibly due to differences in aerobic and anaerobic capacity (Batterham & Birch, 1996; Clarke et al., 2014; 2017). Likewise, the literature reports coping mechanisms within sport differ between genders. For example, females seek more social support and display increased efforts to manage goal frustrations (Crocker & Graham, 1995), use dissociative strategies more

frequently than men (Phillipe & Seiler, 2005) and perceive their environment as a more task oriented climate (Murcia, Gimeno & Coll, 2008). The research therefore demonstrates a difference in both physical performance capacity and cognitive or psycho-behavioural skills of females when compared to males. This supports the assertion that there is a need for caution when drawing from research to make inferences about female athletes in male dominated studies. If the research-practice divide is to be effectively bridged for *all* athletes and robust implications for practice offered, it is important to critically examine the current evidence base and its applicability to both male and female athletes.

This is not to say that TDEs *must* be different, or that the available research in male populations is *not* applicable to female sports. However, data and research is required to ascertain if the current research base can apply. Measuring game locomotor performance capacities of young high potential female athletes using GPS would add to a current scarcity of data and assist practitioners decision making on how best to physically prepare this cohort of players (see Chapters 7 and 8). Similarly investigating psycho-behavioural skills, through for example the PCDEQ2, of young female athletes, would provide a lens for other practitioners working with a similar population to better understand the requisite skills (see Chapter 6).

Recognising the importance of evidence-informed practice in driving policy and practice, and reflecting the gender data gap that is a consistent feature of almost all other domains, I was interested in examining whether a gender data gap exists in TD research, specifically the lack of research relating to female athletes. The aim of this study was to review the peer-reviewed literature in TD published between 1999 and 2019 to examine whether female athletes were represented in the participant sampling. Building on this, the second part of the study discusses some reasons why future studies with female athletes are

important in order to ensure that the literature is reflective of commonalities and differences in their experiences.

3.2 Methods

3.2.1 Development of search strategy

As a scientist-practitioner the aim was to generate practical meaningful knowledge, and in line with my philosophical underpinnings outlined in Chapter 1, this study was underpinned by a pragmatic research philosophy (Giacobbi et al., 2005). The literature search utilised in this study employed review principles similar to conventional systematic reviews in order to ensure that an adequate selection of literature based on replicable criteria occurred (Smith, 2010). A list of keywords relevant to the aim and theme of the research was created (Smith, 2010) and these search parameters were trialled in a preliminary search on the SPORTDiscus database. During this preliminary search, every tenth result was checked and analysed for relevance and to consider whether additional keywords should be included. This process was repeated until the most effective search terms were identified (i.e., the terms that returned the most relevant and specific literature in relation to the research question). Irrelevant terms that repeatedly came up in the search results were excluded (i.e., injury). Following this process, the final list of search terms included the following:

‘Talent Development’ OR ‘Talent Identification’ OR ‘Talent Selection’ OR ‘Talent’ OR ‘Long Term Development’ OR ‘Specialisation’ OR ‘Relative Age Effect’

AND

‘Youth Sport’ OR ‘Youth Athlete’ OR ‘Young Athlete’ OR ‘Adolescence’

AND

‘Maturation’ OR ‘Growth’

AND

‘Psychology’ OR ‘Mental Skills’

NOT

‘Injury’

In the final literature search two relevant databases, SPORTDiscus and Ovid, were broadly, though not exhaustively, searched by the primary author, using the keywords in different combinations to allow for the return of relevant research papers.

3.2.2 Inclusion/exclusion criteria

Inclusion and exclusion criteria were employed to create clearly defined boundaries for the literature search (Smith, 2010). The inclusion criteria were, (a) peer reviewed empirical research studies, (b) published from January 1999 until April 2019 (when the formal search was finalised), (c) in English language, (d) have gathered original qualitative or quantitative evidence from young athletes only (under 21 years of age), that facilitate TD knowledge and understanding, I provide information on the age and gender of the research participants, and (f) contain specific reference to either talent/talent development/talent identification/talent specialisation, long term development/growth/maturation, or psychological skills/psychological attributes to TD within the title, abstract or listed keywords. The exclusion

criteria were, (a) meta-analysis or systematic review studies, (b) studies indicating evidence from stakeholders other than athletes (e.g. coaches, parents, peers etc.), (c) participants over 21 years, (d) no information regarding the age or gender of participants, and no specific reference to either talent/talent development/talent identification/talent specialisation, long term development/growth/maturation, or psychological skills/psychological attributes to TD within the title, abstract or listed keywords.

3.2.3 Search returns

The search process came to a close on the 1st of April 2019 and retrieved 2873 potentially relevant hits. Duplications were removed and abstracts and titles were assessed for relevance. Based on the inclusion/exclusion criteria, 2498 search returns were excluded and 375 papers were kept for full-text retrieval. Most studies were excluded due to duplicates, a lack of definitive relevance to TD, or their focus on senior (above 21 years of age) elite athletes. After full-text retrieval and review, 312 of the 375 papers met the inclusion criteria. Most studies were excluded as a result of the inclusion of coaches or parents in the participant group, no clearly defined age or gender of participants as well as the inclusion of participants above 21 years. This reference list was examined by an experienced external advisory team.

Suggestions from the advisory team included the removal of further studies due to a lack of definitive TD focus in addition to suggestions for consideration of further references. The additional studies were considered and 10 papers were accessed and reviewed. Following this process an additional two studies were added. A total of 276 studies met the inclusion criteria following this process and were analysed for the purpose of this review. Following the

PRISMA flow diagram guidelines developed by Moher et al. (2009), an outline of the detailed overview of the search process, along with reasons why papers were rejected, can be found in Figure 3.1.

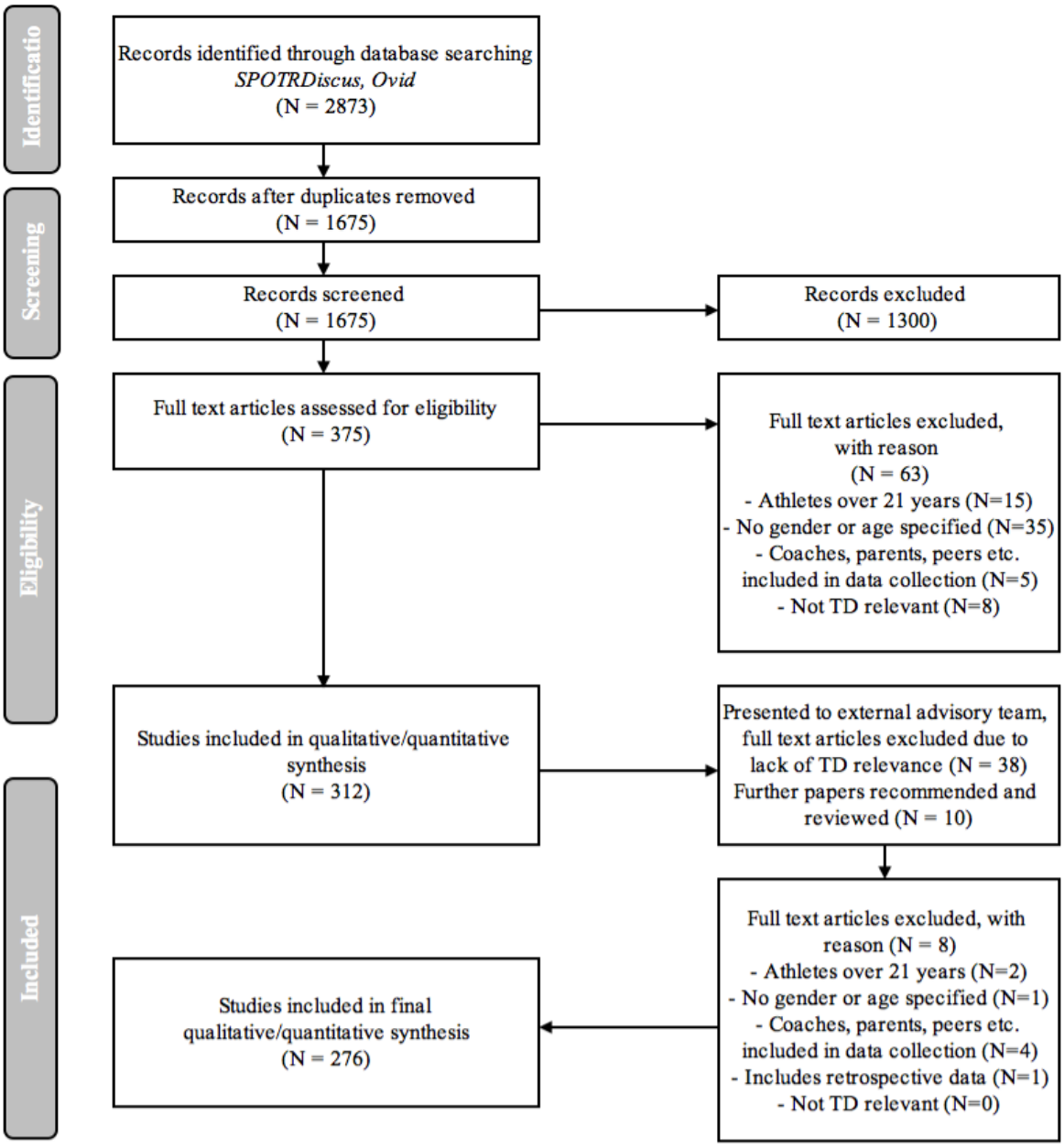

Figure 3.1

Flow Diagram of study selection

3.2.4 Data synthesis

The literature search was used to identify and elicit research papers regarding areas within TD of athletes under 21 years of age. The aim of the literature search was to examine whether a gender data gap was apparent in TD research carried out from 1999 to 2019. As a first step, I went through an extensive process to check all papers for relevance and identify any alternative and appropriate keywords for use within the literature search to ensure accuracy and comprehensiveness. A content analysis was used to extract key information from the data regarding the gender, age and keywords used within each research paper (Pope et al., 2007).

3.2.5 Establishing trustworthiness

To establish trustworthiness and meet the criteria of validity and credibility, a number of processes were followed (Creswell & Miller, 2000; Sparkes & Smith, 2009). This initially took the form of *peer debrief*, which involved a consistent review of the research process by an experienced supervisor who offered their support and criticisms (Creswell & Miller, 2000). Peer debrief took place regularly (i.e., every 2-4 weeks) through meetings and informal discussions with the experienced supervisor. An *advisory team,* comprised of two external researchers who had previously published studies within the explored literature, was also established (Smith, 2010). The advisory team was provided with references of included studies, strategies for developing the research question, inclusion and exclusion criteria, and a briefing about the purpose of the literature search. The included papers and research methods employed were approved by the panel and suggestions for additional inclusions provided.

3.3 Results

Reflecting the aims of this study, I was particularly interested in examining the participant populations included in the TD research from 1999-2019 as these were most recent and relevant. Table 3.1 illustrates the gender breakdown across the selected publications. Of the 276 research papers included in the data synthesis, only 9.4% included a female only population in comparison to 60.1% in a male only population and 30.4% with both males and females included in the participant group (gender aggregated). This finding clearly indicates a gender data gap exists in the TD research from 1999-2019. Table 3.1 also presents the extent to which the gender aggregated research papers report findings on males and females considered together as a single participant group or if the findings were compared between the genders. 77.4% of the 84 gender aggregated papers present results where males and females have been considered separately. It is particularly relevant to this thesis that 86.2% illustrated a difference in the results relating to females in comparison to males, further highlighting the need for female specific research in TDEs.

What about the girls?

Table 3.1

The number and percentage of gender groups (male, female and gender aggregated); and studies where comparisons are made between genders represented in the research papers included in the literature search data set

Gender	Count	%	Gender Comparison (aggregated groups)	Count	%	Reported Difference between Genders	Count	%
Male	166	60.1	Yes	65	77.4	Yes	56	86.2
Female	26	9.4	No	19	22.6	No	9	13.9
Both	84	30.4	*Total*	*84*	*100*	*Total*	*65*	*100*

Having established that a gender data gap was apparent, a review of the results was undertaken to consider whether the data gap was more or less apparent in the literature pertaining to specific topics in TD (see Table 3.2). Research relating to the relative age effect and maturation of youth athletes was the most represented topic in the literature search (37%) and, perhaps surprisingly, research relating to sport specialisation (3.3%) was the least evident. Reflecting the purpose of the study, each topic was then analysed to examine whether a gender data gap was apparent, and this examination found that females were underrepresented across every topic. Females accounted for only 3-17% of the participant groups in the included literature compared to a 38-73% representation for male only groups. Gender aggregated data were also higher than the female only across all but one topic of the literature search. Physical factors returned 8.8% of studies for gender aggregated groups compared to 17.7% for female only groups. The gender aggregated group also accounted for less studies across all topics compared to the male only group.

Table 3.2

The number and percentage of topics and separated per participant group represented in the research papers included in the literature search data set

	All		Male		Female		Both (*M & F*)	
Discipline/Topic	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
Talent Development (Tactical/Performance Focus)	19	6.9	14	73.7	2	10.5	3	15.8
Talent Development (External to Sport/Environmental Focus)	21	7.6	8	38.1	3	14.3	10	47.6
Relative Age Effect/Maturation	102	37	58	56.9	8	7.8	36	35.3
Talent Identification/Selection	60	21.7	42	70	6	10	12	20
Sport Specialisation	9	3.3	6	66.7	0	0	3	33.3
Physical	34	12.3	25	73.5	6	17.7	3	8.8
Psychological	31	11.2	13	41.9	1	3.2	17	54.8

Abbreviations: M, male; F, female

Finally, I examined the data to identify trends within TD research published from 1999-2019. Table 3.3 highlights the growth of this area of research in more recent years. 38.4% of the included literature were published from 2016-2019 compared to only 7.6% of the studies published between 2007-2009. Only 5.8% of the papers included in the literature search were published between 1999-2006. Table 3.3 also highlights the gender breakdown of the published papers by year and presents a clear underrepresentation of research papers with female only populations. Although attention on topics pertaining to TD has increased year-on-year, the gender data gap has remained consistent.

Table 3.3

The number and percentage of publications by year and separated per participant group represented in the research papers included in the literature search data set.

	All		Male		Female		Both (*M & F*)	
Year of Publication	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
2016-2019	106	38.4	58	54.7	8	7.5	40	37.7
2013-2015	86	31.2	55	64	9	10.5	22	25.6
2010-2012	47	17	28	59.6	5	10.6	14	29.8
2007-2009	21	7.6	17	81	1	4.8	3	14.3
1999-2006	16	5.8	8	50	3	18.8	5	31.3

Abbreviations: M, male; F, female

3.4 Discussion

In line with the objectives indicated in Chapter 1, this chapter aimed to examine gaps within TD research, specifically the lack of research relating to female athletes. This study identified the key research areas within TD literature published between 1999 and 2019 (objective 1a) to understand the number of studies representing female only populations (objective 1b). More specifically this research aimed to highlight the number of female only studies and how this compared to the availability of TD research in the male population (objective 1c). The gender data gap represents an unequal representation of females across numerous domains in a world driven by data (Criado-Perez, 2019). Although there has been considerable growth in research relating to TD in recent years, this chapter has illustrated females are vastly underrepresented in the data, highlighting a significant need to explore topics within TD research in female athletes.

Given research should underpin advancements in real world practice within sport and youth athlete development this gender data gap may have significant implications. Gender differences play an important role in the development of young athletes and there are notable differences between males and females in this regard; for example, physical (Batterham & Birch, 1996; Bradley et al., 2014; Clarke et al., 2014; Cramer et al., 2002; Weber et al., 2006), and cognitive (Crocker & Graham, 1995; Murcia et al., 2008; Phillipe & Seiler, 2005) differences between males and females are well documented. Table 3.2 illustrates that the gender data gap is apparent across these important constructs. This becomes problematic when applying current findings to female development pathways and practices since gender can potentially influence youth athlete development. For example, the aerobic fitness evolution of young females progressed at slower rates than their male counterparts (Fornasiero et al., 2018). Similarly, relative age effects are less pronounced in female sports, potentially due to maturational differences between females and males (Romann et al., 2018) or contextually different sport popularity (Andrew et al., 2022; Götze & Hoppe, 2021).

Reflecting a guiding principle as a scientist practitioner *if* data is to be used to inform TD best practice, there is a need for caution when making inferences about female athletes from male dominated research studies. Though beyond the scope of this study, it is important to recognise the complexity of these issues and the need for research to evolve further to adequately and appropriately represent individuals of all gender identities, whether they identify as men, women, or other. However, in this context I have delimited the analysis to male/female to reflect the categorisation of competitive sport.

This literature search highlighted an underrepresentation of female data across *all* included topics of TD research and strongly questions the extent to which the research *as it stands* can be extrapolated with confidence to female TD pathways. The findings highlight there is less evidence on females in research specific to talent identification, physical and psychological development. Despite the dearth of female based TD literature, there is continued growth worldwide of female sport, as referenced in Chapter 1 (Fink, 2015). Research pertaining to male athletes cannot be *assumed* to relate to female athletes and the implications of applying such research findings to female sport are vast, creating TD pathways likely to be unreflective of female athlete needs.

Based on the evidence presented it can be hypothesised that current TD pathways and TDEs for female athletes have been designed and developed based on male data. As such, TDEs and structures for female athletes appear to lack a robust evidence base and may instead be the product of experience, gut feel, and tradition largely adopted from male athlete experiences. There is clearly a need for evidence of the experiences, requirements, and reflections of female athletes on the TD pathway across all topics of TD – physical, psycho-behavioural etc. and a greater visibility of female athletes in the literature. The lack of data for females in TD undermines the ability to understand the experiences of women and girls in sport and the constraints and opportunities they experience. Furthermore, this study presents clear evidence that data collection in TD is distorted by gender biases and how this negatively impacts the ability to design appropriate policies, structures, and systems for female athletes. In addition to the gender data gap, it can also be argued that having no data, or poor data on issues that affect female athletes is a significant issue; especially as some

issues (e.g., maturation, puberty, pregnancy, menstruation) impact female athletes differently than their male counterparts and gender data would help us understand this better.

3.5 Conclusion

In summary, there is a clear need for unbiased data in order to design TD policies and practices – the gender data gap means that we only have a partial snapshot of the experiences and requirements of females in this space. Rigorous gender data will also allow sports to make informed decisions for females in sport and track the efficacy of TD interventions. Accordingly, the remaining chapters set out to examine areas within TDEs in a young female athlete population, using junior female hockey athletes in a complex TD system as indicated in Chapter 1. It is important there is data available to reflect this population which provides a clearer understanding of how this TDE operates. This is not to say it is undoubtedly different to male environments, however without relevant research based evidence practitioners are forced to revert to experiences and recommendations from male TDEs. As a scientist practitioner the chapters that follow aim to help address this research gap; Chapters 4 and 5 investigating the TDE of a female team sport, specifically a national female hockey organisation, Chapter 6 examining the inclusion of PCDEs on the TD pathway, and Chapters 7 and 8 exploring the variability in game locomotor demands within the TDE for a development athlete cohort to better determine a physical readiness to progress through the TD pathway.

Chapter 4: Singing off the same Hymn Sheet? Examining Coherence in the Talent Development Environment (Part 1)

Curran, O., MacNamara, A., & Passmore, D. (2021). Singing off the same hymn sheet? Examining coherence in a talent development pathway (part 1), *Journal of Sports Sciences*, 39(15), pp. 1709-1716. Doi: 10.1080/02640414.2021.1896456

4.1 Introduction

In Chapter 2 the importance of vertical and horizontal coherence in TDEs was highlighted. This seems even more relevant when considering team sports since high potential young team sport athletes co-exist in multiple playing contexts simultaneously. As described in Section 1.2.4 and 1.2.5 this is certainly the case for female Irish hockey, a complex TDE considered throughout this study (see Figure 1.4, p. 14). This TDE represented a useful setting to explore the complexity in a team sport TDE. For example, in this context the Ireland senior Women's Hockey Team had five new caps enter the senior national playing level whilst competing in the 2022 FIH World Cup (Hockey Ireland, 2022). Interestingly, these new caps had varied experience levels, three players were also playing on the under 21 national junior age grade (NJAG) team whilst also playing and training with the senior national squad throughout the year and also competing at the senior club level. The two remaining athletes, one older and one younger, received first caps at the same tournament, yet followed different trajectories entering senior national representation at different ages and experience levels. Females tend to reach puberty earlier and subsequently are advanced in maturity status compared to similar age-matched males (Malina et al., 2004). There is a shallow talent pool in the context of female Irish hockey, therefore it is not surprising that high potential NJAG female Irish hockey players transition towards senior status whilst still competing at lower

representative age grades or lower competitive levels (i.e., domestic). This is consistent with findings in another female TD pathway (football) where players have been fast tracked to international level, possibly due to the smaller talent pool (Simpson et al., 2022).

The premature acceleration of young high potential female hockey players to compete at higher playing levels in the TDE creates complexity in the TD process. The complexity relates particularly to the simultaneous worlds the athletes must navigate through their development journey. In addition to considering the new caps mentioned earlier, in the female Irish hockey TDE there is likely similar age-matched female athletes part of an NJAG team (under 18 or under 21) whilst also playing senior club level and possibly school level hockey and other athletes not part of the national context, yet participate in both school and senior club level hockey. With this in mind, it is important to note that these athletes could enter, exit and possibly re-enter the national TD pathway at varying time points as mentioned in Chapter 2 (Flatgard et al., 2020; Sweeney et al., 2021). Returning to the example discussed earlier, prior to the 2022 FIH World Cup one new cap that was introduced to the Irish senior national team had left the national TD pathway at the under 21 NJAG level and re-entered at the senior national level two years later. In the meantime, this athlete played senior club level hockey. Reflecting the non-linear nature of TD (Abbott et al., 2005), and as discussed in Chapter 2, it makes sense that some athletes will enter, exit and re-enter or be a late entry at any point on the TD pathway. Consequently, there is a need to recognise that multiple worlds co-exist that must operate simultaneously and coherently. If players exit and potentially do not re-enter while others do then team sport TDEs must also cater for participation as well as performance (Collins et al., 2012). Collins et al's Three Worlds Continuum (Collins et al., 2012) suggest that built on a robust foundation of skills, participants can be supported to move between different worlds of participation – participation for elite performance, participation

for personal well-being and participation for personally referenced excellence, as they develop in sport. While admirable as a TD construct, this dynamic trajectory is contingent on a system that facilitates this movement.

The dynamic nature of TD and multiple contexts that co-exist across team sport TDEs makes the case that for the TDE to operate effectively, both horizontal and vertical coherence and alignment is paramount. Communication between coaches across horizontal playing contexts (club, school, national) and vertically on the TD pathway (under 18, under 21, senior) would assist the continued development of athletes that may move between the three worlds. A move away from elite performance (NJAG, TD pathway) towards a lower playing level (domestic club competition for example) does not mean a young high potential athlete cannot participate in this lower playing context with a focus on personally referenced excellence and later may re-enter the TD pathway with a re-focus on participation for elite performance (Collins et al., 2012; Sweeney et al., 2021). Further, communication and collaboration vertically along the TD pathway allows for coherence regarding a young high potential athletes' well-being and holistic development if they move to and from different elite playing levels along the TD pathway (Collins et al., 2012; Hauser et al., 2021).

The TD pathway journey towards the elite senior national level is particularly complex in female team sport because of a range of reasons; the dearth of female specific data, as outlined in Chapter 3, an often shallow talent pool and generally younger senior level representation (Brustio, Cardinale et al., 2021). However, there is a growing interest in high performance female sport. From both a participation and performance perspective female sport is currently experiencing exponential growth. The UEFA women's Euros in July 2022 broke records for attendance at a women's European soccer game, more than doubling the previous record crowd set less than ten years previous in 2013 (87,192 vs 43,301) (UEFA,

2022). A similar story on the same weekend revealed a record crowd in attendance at the Ladies' Gaelic Football championship final in Ireland, again doubling figures from 2013 and the se'enth year in a row there has been growth in the crowd on finals day (RTE, 2022). Unfortunately, the increased interest in female sport contrasts with the volume of TD research pertaining to females (Chapter 3). If the interest in female sport continues to grow it is 'ritical we try to bridge the research gap by providing data to assist coaches, practitioners and female sports organisations make evidence informed decisions about policy and practice. As a first step it is important we understand the TDE operating in female team sports, investigating athletes' perceptions of the cohesion and collaboration inherent in this complex environment and across multiple sub-systems to help establish where and what the potential facilitators and derailers are in the TDE (Bjorndal & Ronglan, 2018; Martindale et al., 2007; Webb et al., 2016). Therefore the purpose of this chapter is to explore the TDE of a national female team sport TDE, through using a national amateur hockey organisation from the perspective of young female players. I was particularly interested in the extent to which the various stakeholder groups were considered to be systematic, cohesive and collaborative and whether there were differences between age groups (i.e. under 16, under 18, under 21), and across contexts (e.g. school, club, national) to understand areas of the TDE that could be improved upon.

In order to examine this question, a quantitative approach was employed using the shortened version of the Talent Development Environment Questionnaire (TDEQ-5). The original TDEQ was developed and validated by Martindale, Collins, Wang, McNeill, Lee, Sproule and Westbury (2010). Further work by Wang, Sproule, McNeill, Martindale and Lee (2011) and Li, Wang, Pyun and Martindale (2015) refined the TDEQ to resolve some practical and psychometric concerns and subsequently developed through exploratory and

confirmatory factor analysis, a shortened and more athlete friendly TDEQ, specifically a 25 item, 5 factor TDEQ (TDEQ-5) was developed. This questionnaire serves as a practical method for measuring effective TD processes, specifically focusing on the holistic and generic processes in effective long term TD. It allows for the evaluation of TD practice, providing a platform for reflection in response to participant perceptions and understandings of the TDE and therefore highlighting areas in need of attention for improving practice in TDEs. The TDEQ-5 has been used as a valid and reliable tool across varying countries and sporting environments to good effect (Brazo-Sayavera et al., 2017; Li et al., 2018; 2015; Siekańska & Wojtowicz, 2017; Thomas et al., 2020).

4.2 Methods

4.2.1 Participants

Seventy seven national female hockey players (mean age = 17.81 ± 2.07 years) were purposefully recruited to participate in the study. All participants were from a single national hockey organisation and comprised three development teams (under 16; U16 n=32, under 18; U18 n=22 and under 21; U21 n=23).

4.2.2 Instrumentation

The Talent Development Environment Questionnaire (TDEQ-5), a 25 item, 5 factor questionnaire was developed and refined by Wang and colleagues (2011) and Li and colleagues (2015) (Appendix A3). The original version (TDEQ; Martindale et al., 2010) had 59 items measuring seven factors. The 25 item, shortened version (TDEQ-5) measures the following five factors: long-term development (5 items); holistic quality preparation (7 items); support network (4 items); communication (4 items); and alignment of expectations (5 items). The internal consistency of the questionnaire shows adequate to good internal reliability (α =

.79–.86) (Li et al., 2015) and, as such, the TDEQ-5 is considered a tool that can be used with confidence in TDE research settings.

4.2.3 Procedure

Ethical approval was obtained from the university's ethical review board. Informed consent was obtained from each participant, and in the case of those under 18 years of age, approval was also obtained from a parent or guardian (Appendix A2). Reflecting the multiple environments that the players simultaneously inhabited, each participant was asked to complete the TDEQ-5 from the perspective of their (a) national level team, (b) senior club level team (if part of one) and (c) school level team (currently or when they had played at school). The questionnaire took approximately 15 minutes to complete. Participants were asked for demographic information and informed that there were no right or wrong answers, given assurance about the confidentiality of their responses, and encouraged to be honest and to ask questions if necessary.

4.2.4 Data Analysis

In line with previous studies (e.g. Mills et al., 2014; Thomas et al., 2020) the TDEQ-5 responses were coded on a 6 point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Scores from negatively worded items were reversed before data analysis so that higher scores related to a perception of a higher quality experience. As recommended by Martindale et al. (2010), mean scores were analysed and reported for each factor. This allowed evaluation and comparison of the players' perceptions of their TDE across school, senior club and national level contexts and between age groups. Differences in the TDEQ-5 subscales between age groups and across contexts were assessed using a two-way mixed analysis of variance (ANOVA), with Bonferroni correction used to protect against Type 1 error.

To examine scale reliability of the current sample, the internal consistency coefficient (Cronbach's alpha) was calculated. A Cronbach's alpha (α) greater than 0.7, 0.8 and 0.9 are respectively regarded as 'respectable', 'very good' and 'excellent' (DeVellis, 2016). The level of statistical significance for all analyses was set to $\alpha = 0.05$. Effect sizes are reported as partial eta squared (η_p^2) and interpreted as the following, 0.01, small; 0.06, medium; 0.14, large. All items were subsequently quartile ranked by proportion of agreement to determine the key strengths and areas for improvement as perceived by players. Items ranked more often by each playing group in the top quartile (i.e., top 25th percentile) were classified as strengths of the TDE. Conversely, items ranked more often by each playing group in the bottom quartile (i.e., bottom 25th percentile) were therefore classified as areas for improvement within the TDE.

4.3 Results

4.3.1 Subscale and item level analysis

The internal consistently of the current sample, assessed using Cronbach's alpha showed excellent internal reliability ($\alpha = 0.9$) (DeVellis, 2016). The TDEQ-5 results are presented as the mean subscale scores of the main variables (Table 4.1) to show how the TDE is perceived by players across each age group (U16, U18, U21) and context (school, club, national). In order to provide a deeper understanding of the players' perceptions across the different age groups and contexts, each variable is presented in more detail to understand trends at an item level in the data (Table 4.2). At an item level, the key strengths (light grey) and primary areas for improvement (dark grey) across the playing groups are highlighted (top and bottom 25th percentile). The reliability

The two-way mixed ANOVA results showed that there were no significant interactions between the age groups per context for each of the TDEQ-5 subscale scores; long term development ($F(4, 74) = 1.262$, $p = 0.293$, $\eta_p^2 = 0.064$), holistic quality preparation ($F(4, 74) = 0.436$, $p = 0.782$, $\eta_p^2 = 0.023$), support network ($F(4, 74) = 1.136$, $p = 0.346$, $\eta_p^2 = 0.058$), communication ($F(4, 74) = 0.528$, $p = 0.716$, $\eta_p^2 = 0.028$) and alignment of expectations ($F(4, 74) = 0.520$, $p = 0.722$, $\eta_p^2 = 0.027$). Results between age groups and across contexts differed for each subscale and are presented below along with item level analysis to provide further insights into the TDE for each subscale score.

4.3.2 Long Term Development

The two-way mixed ANOVA results showed there were no significant differences across contexts ($F(2, 74) = 2.565$, $p = 0.084$, $\eta_p^2 = 0.065$) or between age groups ($F(2, 37) = 0.50$, $p = 0.952$, $\eta_p^2 = 0.003$) on perceptions of long term development. At an item level, across all age groups participants reported that item 19 – their training was specifically designed to help them develop in the long term was only a strength of the national playing context (*M±SD*; U16=5.08±0.49, U18=5.33±0.82, U21=4.88±0.96). This was in contrast to the school (*M±SD*; U16=3.72±1.35, U18=3.50±1.60, U21=4.23±1.36), and club context (*M±SD*; U16=3.92±1.52, U18=4.38±1.33, U21=4.08±1.14). Additionally, there were two strengths highlighted across all age groups. Firstly, item 22 – coaches allowing learning to take place through players making their own mistakes, was a strength across all contexts, reported strongest at the national level among the U16 (*M±SD*; school=4.75±0.80, senior club=4.80±0.75, national=4.85±0.55) and U18 (*M±SD*; school=4.32±1.62, senior club=4.67±1.21, national=5.53±0.52) players, and strongest at the senior club level in the U21 group (*M±SD*; school=4.62±0.87, senior club=4.77±0.89, national=4.38±1.15). The second perceived strength across age groups, item 23 – was coaches not allowing a dip in performance to effect

playing opportunities. This was perceived highest at the school level for U16 (*M±SD*; school=4.72±1.08, senior club=4.12±1.21, national=4.15±0.90) and U21 (*M±SD*; school=4.92±0.86, senior club=4.85±0.77, national=4.25±1.34) players and highest at the national level for U18 players (*M±SD*; school=4.45±1.44, senior club=4.48±1.30, national=4.60±1.59).

4.3.3 Holistic Quality Preparation

The two-way mixed ANOVA results showed no significant differences across contexts, ($F(2, 74) = 2.545$, $p = 0.085$, $\eta_p^2 = 0.064$) or between age groups ($F(2, 37) = 1.127$, $p = 0.335$, $\eta_p^2 = 0.057$) on holistic quality preparation. Deeper insights at an item level highlight this subscale as the lowest performing subscale containing the highest number of areas requiring improvement.

One area reported across all contexts as requiring improvement, item 11 – was the players' perception that they do not receive sufficient help to develop their mental toughness, reported lowest at school level (*M±SD*; U16=3.06±1.66, U18=2.82±1.47, U21=2.77±1.74), and with mean values increasing from the U16 to U21 groups at the national level (*M±SD*; U16=3.46±1.33, U18=3.80±1.66, U21=4.06±1.06).

Another area in need of improvement, particularly among the U18 and U21 groups was item 2 – the perception that players are rarely encouraged to plan and prepare for how things might go wrong. This was highlighted as a particular area for improvement at the senior club and national level among U18 players (M±SD; senior club=3.71±1.39, national=4.00±1.73), and across all contexts among the U21 players (*M±SD*; school=3.08±1.44, senior club=3.62±1.50, national=4.06±1.53).

The third area requiring improvement was item 13 – the perception that coaches rarely talk to players about their well-being. This was highlighted as an area for improvement

for every age group at the senior club (*M±SD*; U16=3.08±1.32, U18=3.86±1.32, U21=3.85±1.29) and national level (*M±SD*; U16=3.46±1.51, U18=4.20±1.32, U21=3.75±1.34), though also reported with low values at the school level (*M±SD*; U16=3.28±1.49, U18=3.50±1.65, U21=3.92±1.50).

A noteworthy area for improvement among the U16 and U21 age groups concerned item 12 – coaches rarely taking the time to talk to other coaches who work with the players. The U16 group reported lower values at the school and senior club level (*M±SD*; school = 3.28±1.55, senior club=3.28±1.48), the U21 group perceived this lowest at the school level (*M±SD*; school=2.92±1.50) and also lower at national compared to senior club level (M±SD; senior club=4.08±1.38, national=3.63±1.50).

4.3.4 Support Network

At the subscale level, the two-way mixed ANOVA results showed the support network subscale mean had a significant medium difference across contexts ($F(2, 74) = 5.458$, $p = 0.006$, $\eta_p^2 = 0.212$). More specifically the national level mean was significantly higher ($p = 0.009$) by 0.790 (95% CI, 0.163 to 1.418; $\eta_p^2 = 0.238$, large) compared to the school context mean. However, this was not significantly different ($p = 0.670$) compared to the club context mean, nor was there a significant difference ($p = 0.118$) between the school and club context means. Similarly, there was a significant small difference in the mean support network subscale score between age groups ($F(2, 37) = 4.971$, $p = 0.012$, $\eta_p^2 = 0.129$). The U16 age group mean was significantly lower ($p = 0.045$) by -0.623 (95% CI, -1.234 to -0.011; $\eta_p^2 = 0.203$, large) compared to the U18 age group mean, and significantly lower ($p = 0.019$) by -0.718 (95% CI, -1.341 to -0.095; $\eta_p^2 = 0.237$, large) compared to the U21 age group mean. However, the U18 and U21 age group means were not significantly different ($p = 1.00$).

Further inspection at an item level showed the support network subscale consisted of two areas of strength; item 1 – each age group viewed the coaches and support staff as being approachable across all contexts, perceived strongest at the national level by the U18 age group (U18 *M±SD*; school=5.05±1.46, club=5.14±1.21, national=5.67±0.62). Among the U16 group, this item was perceived strongest at the school level (*M±SD*; school=4.47±1.34, senior club=4.00±1.30, national=4.31±1.11), and perceived strongest at the senior club level among the U21 group (*M±SD*; school=4.62±1.61, senior club=5.15±1.17, national=4.63±1.63).

Another area of strength was item 7 – perceptions that all coaches and support staff are on the same page. This appeared to be viewed stronger by all age groups at the national level (*M±SD*; U16=4.92±0.95, U18=5.27±0.70, U21=4.94±0.85) than at senior club (*M±SD*; U16=3.96±1.54, U18=4.86±1.04, U21=4.85±0.95) and school level (*M±SD*; U16=4.22±1.26, U18=4.36±1.26, U21=4.92±0.86).

4.3.5 Communication

There were no significant differences between age groups F(2, 37) = 0.232, p = .794, η_p^2 = .012), however, there was a significant large difference across contexts (F(2, 74) = 10.328, p = < .001, η_p^2 = .218). Perceptions of communication were significantly higher (p = 0.001) by 0.786 (95% CI, 0.305 to 1.267, η_p^2 = .218) for the national context mean compared to the school context mean, and were significantly higher (p = 0.013) by 0.580 (95% CI, 0.100 to 1.060, η_p^2 = .218) compared to the club context mean. However, the school and club context means were not significantly different (p =0.547).

Item level analysis indicated that across age groups it is mostly at the national level that item 4 is particularly evident – where coaches talk to players about what current and/or past world class performers did to be successful (*M±SD*; U16=5.00±0.71, U18=4.20±1.37, U21=4.38±1.31). Contrastingly, for all age groups, this item is reported as an area requiring

improvement at the senior club level (*M±SD*; U16=2.92±1.29, U18=2.29±1.31, U21=2.54±1.22) and at the school level among U21 players (*M±SD*; 3.23±1.42).

4.3.6 Alignment of expectations

There was no significant difference across contexts, ($F(2, 74) = 1.724$, $p = .185$, $\eta_p^2 = .045$) or between age groups ($F(2, 37) = 1.707$, $p = .195$, $\eta_p^2 = .084$) for alignment of expectations. At an item level this factor contains two strengths and two areas for improvement. One area requiring improvement across all age groups was item 16 – the communication between coaches and parents regarding what the players are trying to achieve. This item was perceived lowest by all age groups at the national level (*M±SD*; U16=2.46±1.27, U18=2.53±1.19, U21=2.88±1.75). This was also perceived as an area for improvement by the U16 and U18 groups at the school level (*M±SD*; U16=2.81±1.40, U18=3.18±1.59), reporting higher perceptions at the senior club level than school level at all age groups (*M±SD*; U16=3.48±153, U18=3.95±1.53, U21=3.92±1.21).

Despite this, an area of strength was item 3 – players' perception that their parents give advice that fits with the advice they receive from their coaches. There were differences between the age groups on how they perceived this item across the contexts, U16 players regarding this stronger at the school level (*M±SD*; school=4.50±1.19, senior club=4.40±1.20, national=4.46±0.88), U18 players perceiving the senior club as strongest (*M±SD*; school=4.50±1.14, senior club=4.76±1.15, national=4.53±1.41) and the U21 players perceiving the national level strongest (*M±SD*; school=4.85±0.80, senior club=4.38±0.84, national=4.88±0.96).

The second area which required improvement was item 14 – goal setting, where players across all age groups felt they would set goals mostly at national level (*M±SD*; U16=3.69±1.32, U18=4.20±1.66, U21=3.69±1.78) compared to senior club (*M±SD*;

U16=3.24±1.24, U18=4.19±1.47, U21=3.69±1.26) and school level (*M±SD*; U16=3.19±1.40, U18=2.91±1.48, U21=3.23±1.17).

Contrastingly, players reported an area of strength, item 15 – was that they are involved in decisions about their sport development, perceived strongest at the national level among the U16 (*M±SD*; school=4.59±1.13, senior club=4.32±1.12, national=4.92±1.12) and U18 (*M±SD*; school=4.36±1.53, senior club=4.76±0.81, national=5.20±1.01) players, and strongest at the senior club level among the U21 players (*M±SD*; school=4.62±1.12, senior club=4.85±1.03, national=4.69±0.79).

Table 4.1

TDEQ-5; subscale mean (M) and standard deviation (SD) of player perceptions of the TDE quality per age group at school, senior club and national level.

		Long Term Development		Holistic Quality Prep		Support Network		Communication		Alignment of Expectations	
		M	***SD***	**M**	***SD***	**M**	***SD***	**M**	***SD***	**M**	***SD***
U16 PLAYERS	**(N)**										
NATIONAL	13	4.77	*0.34*	3.82	*0.75*	4.58	*0.76*	4.58	*0.81*	3.85	*0.68*
SENIOR CLUB	25	4.32	*1.03*	3.34	*1.20*	3.50	*1.29*	3.87	*0.69*	3.78	*1.09*
SCHOOL	32	4.37	*0.86*	3.44	*1.33*	3.52	*1.34*	3.50	*0.89*	3.62	*1.07*
U18 PLAYERS	**(N)**										
NATIONAL	15	4.87	*0.54*	4.19	*0.82*	4.98	*0.81*	4.48	*0.90*	4.03	*0.69*
SENIOR CLUB	21	4.39	*0.99*	3.76	*1.21*	4.43	*1.19*	3.84	*0.95*	4.27	*1.12*
SCHOOL	22	4.03	*1.15*	3.59	*1.19*	4.05	*1.11*	3.64	*0.92*	3.53	*0.98*
U21 PLAYERS	**(N)**										
NATIONAL	23	4.45	*0.96*	4.06	*0.94*	4.66	*0.99*	4.37	*0.75*	4.08	*0.59*
SENIOR CLUB	13	4.43	*0.73*	4.06	*1.00*	4.83	*1.06*	3.98	*0.47*	4.23	*0.66*
SCHOOL	13	4.55	*0.52*	3.41	*1.07*	4.27	*1.08*	3.92	*0.65*	4.05	*0.96*

Table 4.2

TDEQ-5; mean (M) and standard deviation (SD) of TDEQ-5 items within each factor per age group at school, senior club and national level; key strengths (light grey) and primary areas for improvement (dark grey) are highlighted (top and bottom 25th percentile).

TDEQ-5 Theme		TDEQ-5 Question	U16 Players						U18 Players						U21 Players					
			SCHOOL (n=32)		SENIOR CLUB (n=25)		NATIONAL (n=13)		SCHOOL (n=22)		SENIOR CLUB (n=21)		NATIONAL (n=15)		SCHOOL (n=13)		SENIOR CLUB (n=13)		NATIONAL (n=23)	
			M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*	M	*SD*
Long Term Development	19	My training is specifically designed to help me develop effectively in the long term	3.72	*1.35*	3.92	*1.52*	5.08	*0.49*	3.50	*1.60*	4.38	*1.33*	5.33	*0.82*	4.23	*1.36*	4.08	*1.14*	4.88	*0.96*
	20	I spend most of my time developing skills and attributes that my coach tells me I will need if I am to compete successfully at the top/professional level	3.97	*1.49*	4.56	*1.06*	5.15	*0.69*	3.50	*1.60*	4.81	*1.14*	4.73	*0.70*	4.54	*1.05*	4.62	*1.21*	4.81	*1.11*
	22	My coach allows me to learn through making my own mistakes	4.75	*0.80*	4.80	*0.75*	4.85	*0.55*	4.32	*1.62*	4.67	*1.21*	5.53	*0.52*	4.62	*0.87*	4.77	*0.89*	4.38	*1.15*
	23	I would be given good opportunities even if I experienced a dip in performance	4.72	*1.08*	4.12	*1.21*	4.15	*0.90*	4.45	*1.44*	4.48	*1.30*	4.60	*1.59*	4.92	*0.86*	4.85	*0.77*	4.25	*1.34*
	25	My coach emphasises that what I do in training and competition is far more important than winning	4.38	*1.16*	4.08	*1.23*	4.62	*1.12*	3.91	*1.54*	4.57	*1.14*	4.53	*1.06*	4.46	*1.20*	3.85	*1.41*	4.31	*1.14*
Holistic Quality Prep	2	I am rarely encouraged to plan for how I would deal with things that might go wrong	3.47	*1.68*	3.40	*1.41*	3.92	*1.12*	3.45	*1.41*	3.71	*1.39*	4.00	*1.73*	3.08	*1.44*	3.62	*1.50*	4.06	*1.53*
	5	My coach doesn't appear to be that interested in my life outside of sport	4.25	*1.44*	3.40	*1.65*	3.08	*1.32*	3.86	*1.73*	4.29	*1.31*	4.27	*1.49*	3.77	*1.30*	4.15	*1.35*	4.06	*1.44*
	10	The guidelines in my sport regarding what I need to do to progress are not very clear	4.16	*1.30*	3.80	*1.44*	4.23	*1.09*	3.41	*1.18*	3.90	*1.06*	4.53	*0.99*	3.62	*1.33*	4.46	*1.08*	4.44	*1.36*
	11	I don't get much help to develop my mental toughness in sport effectively	3.06	*1.66*	3.12	*1.37*	3.46	*1.33*	2.82	*1.47*	3.33	*1.46*	3.80	*1.66*	2.77	*1.74*	3.54	*1.65*	4.06	*1.06*
	12	My coach rarely takes the time to talk to other coaches who work with me	3.28	*1.55*	3.28	*1.48*	3.77	*1.42*	3.91	*1.69*	4.38	*1.46*	4.40	*1.76*	2.92	*1.50*	4.08	*1.38*	3.63	*1.50*
	13	My coach rarely talks to me about my well-being	3.28	*1.49*	3.08	*1.32*	3.46	*1.51*	3.50	*1.65*	3.86	*1.32*	4.20	*1.32*	3.92	*1.50*	3.85	*1.29*	3.75	*1.34*
	17	I am not taught that much about how to balance training, competing and recovery	3.28	*1.61*	3.44	*1.65*	4.85	*1.34*	4.18	*1.62*	3.90	*1.51*	4.93	*1.22*	3.77	*1.54*	4.69	*1.26*	4.75	*0.86*

Support Network	**1**	I can pop in to see my coach or other support staff whenever I need to (e.g. physiotherapist, psychologist, strength trainer, nutritionist, lifestyle advisor etc)	4.47	*1.34*	4.00	*1.30*	4.31	*1.11*	5.05	*1.46*	5.14	*1.21*	5.67	*0.62*	4.62	*1.61*	5.15	*1.17*	4.63	*1.63*
	7	Those who help me in my sport seem to be on the same wavelength as each other when it comes to what is best for me (e.g. coaches, physiotherapists, sport psychologists, strength trainers, nutritionists, lifestyle advisors etc.)	4.22	*1.26*	3.96	*1.54*	4.92	*0.95*	4.36	*1.26*	4.86	*1.04*	5.27	*0.70*	4.92	*0.86*	4.85	*0.95*	4.94	*0.85*
	9	Currently, I have access to a variety of different types of professionals to help my sports development (e.g. physiotherapist, sport psychologist, strength trainer, nutritionist, lifestyle advisor etc.)	2.94	*1.44*	3.40	*1.60*	4.92	*1.44*	3.50	*1.95*	4.48	*1.68*	4.73	*1.22*	3.92	*2.06*	5.00	*1.04*	4.75	*1.69*
	18	My coaches talk regularly to the other people who support me in my sport about what I am trying to achieve (e.g. physiotherapist, sport psychologist, nutritionist, strength & conditioning coach, life style advisor etc.)	2.75	*1.32*	3.12	*1.39*	4.15	*1.14*	3.14	*1.21*	4.19	*1.53*	4.53	*1.46*	3.62	*1.80*	4.31	*1.43*	4.44	*1.03*
Communication	**4**	My coach and I talk about what current and/or past world class performers did to be successful	3.28	*1.71*	2.92	*1.29*	5.00	*0.71*	3.68	*1.67*	2.29	*1.31*	4.20	*1.37*	3.23	*1.42*	2.54	*1.22*	4.38	*1.31*
	6	My coach and I regularly talk about things I need to do to progress to the top level in my sport (e.g. training ethos, competition performances, physically, mentally, technically, tactically)	4.19	*1.47*	4.32	*1.19*	4.38	*1.33*	3.91	*1.63*	4.76	*1.34*	5.07	*1.28*	4.62	*0.77*	4.46	*1.50*	4.44	*1.36*
	8	My coach and I often try to identify what my next big test will be before it happens	3.41	*1.50*	3.92	*1.29*	4.00	*1.53*	3.55	*1.65*	4.38	*1.25*	4.13	*1.25*	3.69	*1.03*	4.23	*1.05*	4.31	*1.20*
	21	My coach explains how my training and competition programme work together to help me develop	3.44	*1.46*	3.88	*1.37*	4.92	*0.49*	3.41	*1.68*	4.33	*1.28*	4.87	*1.19*	4.15	*1.28*	4.69	*1.28*	4.56	*0.81*
Alignment of Expectations	**3**	The advice my parents give me fits well with the advice I get from my coaches	4.50	*1.19*	4.40	*1.20*	4.46	*0.88*	4.50	*1.14*	4.76	*1.15*	4.53	*1.41*	4.85	*0.80*	4.38	*0.84*	4.88	*0.96*
	14	I regularly set goals with my coach that are specific to my individual development	3.19	*1.40*	3.24	*1.24*	3.69	*1.32*	2.91	*1.48*	4.19	*1.47*	4.20	*1.66*	3.23	*1.17*	3.69	*1.26*	3.69	*1.78*
	15	I am involved in most decisions about my sport development	4.59	*1.13*	4.32	*1.12*	4.92	*1.12*	4.36	*1.53*	4.76	*0.81*	5.20	*1.01*	4.62	*1.12*	4.85	*1.03*	4.69	*0.79*
	16	My coaches make time to talk to my parents about me and what I am trying to achieve	2.81	*1.40*	3.48	*1.53*	2.46	*1.27*	3.18	*1.59*	3.95	*1.53*	2.53	*1.19*	3.85	*1.52*	3.92	*1.21*	2.88	*1.75*
	24	My progress and personal performance is reviewed regularly on an individual basis	3.03	*1.58*	3.48	*1.53*	3.69	*1.11*	3.45	*1.68*	4.48	*1.18*	4.27	*1.39*	3.69	*1.18*	4.31	*1.14*	4.75	*1.24*

4.4 Discussion

This chapter explored a complex national female team sport TDE and the coherence, or lack of across the school, club and national contexts from the perspective of young female players so areas requiring attention in the TDE could be identified. Reflecting the objectives set out in Chapter 1, this chapter aimed to analyse quantitative data through the TDEQ-5 of young female team sport athletes (objective 2a) and identify and understand areas of the TDE that could be improved upon (objective 2c). Explored previously in Chapter 2, it is common in national team sports that young high potential athletes develop towards the senior national team whilst simultaneously engaged in other environments (school, club, regional), each impacting their development experience and progression as an international athlete (Sweeney et al., 2022). This chapter provides insight into young female hockey players' experience across these different contexts in the TDE, navigating multiple coaches, teams and demands on their pathway journey.

The results outlined In this chapter highlight the TDE strengths and areas for improvement across these specific TDEs contexts and how these vary between age groups. The results demonstrate that the long term development of players is a positive feature of this NGB's TDE. Though the long term nature of training was perceived strongest at the national level by all age groups, it was evident that all stakeholders place emphasis on long term aims, for example allowing mistakes to happen *(item 22)* and without letting performance dips to affect playing opportunities *(item 23)*. This generates a focus on future development over immediate success, a common positive feature of other successful TDEs with male populations in the literature (Larsen et al., 2013; Mills et al., 2014).

Singing off the same Hymn Sheet (part 1)

Research indicates a good support network in conjunction with a long term development focus can positively influence intrinsic goal striving and intrinsic motivation (Wang et al., 2011). In this TDE players across all age groups experienced greater support networks and communication with their coaches regarding their performance at the national level. Players of all age groups perceived their national coaches to be on the same page compared to the school or senior club level *(item 7)*. Additionally, communication plays a big role in player development, particularly for females who place great importance on communication (Siekańska & Wojtowicz, 2017). It was clear from the results that communication between coaches and players aimed at helping athletes develop towards the future was perceived strongest at the national level for all age groups.

The multiple contexts these players must navigate to reach their potential should be coherent with a shared understanding of the development needs and processes (Bjorndal & Ronglan, 2018; Webb et al., 2016). As outlined in Chapter 2, the alignment of expectations among stakeholders is therefore an important feature of high quality TDEs. The results here were mixed across contexts. Players indicated that their parents often give them advice that fits with what they hear from their coaches from each context, yet a perceived area requiring improvement was the lack of communication between coaches and parents about their development *(item 16)*, similar to findings in male football academies (Mills et al., 2014). Interestingly this appeared lowest at the national level for all age groups, suggesting few relationships develop between national coaches and parents. This is a key area requiring improvement given parents are an important stakeholder to consider for players to achieve optimal performance development (Collins & MacNamara, 2022; Mills et al., 2014).

A further area highlighted across all contexts was the lack of time spent by coaches setting individual goals with players *(item 14)*; this was perceived particularly low at the

school level and highest at the national level, albeit still an area requiring improvement across all age groups and contexts. Individual goal setting and development is an important area requiring improvement across all contexts in this TDE since research relating to high quality TDE experiences highlights the need for attention to individual development which in turn assists positive performance progress (Ivarsson et al., 2015).

The lowest performing characteristic across contexts and for each age group was the holistic preparation of players. The holistic and systematic nature of successful TDEs has been well established in the literature (Aalberg & Saether, 2016; Henriksen et al., 2011; 2010a; 2010b; Larsen et al., 2013). Successful TDEs spend time developing resources and tools to allow athletes to utilise psycho-behavioural skills to navigate the pathway to the top. Contrastingly, in this TDE the TDEQ-5 results highlighted that players of all age groups felt there was a lack of support in developing mental toughness *(item 11)* across all contexts. However, players' experience of developing mental or psychological toughness appeared to increase from school to senior club to national level and experiences at national level from U16 to U21 age groups, yet still remains an area in need of improvement across the TDE, similar to findings in another female TD pathway (Simpson et al., 2022). Additionally, the results suggest that players were not often prepared to deal with times when things may go wrong *(item 2)*, particularly noted by U18 and U21 players at the senior club and national level. In response to this, later in this thesis, Chapter 6 investigates the presence, or indeed the lack of psychological skill development in this cohort of athletes, exploring what, if any, psycho-behavioural skill development is incorporated in the TD pathway, either organically or through structured learning.

The poor holistic quality preparation of players across all contexts and age groups within this TDE is a key characteristic requiring improvement that could be achieved through,

for example, a systematic approach to the teaching, testing and refining of the psycho-behavioural skills that support athletes' ability to navigate their pathway (Collins & MacNamara, 2017; Taylor, Ashford & Collins, 2022). Crucially given the need to ensure that athletes can successfully transfer out of a TD pathway, psycho-behavioural skills have been shown to be applicable across contexts in supporting athletes to optimise competition and training opportunities but equally applicable to other areas of life (Collins et al., 2019). Facilitation in the development of these transferable psycho-behavioural skills can assist in an athlete's autonomous navigation of the pathway (Hauser et al., 2022; Lundqvist et al., 2022; Ryom et al., 2020), particularly in a complex system where athletes experience multiple different teams, coaches, expectations and development challenges.

Lastly, the TDEQ-5 demonstrated a lack of focus on player well-being *(item 13)*, another low reported area, especially by the U18 and U21 players in both the senior club and national playing contexts. Psychological well-being is a key factor in successful TD with high quality TDEs associated with greater reported levels of well-being (Hauser et al., 2022; Ivarsson et al., 2015). It is therefore important that coaches in this TDE place more emphasis on this area, increasing interaction with players regarding their well-being.

4.5 Conclusion

It is clear that some contrasts and similarities exist between the multiple contexts that form this national hockey organisation's TDE. Indeed there are positive characteristics evident across all stakeholders; a focus on long term development, good surrounding support networks and communication between coaches and players. However, there is much less focus on individual attention, player well-being, and holistic development in addition to communication between coaches and other important stakeholders across the multiple

contexts. The latter demonstrates a big gap in this TDE. Webb and colleagues (2016) highlight the importance of coherence between stakeholders for the successful transition of players through the pathway (outlined earlier in Section 2.1.5). Additionally, further attention to the holistic preparation and individual player development of young athletes in a coherent and systematic manner across all development contexts could improve players' experience of this TDE (Aalberg & Saether, 2016; Henriksen et al., 2011; 2010a; 2010b; Larsen et al., 2013; Taylor, MacNamara & Taylor, 2022). Further, communication between coaches and players regarding development was strongest at the national level, while an area requiring improvement highlighted in some age groups was the communication between coaches across developmental contexts (Taylor, MacNamara & Taylor, 2022). An additional area that requires improvement includes the alignment of expectations between the stakeholders and the national age groups.

A critical reflection of this study points towards the quantitative enquiry used and the shallow detail learned through the TDEQ-5 process, even though multiple contexts were explored. However, this chapter's study has provided an indication of the facilitators and derailers that are evident in this TDE in addition to providing a snapshot of the TD system and level of coherence amongst the important stakeholders, highlighting the areas that require improvement. A more detailed insight would help to better understand the systems and processes in place throughout this complex TDE. Therefore, in Chapter 5, a qualitative approach was adopted to gain rich insights from the perspective of young athletes and to triangulate against the quantitative data provided here. This mixed methods approach across Chapters 4 and 5 should provide greater insights into athletes' perceptions of the TDE and how a lack of an integrated systematic approach and poor coherence impacts development. Chapter 5, therefore, provides a follow up study, aiming to expand on this chapter's findings

with rich qualitative insights into how these athletes view their ability to navigate the current derailers and barriers on their pathway journey through this complex TDE. Additionally, it investigates the opinion of pathway practitioners regarding the same to create a more rounded view of the TDEs successes as well as failings or inefficiencies.

Chapter 5: Singing off the same Hymn Sheet? Examining Coherence in the Talent Development Environment (Part 2)

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5.1 Introduction

This thesis was underpinned by a pragmatic approach, aiming to use research to answer practical questions in applied contexts as noted in Chapter 1 (Feilzer, 2010). Chapter 4 brought to light the weaknesses or gaps that were apparent following analysis of the TDEQ-5 in a female national team sport TDE. Critically, analysis of the TDEQ-5 results are open to interpretation based on research bias unless research triangulation is used for example to gather a deeper insight and understanding of the results from the participants (Giacobbi et al., 2005). Reflecting my philosophical underpinnings as a pragmatist the TDEQ-5 analysis did not satisfy in providing enough detailed information regarding the workings of the TDE, how it operates, is influenced or guided in order to inform future practice. Further exploration of the themes explored through the TDEQ-5 was warranted. Considering the quantitative nature of Chapter 4, a mixed method approach appeared the most suitable means to gain a richer perspective of the phenomenon under investigation (Feilzer, 2010; Giacobbi et al., 2005). Therefore this chapter describes a qualitative investigation using semi-structured focus groups to provide a platform for pathway players, coaches and other pathway staff members to articulate their interpretations of the TD processes and TDEQ-5 factors explored in Chapter 4. It was important to consider the athletes' perspectives in more detail and additionally it was as important to gain deeper insights into the workings of the TDE from other

perspectives, specifically the pathway staff members to provide a varied, clear and broad understanding of how the TDE operates across the multiple playing contexts.

In Chapter 2 the POP principle (Performance-Outcome-Process) was outlined as an approach to help understand how coaches and other pathway staff make choices about why they do what they do on the TD pathway (Collins et al., 2019). Clearly in an ecosystem as varied as a national team sport TDE, not all coaches and practitioners will operate with the same philosophy, coaching style, expectations or training environment. Indeed, variation in coaching styles and environments can be conducive to providing a blend of experiences to a young high potential athlete (Webb et al., 2016). Importantly, it is the degree of variation that has been found to matter. The coaches and stakeholders operating across multiple contexts or sub-systems within the TDE must be aware of what they are trying to achieve, both within their own environment and outwith that environment, considering the broader picture for the young development athlete.

The literature describes how an optimal level of variation is a desired element of the TD pathway where young development athletes experience a “ping-pong” variation of coaching styles, challenges, feedback, and experiences (Webb et al., 2016, p. 1801); this “ping-pong” bandwidth of experience should ensure that young athletes receive inputs from coaches, systems and environments that are not too different or too similar. Instead, Webb and colleagues (2016) describe a ‘goldilocks’ approach which provides athletes with enough variation to keep them challenged and progressing without creating too much confusion, too high challenge and too low assistance or support. As an example, when development athletes receive various and contradictory feedback from multiple sources, a likely occurrence in a team sport TDE where athletes are involved across multiple playing contexts, the athletes will apply their own weighting to the feedback (Taylor et al., 2021). When this occurs at early

stages of the pathway, these athletes may lack the sensemaking skills (Taylor et al., 2021) to take multiple sources of feedback on board, and their own judgement regarding what feedback to which they give most attention may be skewed. Too much contradiction across contexts could bring about too varied experiences and an undesired bandwidth of experience that the athlete cannot cope with nor of which they can make sense.

Each coach and practitioner will undoubtedly fulfil their duties in line with their own philosophy and style and inevitably create varied experiences for development athletes, i.e., varied processes across contexts that align to the performance goal and outcomes set by the NGB are encouraged to provide this blend of variety that is a positive feature (Webb et al., 2016). This is considered positive as long as it is not too varied, too different or contradictory but critically is consistent with the system's objectives overall. Alignment towards the process markers or outcomes endeavours to streamline the development experience closer to the 'goldilocks' approach, where the processes deemed appropriate in meeting these objectives fit a bandwidth, thereby practitioners can align with the performance goal and outcomes set out by the NGB while applying their own coaching systems and values in their specific context (i.e., varied experiences) (Bjørndal & Ronglan, 2018; Collins et al., 2019). Furthermore, communication, interaction and flexible adaption to support athletes navigating the TD pathway are crucial for success (Bjørndal, et al., 2017; Taylor, MacNamara & Taylor, 2022).

Chapter 4 began the enquiry into the coherence and alignment of the operations in a female national team sport TDE, however, lacked detail and the richness required to provide an in-depth understanding. Therefore, the aim of this chapter was to gain deep qualitative insights into the TDE based on the themes presented in the TDEQ-5 used in the previous chapter. Of particular interest was the extent to which the various stakeholder groups were considered to be systematic, cohesive and collaborative. In order to gain this insight, players

and pathway staff members from across the TDE pathway participated in semi structured focus groups.

5.2 Methods

5.2.1 Research Philosophy

Reflecting the philosophical underpinnings outlined in Chapter 1, this study in particular showcases my pragmatic research philosophy. I was particularly interested in using a mixed method approach, thereby building on the previous quantitative findings and using qualitative methods to further examine stakeholders' perceptions of the strengths and weaknesses of the broad TDE in which they operate. In line with my pragmatic philosophy this shaped all aspects of the research process including the aim of the study (i.e., practical solutions to a meaningful problem), the function of theory (i.e., the use of the TDEQ-5 to support the qualitative process), the role of the researcher, and criteria for evaluating research. Pragmatism maintains that researchers are not passive observers; I have experience working with TD pathways and in particular this context, and additionally, throughout the research, I pulled on these and on the experiences of my supervisory team acting as critical friends to facilitate novel and innovative insights (Bryant, 2009). This positioning provided the platform for a detailed enquiry, allowing me to combine my applied experience in TD with relevant literature, considering myself as a co-constructor of knowledge, attempting to generate meaningful information to better inform practice and apply the learnings in female team sport TDEs.

5.2.2 Participants

Twenty-seven national junior age grade (NJAG) female hockey players (mean age = 17.96 ± 2.58 years) and fourteen pathway staff members (e.g., coaches and support staff (e.g.,

sport science support, team managers)) of school, senior club, provincial (regional) and NJAG teams (mean age = 37.36 ± 8.21 years) were purposefully recruited to participate in semi-structured focus groups (n=7; player focus groups n=3, pathway staff focus groups n=4). Players were recruited as they were part of the NGBs NJAG teams that form the TD pathway (player focus groups; U16 n=9, U18 n=8, U21 n=10) while simultaneously playing on provincial, club and/or school teams.

The pathway staff members were recruited given they had experience within and across the TDE and in order to initiate detailed stakeholder understanding throughout the TDE while examining alignment and coherence. The pathway staff focus groups consisted of coaches and pathway support staff from each NJAG team, ten coaches with a mean of 14.17 (±5.61) years coaching experience, and four support staff members (e.g., sport science support, team managers) with a mean of 6.5 (±1.73) years of pathway support staff experience, (pathway staff focus groups; U16 n=2, U18 n=5, U21 n=4; coaches representing school and senior club only views n=3). The lower number of non-NJAG team coaches reflects the nature of the coaching experience of those involved with NJAG teams, where these participants also had vast experience coaching in school, senior club and provincial hockey while developing the experience to acquire their national role.

5.2.3 Procedure

Ethical approval was obtained from the university's ethical review board. Participants were informed about the study and ethical issues prior to the focus group meetings. Each participant provided informed consent, and in the case of those under 18 years of age, consent was also obtained from a parent/guardian (Appendix A6). The focus groups lasted on average for 61 minutes, excluding the introduction and debrief. All focus groups were conducted by the first author via an online meeting software (Zoom). Focus groups were

conducted with players and pathway staff members separately, and with each playing group independently. The focus group guide was refined and developed as the data collection progressed (Appendix A7 and A8). The interview format consisted of primary questions, probe questions and follow-up questions to ensure an accurate understanding of responses. Data were recorded and transcribed verbatim with participant names changed to pseudonyms.

The focus group question guide for players and for pathway staff was based on the five factors outlined in the TDEQ-5, i.e., long term development, holistic quality preparation, support network, communication, and alignment of expectations (Li et al., 2015). A pilot focus group consisting of five team sport athletes under 21 years from different sport teams was first conducted to check the flow of questions and the participant interaction and conversation sharing in response to the questions asked. This allowed for the question guide to be redefined as needed before data collection. Players were questioned about their experiences across school, senior club and international hockey and the coherence of approach between each. However, the provincial level was also added to the focus group conversation due to participants in the early focus group reflecting it as being part of the process of bridging the gap between school and club level to national representative hockey.

5.2.4 Data Analysis

Due to the exploratory nature of this investigation, an inductive-deductive reflexive thematic analysis approach (Braun & Clarke, 2006; 2019) was employed. This process of analysis included: (a) a familiarisation phase where the transcripts were independently and critically studied by the research team (b) data coding phase where the data were organised in a meaningful and systematic way (c) initial themes were generated by clustering codes to identify higher level patterns (d) a constant comparative process to review and develop themes with careful collaboration, discussion and reflection between myself and the

supervisory team (or 'critical friends') until consensus was reached about the themes' content I the themes were refined, defined and named with an emphasis on considering the relationships, interconnections and boundaries between the themes and to check they were identifiable within the whole data set (f) a deductive analysis was then conducted to examine the lower-order themes in relation to the features of effective TDEs outlined by Martindale et al. (2005; 2007), i.e. long-term aims and methods; appropriate development, not early success; individual and ongoing development; wide ranging, coherent messages and support.

5.2.5 Trustworthiness

Several steps were taken to address the trustworthiness of the data collection and analysis procedure. Considering the nature of reflexive thematic analysis, it is important to note my role as a scientist-practitioner aiming to use research to inform practice, though of course, my practical experience in TD created some subjectivity during data analysis (Braun & Clarke, 2019). Attempting to account for this in addition to the data being triangulated, the process and outcomes of interviews were shaped by trust and rapport with the participants (Sparks & Smith, 2009). These features were enhanced by a) my role in the sport in which the participants were involved and therefore the knowledge of their sporting environment, and b) my awareness of the issues being discussed. Reflecting best practice recommendations (Smith & McGannon, 2018) trustworthiness was enhanced as all participants were contacted to gather their reflections on the data collection, having been sent a copy of the transcript from their individual focus group. All participants perceived the data to be representative of their experiences with one participant offering an additional piece of information.

Peer debriefing occurred throughout the thematic analysis with the supervisory team acting as critical friends through challenging data interpretation (Creswell & Miller, 2000).

Where alternative coding was suggested, discussion occurred until an agreement was reached.

The use of a reflective diary throughout the data analysis procedure helped to further ensure the interpretations of the data were transparent and consistent. Acknowledging my role, previous experiences in TD and assumptions of the TDE influenced my interpretation of data, and ongoing critical reflection with my supervisory team assisted in generating themes that were representative and consistent with the data.

5.3 Results and discussion

Reflecting the objectives set out in Chapter 1 and adding to the information discussed in Chapter 4, this chapter explored the same complex national female team sport TDE and the coherence, or lack of across the school, club, provincial and national contexts. To support the results from Chapter 4 this chapter aimed to analyse qualitative insights into the female team sport TDE from the perspective of young female athletes and pathway staff members using semi structured focus groups based on the themes presented in the TDEQ-5 (objective 2b) to provide a more detailed and rounded view of the areas requiring attention in the TDE (objective 2c). Such information allows evidence informed suggestions towards areas in the TDE that could be improved upon**.** Accordingly, and reflective of the higher-order themes, data are presented under the features of effective TDEs that were identified in the data analysis. Exemplar quotations are used throughout and, in all cases, are marked as P=player, C=coach or S=support staff followed by an assigned number depending on the participant. It was felt appropriate to present the results with accompanying discussion so that a connection can be readily established between the findings of this study and the literature.

5.3.1 Long-term aims and methods

Throughout the data there was consensus that a focus on long-term aims and methods existed in the TDE, in line with findings from Chapter 4. Most participants agreed that across all contexts the goal is to develop players towards potential senior national representation:

> *"the coaches are always talking about next year, … always bring in something about the senior team"* (P13)

The NJAG coaches try to help players understand what they need to aim for and to think about their future development. C5 typified this by stating that, you are always trying to *"produce a good crop of players who are capable of stepping up to the next level"*. At lower playing levels the coaches described how they try to push the players towards higher representation; *"encourage the girls to go for trials"* (C13). Despite this seemingly harmonious long-term desire, there was evidence of misalignment between the stakeholders across the TDE contexts, often leading to *a siloed approach*:

> *"I don't think at school they see themselves as part of that pathway and I don't know if everyone feels that they're a stakeholder in the pathway … we're all kind of separate, I don't think there's that clear alignment through it all*" (C2)

Additionally, evidence suggested that some school and senior club coaches *"think that their team is the most important"* and that "*I don't think he cares, even if it wasn't an important game he would still play me for the full game"* (P15). Although the literature recommends players experience different coaching styles, challenges and environments to aid their development and allow for the necessary "ping-pong" (Webb et al., 2016), it is important that coaches understand the bigger picture outside their own environment. Horizontal alignment across contexts should allow a fluid pathway, with varied processes designed to suit the player and contextual needs, yet aligned to the pathway outcome variables leading to

coherent and systematic player development, seen elsewhere in the literature (Bjørndal et al., 2017; Costello et al., 2022; Larsen et al., 2020; Mathorne et al., 2020). Results from Chapter 4 indicated the alignment of expectations factor was the lowest performing factor and thereby the area requiring the most improvement in the TDE. Similarly results from this chapter suggest the coherent and systematic development was not evident with the *siloed approach to player development* further extending to the quality and consistency of the feedback players receive from their different coaches across the various contexts. Similar to other complex team sport TDEs (Bjørndal & Ronglan, 2018; Taylor & Collins, 2021) players described receiving contrasting and often conflicting development advice from different coaches:

> *"somebody was telling me one thing and then I was getting told something different and then they didn't like the idea, so one coach didn't like an idea of another coach"* (P16)

The influence of this advice had short term impact, with players changing the way in which they played and adjusting their performance depending on the coach working with them on a particular day:

> *"I would end up having to tailor my performance depending who I was training or playing with at the time, which obviously wasn't helping at all because I wasn't able to develop anything properly"* (P18)

The *siloed approach to player development* is further exacerbated within the TDE because coaches hold perceptions about other coaches as "*having egos*" (C1) or as "*not willing to take on board what the other has to say*" (C2). There appeared to be a lack of a 'community' or 'network' of coaches with almost all pathway staff members describing the environment as "*insular*" with "*coaches not wanting to have conversations with one another*"

(C10). This lack of a clear system and unified direction drove coaches to work in isolation, even though there was a recognition that this was not best practice:

> "*other European environments that I've seen have coaches that go mingle, they go in between each programme, they go up, down, and they go all over the place, but there is a clear direction and directive that they have to work towards,"* (C3)

Interestingly, coaches and pathway support staff shared the perspective that little direction was provided by the NGB which resulted in *a lack of coherence between stakeholders across contexts* as a consequence with a perceived void in who was charged with ensuring a consistent direction in performance goal, approach and mindset across and between development contexts (Bjørndal & Ronglan, 2018; Henriksen et al., 2014; Lundqvist et al., 2022; Mathorne et al., 2020).

5.3.2 Appropriate development, not early success

The lack of systematic joined-up thinking, as well as a disconnect between coaches further extends to the performance measures set by each playing group in the TDE. At school, club and some provincial level teams there was a perceived focus on *early success* with an emphasis on winning now over individual development or long-term progression:

> *"school and club, definitely the main focus is winning, and provincial as well, there's not any development, but international I think they want to develop you because you're going to be playing international longer"* (P16)

This echoes results from Chapter 4 where long term development had higher scores reported at the national level compared to the club and school context. When players moved into provincial and national levels there was a stronger emphasis on *future development.* This was especially evident at NJAG:

> *"they were like guys it doesn't really matter what the score is because all we're looking for is to see that you learned from yesterday, which is really good"* (P5)

Despite the emphasis on *future development* at NJAG, pathway staff members and players had different perceptions regarding the performance goals and outcome measures of the pathway stages. The data suggested that U16 outcome measures were perceived by the players as "*needing to win*" international tournaments with P13 noting that *"it's quite focused on six nations in the summer".* The objective of the U18 programme appears to alter depending on the year they were in (based on bi-annual European championships):

> *"it's [this year] been about trying to develop a smaller group that's more outcome driven, whereas the year before, we had a larger group that was built towards trying to develop skill sets as best we can to send a larger group of players up to [U21s head coach]"* (C3)

The U21 players reported the outcome measure of their national programme was focused on "*developing for the future"*:

> *"I was on the development panel and I knew I wasn't going to make it, but the U21 coaches were still as interested in me … I still took part in all trainings, still did the strength and conditioning and I definitely improved a lot that year and I didn't go to any tournament"* (P21)

As the system controller, the NGB is responsible for defining its programme objectives and outcome measures (Collins et al., 2019), a lack of direction appears to have rendered a mismatch between the outcome measure of the programme stages. These contrasting participant perceptions illustrate a lack of consistent systematic alignment and coherence reflecting a gap between what happens and what is recommended in the literature, as seen

already in Chapter 4 (Aalberg & Saether, 2016; Larsen, et al., 2013; Taylor, MacNamara & Taylor, 2022).

5.3.3 Individual and ongoing development

The data highlighted that *individual development* was more evident in the NJAG settings and featured less at club, school and provincial levels, where team performance dominated:

> *"I think with interprovincial or club, they like to get the team better, but it's not a long-term goal it's just for the season. I think for [national] training, that is definitely to get individually better but, as well as a team, both"* (P14)

Participants described an individualised developmental approach at NJAG level with coaches using national training camps and even international competitions to support and interact with players in terms of development plans and individual feedback:

> *"you've more time during the tournament on their rest day, we sat with [the players] individually and gave them feedback, what they did really well*" (C1)

Notably this individual developmental and personal feedback within NJAG contexts becomes more detailed and individualised as players progress through the pathway:

> *"I'd say it's probably mostly [U21 head coach], he does an individual development plan for everyone. So when he had those individual meetings, he sat down with me and it was really focused on things that I definitely needed to improve on and I also had to come up with three things that I was currently doing well that I still wanted to develop"* (P21)

Since a prominent feature of successful TDEs is the focus on the individual (Henriksen et al., 2010a; 2010b; 2011; Ivarsson, et al., 2015), it is important that the NGB considers how to support pathway staff members to focus on individual development across all developmental environments.

Additionally and reflecting findings in Chapter 4 where the inclusion of psychological skill development was perceived as a weakness of the TDE and requiring improvement, as is reflected in another female TD pathway (Simpson et al., 2022), though all pathway staff members recognised the importance of *psychological skill development*, the data highlighted that little emphasis is placed on developing the psycho-behavioural skills needed to support players in navigating the pathway. This is in contrast with the literature that states the importance of developing psycho-behavioural skills, such as PCDEs to assist youth athletes with making the most of the development opportunities they are afforded (Larsen, et al., 2014; MacNamara, et al., 2010b). The greatest exposure to *psychological skill development* seemed to occur in the U21 NJAG where a sports psychologist works with the players throughout the year, educating and providing situations for the practical development of psycho-behavioural skills. This appeared pivotal in helping players to understand and develop resilience, react to failures, and remain positive on the pitch with P21 stating how:

> *"she [psychologist] just went through beforehand how to deal with the pressures of a tournament and the ups and downs that it brings and she also brought us closer together as a team"*

Assisting youth athletes to develop psycho-behavioural skills such as PCDEs is important to help them cope with, and manage the pressures and lifestyle demands encountered as they progress through the TD pathway and are a discouraging omission from the other NJAG teams and contexts across the TDE (Holt & Dunn, 2004; MacNamara et al., 2010b). This omission prompted a follow up study using the PCDEQ2, which will be detailed in Chapter 6.

5.3.4 Wide ranging, coherent messages and support

Coherence and communication are essential for effective TD (Aalberg & Saether, 2016; Bjørndal & Ronglan, 2018; Mathorne et al., 2020; Taylor & Collins, 2021). Both pathway staff

members and players highlighted that while some level of communication exists both horizontally and vertically, it was largely unplanned and did not promote integration and alignment between contexts. Similarly results in Chapter 4 indicated a lack of communication between stakeholders, where this item was a highlighted area requiring improvement. Where *communication between stakeholders* did occur it was described as 'firefighting' and centred around logistical issues such as training load and fixture clashes rather than broader development or coaching issues:

> *"I think there would only be communication if something clashed … that was the only reason he'd communicate with one of the coaches, if he wanted me to play a match and not go to training"* (P14)

Reflecting the ad hoc nature of the TDE the coaches felt they were only likely to have conversations with other coaches where an established relationship existed. C10 typified this by stating:

> *"because I know them very well, WhatsApp's, phone calls are easy to do. I've touched base with him about a few players that he was interested in me taking a bit of a look at and maybe suggesting to [U21 head coach] a bit more, but that's just because I know him"*

As discussed previously, the participants perceived a lack of direction and support from the NGB. Consequently, the NJAG coaches felt they were not supported sufficiently and do not receive sufficient direction from the NGB regarding their programme role as TD coaches. The coaches' perceived a lack of a 'top-down' approach leading to a lack of coherence and a paucity of conversations between the NGB and coaches on the pathway:

> *"how much structure comes from above? How much structure comes from a high performance committee or a senior head coach down through 21s? What are the*

21s looking for, what are the seniors looking for so that what do the 18s need? What does a senior player or what should a senior player look like when they're leaving an 18s programme at both [province] and [international] level? I haven't really seen that in place" (C4)

As a result of the *negative support* and lack of direction from the NGB, participants described gaps in the technical, tactical, and physical development of players on the pathway, again contrasting the need for this encouraged in the literature (Collins et al., 2019; Larsen et al., 2020; Taylor, MacNamara & Taylor, 2022). This is not unlike other pathways, where Morley et al. (2022) suggest the development coaches in their study expressed a desire to be supported and guided in creating and maintaining coherence between stakeholders. Similarly, the NJAG coaches in this study felt the NGB could provide a framework to empower coaches to reach out and work with other coaches across the multiple contexts:

"*I'd love to be empowered to have more interaction with interprovincial programs, have more interaction from them, from that development stage where you get to see maybe what they're like … I think it would give us more of a whole picture, I think it's more so that there needs to be empowerment from above that says, look you guys have to go out and help with these interprovincial programs, help with these players, help build a programme and skill set towards an [international] level*"(C3)

Additionally, the school and club coaches shared similar feelings and felt a lack of recognition from the NGB as being a part of the TD process, working towards the same development goals:

> *"Certainly not from my experience, where as a national body they're trying to make everybody feel we're working towards the same objective … everybody's doing their own thing*" (C14)

5.4 Conclusion

Considering the complex nature of team sport TDEs where multiple contexts co-exist (school, club, provincial, national), it is important to note the positive features of this TDE. In line with the study in Chapter 4 there was agreement among participants that the long-term development of players is at the forefront of pathway staff members and subsequently players' minds, a common feature of effective TD (Martindale et al., 2010; Henriksen et al., 2010a, 2010b). Additionally, while a shared perception of the presence of individual development existed, it is more prominent at the NJAG level. In line with findings in Chapter 4, a less positive feature of this TDE was a paucity of effective communication between coaches across contexts with a significant gap identified in addressing players' individual development needs. Of course time constraints at the lower playing level contexts; club and school, make it difficult for coaches to give time to individual attention. However, the siloed approach to player development was exacerbated in this TDE by mismatches regarding the performance goals, outcome measures and processes (POP principle; Collins et al., 2019) that reflect the NGB pathway stages. Though varied experiences across contexts are welcomed (Webb et al., 2016), if the NGB outlines the TDE performance goals at each stage of the pathway, the outcome measures set to achieve these and guides pathway practitioners and other coaches to align to these objectives greater coherence across the TDE should result (Taylor, MacNamara & Taylor, 2022).

Crucially, there was a shared perspective among pathway staff members of a lack of clear direction provided by the NGB in this study. NGBs should strive to create a coherent, systematic approach to player development (Taylor, MacNamara & Taylor, 2022). The clear disconnect evident throughout the TDE is a reflection of a lack of direction or a 'top-down' NGB approach, without an opportunity for bi-directional open communication (Taylor, MacNamara & Taylor, 2022). The apparent non-existence of a defined TD system or set of guiding principles and processes requires improvement if this TDE is to become more effective in developing future successful international athletes. Furthermore, the NGB can encourage fluidity, independence, own coaching styles and therefore variety in the processes used to meet the set outcome measures across contexts (Collins et al., 2019), yet require communication between and within contexts concerning individual athletes to assist coaches across the TDE in supporting high potential young athlete development (Bjørndal & Ronglan, 2018; Taylor & Collins, 2021; Webb et al., 2016).

Throughout this study it is apparent the results reflect similar findings to Chapter 4, however the value of including this qualitative information from both the athlete and pathway staff members perspective is key in providing richer quality information to allow better detailed practical solutions be recommended for the NGB. The insights provided by the coaches and other pathway staff members supplemented the data from Chapter 4 to allow for a deeper understanding of the disconnect within and across the TDE and the lack of direction provided by the NGB. The quantitative data from Chapter 4 alone though informative is benefited with the additional richer information that shares perceptions from the TDEQ-5 allowing for the triangulation of that data. Additionally it provides greater insights regarding the areas that require the most support and attention if practice is to be improved to reflect research best practice guidelines (Martindale at al., 2010).

The lower talent pool and shorter provincial window in this TDE means a higher proportion of players will transition from the lower playing levels (club and school) directly to national representative programmes (Figure 1.4) (Andrew et al., 2022; Götze & Hoppe, 2021). Unlike male professional academy structures where an introduction to a high performance environment, TD processes and link to senior team practices is common (Costello et al., 2022), female team sport TDEs lack the resources, staffing and structures to mirror this bridging setting (Emmonds et al., 2019; Simpson et al., 2022). Reflecting this, the female team sport TDE in this study requires particular attention on the systematic development of players and the coherence required in assisting the process. Though it appears the NGB has less control or direct influence on the lower domestic levels, the influence of these contexts in preparing young high potential athletes for the transition to national representation is clear and the NGB should support better coherence and alignment in the TD process. It may be that it requires a different TD curriculum (Taylor & Collins, 2022), however two key variables requiring attention in the TDE to assist achieving quality preparation and successful transition through the pathway are psycho-behavioural skill and physical development (Collins & MacNamara, 2022; Williams & MacNamara, 2022).

Of interest in this study and also highlighted in Chapter 4 was the discovered lack of psycho-behavioural development for players throughout the pathway, especially at NJAG level, unlike other successful TDEs (Henriksen et al., 2010a; 2010b; 2011; Larsen et al., 2014). Psycho-behavioural skill development is beneficial in supporting athletes to develop skills to assist them to navigate the challenging journey towards the senior elite level. The natural ebb and flow in development, progression and challenge encountered on route to the top makes the possession of psycho-behavioural skills, i.e., PCDEs desirable to allow young athletes better cope with the rollercoaster of uncertainty and difficulties they face (Collins &

MacNamara, 2012; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2021b). As such Chapter 6 set out to investigate what level of psycho-behavioural skill development, if any, is included in this specific TDE and if so, what is included at each pathway stage? What PCDEs are common in the TDEs senior national level athletes and are these being developed either systematically or organically throughout the TDE?

Chapter 6: Psychological Characteristics for Developing Excellence (PCDEs), a consideration in the TDE

6.1 Introduction

Throughout this thesis the multidimensional nature of TD has been reiterated. The benefit of including psychological skills and behaviours in the development of young high potential athletes was already highlighted in Chapter 2 (Section 2.4), and the teach-test-tweak-repeat approach as a possible means for embedding the learning of these psychological skills and behaviours, i.e., PCDEs, in development contexts (Collins & MacNamara, 2017). A list of PCDEs has been outlined in Chapter 2 (see Table 2.1). The qualitative findings in Chapter 5 highlight that the high potential young athletes in the TDE studied clearly understood the potential benefit of psychological skill development but recognised its lack of inclusion in their TD pathway.

To reach the elite senior level young high potential athletes are pushed to attain high levels of physical ability i.e., strength, power, speed, and fitness (Burgess & Naughton, 2010; Burgess et al., 2012; Vescovi, 2016; Watts, 2014). Additionally, TD pathways aim to progress athletes' technical skills and tactical awareness to superior levels (Doncaster & Unnithan, 2019; Forsman et al., 2016). The journey from junior development level to the elite senior national level is challenging, difficult, accompanied by failure and sometimes under performances and losses (Collins & MacNamara, 2012; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2021b). Indeed it is not an easy journey to reach such high levels of performance and literature suggests high potential young athletes that do not quite make it to the top attribute their failure to reach their potential to a lack of psychological skills e.g., commitment, perseverance, coping with pressure (Collins & MacNamara, 2017; Taylor &

Collins, 2019). Critically, the crux of failing to include psychological skill development such as PCDEs might only be recognised when athletes reach the tail end of the pathway; previously explored in Chapter 2 (Gledhill et al., 2017; Larsen et al., 2014; Taylor & Collins, 2021b). A young high potential athlete can lean on PCDEs such as self-awareness, focus and distraction control and commitment to push through the difficult and challenging training blocks, and possible failures or underperformances they may experience (Collins et al., 2016b; Laureys, et al., 2021; Taylor & Collins, 2012b). To encourage coaches and practitioners to support the inclusion of PCDEs on the TD pathway it is important the NGB educates pathway coaches and practitioners on the benefit and inclusion of PCDEs to young high potential developing athletes and TD programmes (Collins & MacNamara, 2017; Taylor & Collins, 2019).

Taylor & Collins (2021b) noted young athletes with an ability to cope with pressure and emotional disturbances are given more opportunities to play up with higher playing levels. Additionally, Elferink-Gemser and colleagues (2007) assessed young male and female athletes in a successful national hockey organisation on a multitude of variables; anthropometric, physiological, technical, tactical and psychological. The results indicated the greatest difference between the elite and sub-elite young female athletes could be attributed to higher levels of motivation and confidence in the elite cohort (Elferik-Gemser et al., 2007). In another example already outlined in Section 2.4.4 a study by Edwards and colleagues suggested differences existed in the PCDEs present in female players that were selected and not selected to a national pathway programme (Edwards et al., 2022). Despite these studies, Chapter 3 highlighted the lack of research on female athletes across TD and this is mirrored in terms of psychological factors. This is interesting as there is already research that points towards gender differences in psychological skills and behaviours. For example, males and females appear to apply varied coping strategies in response to sport related stress, where

females use more problem focused coping strategies such as planning and communication more often than males (Nicholls et al., 2007). Similarly, Crocker and Graham (1995) report females tend to seek social support and apply increased effort in managing goal frustrations more than males, supporting the assertion from Chapter 3 that there is a need for caution when referring to the literature to make inferences about female athletes in male dominated research areas.

Further to these considerations, since the results from Chapters 4 and 5 provided evidence to suggest an omission of psychological skill development in the considered TDE, the aim of the research study in this chapter was to investigate the PCDEs present throughout the TD pathway stages of the same national female team sport TDE in each female playing group (under 16, under 18, under 21 and senior), using the PCDEQ2 (Hill, MacNamara & Collins, 2018) that was outlined in Chapter 2 (Section 2.4.4). This questionnaire is a useful tool to assist practitioners to capture the areas requiring support regarding PCDE development, acting as a lens to look at psycho-behavioural skill development. Additionally, this chapter's study aimed to understand any differences in PCDEs between the NJAG athletes and the senior elite athletes.

6.2 Methods

Seventy seven national female hockey players (mean age = 17.81 ± 2.07 years) were purposefully recruited to participate in the study. All participants were from a single national hockey organisation and comprised three development teams (under 16; U16 n=32, under 18; U18 n=22 and under 21; U21 n=23).

6.2.1 Participants

One hundred and three female national hockey players were purposefully recruited to participate in the study as they were part of a single national hockey organisation and were part of the national TD pathway or national senior representative team. The participants were from three different age grade teams (under 16; U16 n=28, under 18; U18 n=22; under 21; U21 n=28) and the senior national team (n=25) representing 91% of the total national female representative players.

6.2.2 Instrumentation

In addition to the information already outlined in Chapter 2 (2.4.4), the PCDEQ2 (Appendix A4) has been refined through exploratory factor analysis and satisfies the acceptable variance range with the factor solution accounting for 40% of the explained variance and an overall good level of internal reliability of $\alpha = 0.879$, with factors 1 to 7 (Table 6.1) returning Cronbach alpha values of 0.905, 0.876, 0.829, 0.715, 0.814, 0.805, and 0.720 respectively (Hill et al., 2018). It must be noted this questionnaire is an assessment tool and is not recommended as a talent selection tool. Rather it has been recommended to be used as part of the puzzle and can help to identify characteristics associated with effective development that may require support or be used as a monitoring tool to assess the impact and effectiveness of an intervention (Hill et al., 2018). This study used the PCDEQ2 for the former, to gain insight into whether there were differences in the levels of psycho-behavioural skills between the playing groups (U16, U18, U21, Senior) in a national hockey organisation and to better understand what areas need the most support for each playing group.

6.2.3 Procedure

Ethical approval was obtained from the university's ethical review board. Informed consent was obtained from each participant, and in the case of those under 18 years of age, approval was also obtained from a parent or guardian (Appendix A2). Participants were given the opportunity to complete the questionnaire online from April 27th 2020 until May 27th 2020. The questionnaire took approximately 16 minutes to complete. Participants were asked for demographic information (age, gender), encouraged to be honest when answering questions, and given assurance about the confidentiality of their responses.

6.2.4 Data Analysis

The PCDEQ2 responses were coded on a 6-point Likert scale, ranging from 1 (very unlike me) to 6 (very like me). Mean scores were analysed and reported for each factor. This allowed evaluation and comparison between the playing groups (U16, U18, U21, Senior) and comparison to the 'ideal score' illustrated in Table 6.1. Assumption testing was conducted on the various data sets to check for normality and homogeneity of variance and no violations were noted. As the PCDE factors are independent characteristics, a one-way ANOVA was used for each factor to determine any significant difference between the playing groups with follow-up Tukey HSD post hoc tests. To examine scale reliability of the current sample, the internal consistency coefficient (Cronbach's alpha) was calculated. A Cronbach's alpha (α) greater than 0.7, 0.8 and 0.9 are respectively regarded as 'respectable', 'very good' and 'excellent' (DeVellis, 2016). The level of statistical significance for all analyses was set to $\alpha = 0.05$. Effect sizes are reported as partial eta squared (η_p^2) and interpreted as the following, 0.01, small; 0.06, medium; 0.14, large. Additionally, the coefficient of variation was calculated by dividing the standard deviation by the mean and expressed as a percent (%CV) for each factor to understand the within-group variation. All items within each factor were

subsequently ranked from highest to lowest for each playing group. The three items that scored highest per factor by each playing group were highlighted for comparison, to provide a more in depth insight into the commonalities or differences between the groups.

Table 6.1

PCDEQ2 factors (the ideal score), and an explanation of what they mean, taken from Hill et al. 2018, p. 8-9

Factor	Explanation
1. Adverse Response to Failure (1)	athletes scoring high in this domain are likely to have suboptimal interaction with developmental challenge
2. Imagery and Active Preparation (6)	highlights the need for effective and controllable imagery in both skill refinement and the management of arousal
3. Self-Directed Control and Management (6)	draws heavily on the construct of self-regulation and self-control, and is an adaptive influence on talent development
4. Perfectionistic Tendencies (3.5)	consists of a combination of items initially included to assess perfectionism, anxiety, fear of failure, and the obsessive component of passion, along with one negatively framed item relating to realistic performance evaluation
5. Seeking and Using Social Support (6)	based around the facilitative role effective support networks play along the talent development pathway
6. Active Coping (6)	recognises the proactive, self-regulated deployment of coping mechanisms
7. Clinical Indicators (1)	incorporates items from each of the original constructs relating to mental health, namely eating disorders, anxiety, depression, and behavioural change; issues that not only impact upon the talent development process but also athlete wellbeing

6.3 Results

The internal consistently of the current sample, assessed using Cronbach's alpha showed very good internal reliability (α = 0.84) (DeVellis, 2016). The PCDEQ2 results are presented as the mean score, standard deviation (SD), confidence interval (CI) and within-group coefficient of variation expressed as a percent (%CV) for each of the seven factors (Table 6.2) to show any differences between playing groups (U16, U18, U21, Senior). For each factor, the playing group with the highest score had a corresponding lowest %CV. The one-way ANOVA results showed the only significant difference between playing groups was for Factor 1 - Adverse Response to Failure, with the greatest difference between groups occurring between the senior and U18 playing group (mean ± SD, 0.59 ± 0.23, p = 0.05). However, despite non-significant results in the one-way ANOVA for all other factors, Figure 6.1 illustrates differences occurring between the playing groups for each factor. Additionally Table 6.3 provides a deeper understanding of the highest scored items in each factor per playing group to provide more insight for comparison purposes, with some similarities occurring between playing groups. All playing groups scored closest to the 'ideal score' on Factor 4 - Perfectionistic Tendencies and furthest from the 'ideal score' on Factor 1 - Adverse Response to Failure. In order to provide a deeper understanding of these comparisons between playing groups per factor, each factor is outlined in detail.

6.3.1 Factor 1 - Adverse Response to Failure

The one-way ANOVA results showed this was the only factor to have significant medium differences between playing groups ($F(3, 99) = 2.964$, $p = 0.04$, $\eta_p^2 = 0.08$). The greatest difference occurred between the senior and U18 playing groups. The U18 playing group scored the highest in this factor with the lowest %CV (4.1 ± 0.7; %CV, 17.1). The senior playing group scored the lowest in this factor (3.6 ± 0.9) with the highest %CV (25.5). All

playing groups reported the item "*When I am failing at something, I hate the fact that I am not in control of the outcome*" among their three highest scored items for this factor, reporting this to be closer to 'very like them' (Table 6.3).

6.3.2 Factor 2 – Imagery and Active Preparation

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The U18 and Senior playing groups showed similar scores in this factor (4.0 ± 0.6 and 4.0 ± 0.8, respectively). The U21 playing group scored the lowest in this factor (3.8 ± 0.8) with the highest %CV (21.2). All playing groups reported the item "*I regularly imagine what a good performance feels like*" among their three highest scored items for this factor, reporting this to be closer to 'like them' (Table 6.3).

6.3.3 Factor 3 – Self-directed Control and Management

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The U18 and Senior playing groups showed similar scores in this factor (4.4 ± 0.7 and 4.4 ± 0.8, respectively). The U16 playing group scored the lowest in this factor (4.1 ± 0.9) with the highest %CV (21). All playing groups reported the items "*I would usually blame other people or circumstances for failure*" and "*I am lazy*" among their three highest scored items for this factor, reporting this to be closer to 'unlike them' (Table 6.3).

6.3.4 Factor 4 – Perfectionistic Tendencies

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The U18 playing group scored the highest in this factor with the lowest %Coefficient of Variation, %CV (3.5 ± 0.6; %CV, 16.5) and were the closest score to the 'ideal score' of 3.5. The U21 playing group scored the lowest in this factor

(3.0 ± 0.7) with the highest %CV (22.6) and the furthest from the 'ideal score'. All playing groups reported the items "*The people around me expect me to be perfect at everything I do*" and "*I get annoyed very easily*" among their three highest scored items for this factor. The U16, U18 and Senior groups reported these items to be closer to 'a bit like me', whereas the U21 group reported these items to be closer to 'a bit unlike me'.

6.3.5 Factor 5 – Seeking and using Social Support

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The U21 playing group scored the highest in this factor with the lowest %CV (4.6 ± 0.7; %CV, 15.1). The U18 playing group scored the lowest in this factor (4.3 ± 0.8). All playing groups reported the items "*When faced with a problem there is no one I can ask to help*" and "*I value and use the opinion of others about my performance*" among their three highest scored items for this factor, reporting this to be closer to being 'unlike them' and 'like them' respectively.

6.3.6 Factor 6 – Active Coping

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The Senior playing group scored the highest in this factor with the lowest %CV (4.8 ± 0.5; %CV, 11). The U16 playing group scored the lowest in this factor (4.5 ± 0.5). All playing groups reported the items "*I like to take control when dealing with problems*" and "*When we need to work hard I am first in the queue*" among their three highest scored items for this factor, reporting this to be closer to being 'like them'.

6.3.7 Factor 7 – Clinical Factors

The one-way ANOVA results showed there were no significant differences between playing groups for this factor (Table 6.2). The U18 playing group scored the highest in this

factor with the lowest %CV (3.2 ± 0.7; %CV, 23.4). The U21 and Senior playing groups scored the lowest in this factor (2.9 ± 0.8, 2.9 ± 0.7 respectively) with a %CV of 27.2 and 25.2 %CV respectively. All playing groups reported the items "*After eating, I sometimes feel guilty about its effect on my body shape*" and "*I worry about putting weight on*" among their three highest scored items for this factor, reporting this to be closer to being 'a bit like them'.

Table 6.2

Playing group responses to the PCDEQ2 and one-way ANOVA results of between group comparisons for each factor

		U16 *n=28*	U18 *n=22*	U21 *n=28*	Senior *n=25*	p	Partial Eta Sq. (η_p^2)
1. Adverse Response to Failure (1)	Mean ± SD	3.9 ± 0.7	4.1 ± 0.7	3.6 ± 0.8	3.6 ± 0.9		
	95% CI	3.6 - 4.1	3.8 - 4.5	3.3 - 3.9	3.2 - 3.9	p=0.04	0.08
	CV(%)	18	17	23.3	25.5		
2. Imagery and Active Preparation (6)	Mean ± SD	3.9 ± 0.8	4.0 ± 0.6	3.8 ± 0.8	4.0 ± 0.8		
	95% CI	3.6 - 4.2	3.7-4.3	3.5 - 4.1	3.7 - 4.3	p=0.59	0.02
	CV(%)	20.5	15.6	21.2	19.9		
3. Self-Directed Control and Management (6)	Mean ± SD	4.1 ± 0.9	4.4 ± 0.7	4.2 ± 0.8	4.4 ± 0.8		
	95% CI	3.8 - 4.4	4.1 - 4.7	3.9 - 4.5	4 - 4.7	p=0.51	0.02
	CV(%)	21	15.7	19.5	17.9		
4. Perfectionistic Tendencies (3.5)	Mean ± SD	3.4 ± 0.7	3.5 ± 0.6	3.0 ± 0.7	3.3 ± 0.6		
	95% CI	3.1 - 3.7	3.2 - 3.7	2.8 - 3.3	3.1 - 3.6	p=0.08	0.07
	CV(%)	21.3	16.5	22.6	18.6		
5. Seeking and Using Social Support (6)	Mean ± SD	4.3 ± 0.8	4.3 ± 0.8	4.6 ± 0.7	4.5 ± 0.9		
	95% CI	4 - 4.6	4 - 4.6	4.3 - 4.9	4.1 - 4.8	p=0.32	0.04
	CV(%)	19.1	18	15.1	19.1		
6. Active Coping (6)	Mean ± SD	4.4 ± 0.5	4.7 ± 0.6	4.6 ± 0.6	4.8 ± 0.5		
	95% CI	4.2 - 4.7	4.5 - 5	4.4 - 4.8	4.5 - 5	p=0.19	0.05
	CV(%)	12.2	12.7	12.3	11		
7. Clinical Indicators (1)	Mean ± SD	2.9 ± 0.8	3.2 ± 0.7	2.9 ± 0.8	2.9 ± 0.7		
	95% CI	2.7 - 3.3	2.8 - 3.5	2.6 - 3.2	2.6 - 3.2	p=0.61	0.02
	CV(%)	25.1	23.4	27.2	25.2		

Abbreviations: SD, standard deviation; CI, confidence interval; CV, coefficient of variation

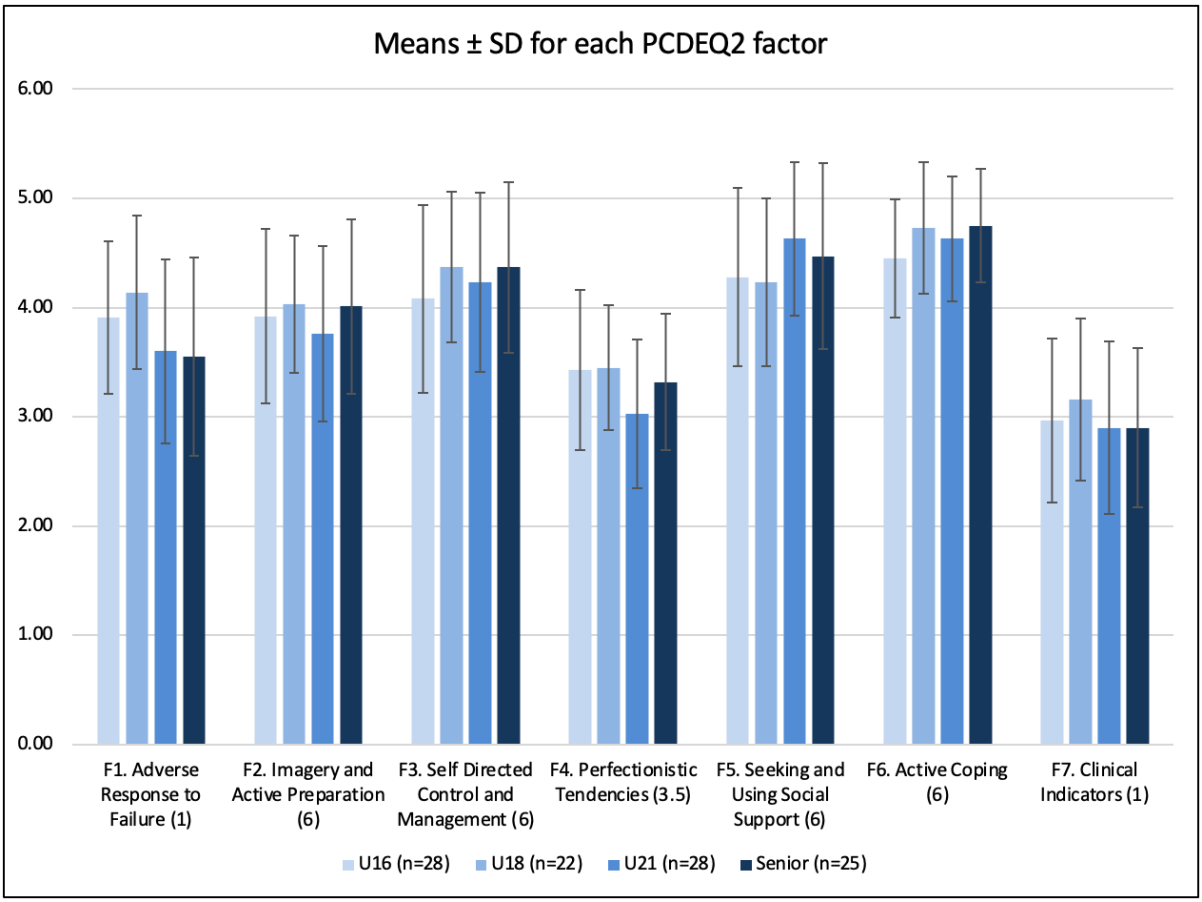

Figure 6.1

Mean and standard deviation (SD) for each PCDEQ2 factor per playing group

Table 6.3

Mean and standard deviation (SD) of PCDEQ2 items within each factor per playing group; U16, U18, U21 and Senior

		U16		U18		U21		Senior	
		n=28		*n=22*		*n=28*		*n=25*	
Factor	**Question**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
FACTOR 1 - Adverse Response to failure (21 items)	The day-to-day setbacks can often get me down	4.25	*1.21*	4.50	*0.91*	3.96	*1.23*	4.00	*1.04*
	My sleep is often disturbed by worrisome thoughts	3.36	*1.64*	4.23	*1.57*	2.93	*1.54*	3.28	*1.57*
	Even minor setbacks disturb my focus	3.43	*1.10*	3.77	*1.02*	2.64	*1.16*	2.80	*1.19*
	When I am failing at something, I hate the fact that I am not in control of the outcome	5.11	*1.07*	5.32	*0.65*	4.36	*1.22*	4.40	*1.41*
	I often worry that bad things will happen	4.36	*1.42*	4.64	*1.22*	3.36	*1.75*	3.60	*1.38*
	When things are going wrong for me, my future seems uncertain	3.18	*1.19*	4.14	*1.52*	3.68	*1.25*	3.68	*1.35*
	I often keep thinking about the mistakes I have made and let this interfere with my performance	4.25	*1.43*	4.45	*1.37*	3.96	*1.10*	3.68	*1.03*
	I find it difficult to overcome my feelings of anxiety when I perform	3.36	*1.59*	3.45	*1.18*	2.89	*1.31*	2.96	*1.49*
	When things go wrong, I find it difficult to see a way forwards	3.14	*0.97*	3.41	*1.10*	2.61	*0.96*	2.60	*1.19*
	When things are not going well, I get worried about what other people will think	5.04	*1.07*	4.82	*1.01*	4.07	*1.30*	4.20	*1.47*
	Although they may not say it, other people get upset when I make mistakes	3.29	*1.30*	3.36	*1.22*	3.18	*1.31*	3.36	*1.11*
	If I make a mistake I dwell on it and can't see the big picture	3.61	*1.23*	3.64	*1.50*	2.86	*1.18*	2.96	*1.43*
	When I am not succeeding, I feel like people lose interest in me	3.54	*1.45*	3.36	*1.22*	3.50	*1.40*	3.32	*1.49*
	I tend not to worry about things*	4.29	*1.44*	5.14	*1.04*	3.96	*1.57*	4.36	*1.58*
	I often lie awake at night thinking things over and over	4.39	*1.40*	4.91	*1.19*	3.86	*1.84*	4.08	*1.38*
	When I am failing, I worry most about what others think about me	4.29	*1.44*	4.00	*1.51*	3.93	*1.54*	4.12	*1.13*

	I often feel nervous	4.82	*1.33*	4.45	*1.34*	4.43	*1.17*	3.44	*1.53*
	I sometimes feel down without really knowing why	3.39	*1.29*	3.91	*1.54*	3.82	*1.33*	3.72	*1.37*
	When I make a mistake I find it difficult to get my focus back on task	3.32	*1.31*	3.64	*1.26*	3.18	*1.06*	3.12	*1.01*
	I get distracted thinking about how other performers are doing	3.71	*1.46*	3.68	*1.17*	3.75	*1.24*	3.32	*1.49*
	When I am failing, I am afraid I might not have what it takes	4.07	*1.36*	4.23	*1.15*	4.54	*1.00*	3.64	*1.44*
FACTOR 2 - Imagery and Active Preparation (15 items)	I include imagery in my preparation	4.21	*1.34*	4.32	*1.17*	4.14	*1.51*	4.36	*1.32*
	I use imagery to improve my physical performance	3.96	*1.29*	3.68	*1.29*	4.00	*1.22*	3.92	*1.47*
	I have a carefully thought out plan of my pathway to the top	3.43	*1.60*	3.41	*1.30*	3.14	*1.11*	3.96	*1.46*
	I imagine coping with setbacks	3.50	*1.35*	3.68	*1.21*	3.43	*1.26*	3.68	*1.52*
	I regularly imagine what a good performance feels like	4.68	*1.06*	4.73	*0.88*	4.89	*1.17*	4.52	*1.08*
	I regularly set clear targets for myself	4.46	*1.43*	4.09	*1.15*	4.11	*1.17*	4.52	*1.39*
	I like to try things out in my head first	4.25	*1.40*	4.18	*1.26*	3.68	*1.02*	3.88	*1.36*
	I use mental rehearsing to focus myself on what I have to do	3.61	*1.29*	3.59	*1.33*	3.43	*1.35*	3.72	*1.21*
	I can clearly see my pathway to the top	3.57	*1.43*	3.36	*1.14*	2.89	*1.20*	4.08	*1.19*
	I take time to clarify what is required	4.11	*1.10*	4.18	*1.01*	4.04	*1.14*	4.52	*1.08*
	I tend to run through things over and over again	4.43	*1.35*	4.77	*0.81*	4.07	*1.39*	4.36	*1.22*
	Before attempting a skill, I imagine myself performing it	4.18	*1.39*	4.55	*0.96*	4.00	*1.52*	4.08	*1.26*
	I incorporate mental rehearsal in my practice	3.43	*1.20*	3.55	*1.37*	3.64	*1.31*	3.72	*1.28*
	Before I arrive at a performance venue, I mentally rehearse my performance there	3.46	*1.37*	4.09	*1.23*	3.50	*1.32*	3.44	*1.45*
	When I have to do something that worries me, I imagine how I will overcome my anxieties and perform successfully	3.36	*1.28*	4.14	*1.13*	3.57	*1.29*	3.48	*1.36*

FACTOR 3 - Self Directed Control and Management (14 items)	I do certain things that are bad for me if they are fun*	4.46	*1.32*	4.45	*1.14*	3.61	*1.26*	4.20	*1.38*
	My life is well organised	4.39	*1.26*	4.41	*1.14*	4.50	*1.35*	4.68	*1.11*
	I give myself treats even when I don't achieve my goals*	4.14	*1.58*	4.23	*1.07*	3.86	*1.11*	3.20	*1.41*
	People would say that I am very self-disciplined	4.43	*1.17*	4.64	*0.90*	4.57	*1.07*	4.80	*1.12*
	I sometimes forget items of equipment*	3.61	*1.73*	4.50	*1.26*	4.14	*1.56*	3.88	*1.92*
	I would usually blame other people or circumstances for failure*	4.50	*1.23*	5.00	*1.02*	4.71	*1.30*	4.92	*1.08*
	I often act without thinking through all the alternatives*	3.71	*1.46*	4.14	*1.42*	4.61	*1.17*	4.44	*1.33*
	I am lazy*	4.61	*1.26*	5.05	*1.00*	4.96	*0.96*	5.36	*0.99*
	I am good at resisting temptation	3.46	*1.43*	4.09	*1.19*	3.71	*1.24*	4.20	*1.15*
	I often do things I know I shouldn't do*	4.64	*1.16*	4.73	*1.03*	4.50	*1.45*	4.64	*1.58*
	I often forget appointments or timings*	4.32	*1.49*	4.86	*1.32*	5.00	*1.15*	4.68	*1.65*
	I wish I had more discipline*	3.14	*1.48*	3.41	*1.30*	3.07	*1.46*	3.76	*1.54*
	I prepare carefully for training sessions	4.14	*1.30*	4.14	*1.04*	3.82	*1.19*	4.24	*1.13*
	I have a hard time breaking bad habits*	3.61	*1.34*	3.68	*1.32*	4.04	*1.35*	4.08	*1.26*
FACTOR 4 - Perfectionistic Tendencies (10 items)	When I fail, people are less interested in me	3.25	*1.60*	3.27	*1.28*	3.25	*1.40*	3.36	*1.47*
	The day-to-day setbacks can often get me down	3.36	*1.13*	4.18	*1.22*	3.36	*1.22*	3.48	*1.26*
	The people around me expect me to be perfect at everything I do	3.89	*1.42*	3.73	*1.20*	3.32	*1.31*	3.80	*1.44*
	My preparation for competition has to be exactly the same each time	2.89	*1.42*	3.23	*1.51*	2.93	*1.30*	2.92	*1.38*
	If I don’t give my sport all of my attention, all of the time, my performances will suffer	3.57	*1.43*	3.45	*1.30*	2.89	*1.29*	2.84	*1.49*
	I only feel happy when I win	3.36	*1.34*	3.23	*1.31*	2.82	*1.19*	3.44	*1.42*

	I can't be bothered with people who don't always strive to better themselves	3.29	*1.08*	3.14	*1.32*	2.96	*1.32*	3.44	*1.19*
	My mood depends entirely on my sporting success	3.68	*1.33*	4.05	*1.09*	3.25	*1.17*	3.80	*1.53*
	I get annoyed very easily	4.04	*1.37*	3.73	*1.20*	3.39	*1.55*	3.68	*1.46*
	When I am failing, significant others are often disappointed in me	2.96	*1.48*	2.50	*1.22*	2.07	*0.86*	2.48	*1.39*
FACTOR 5 - Seeking and using social support (9 items)	I dislike asking people for help and advice*	3.93	*1.51*	4.00	*1.41*	4.36	*1.37*	4.08	*1.41*
	I often seek advice from different people	4.07	*1.15*	4.36	*1.33*	4.39	*1.10*	4.52	*1.36*
	I know who to go to get things done	4.50	*0.96*	4.55	*1.06*	4.61	*0.92*	4.72	*0.98*
	I am keen to ask other people for help	3.96	*1.29*	3.86	*1.32*	4.14	*1.33*	3.92	*1.55*
	If I don't know something, I will find out who to ask	4.36	*1.22*	4.14	*1.36*	4.75	*0.97*	4.68	*0.95*
	I think asking other people for help is a sign of weakness*	4.25	*1.51*	4.45	*1.30*	4.86	*1.24*	4.76	*1.36*
	I often find it hard to talk to other people about things that are bothering me*	2.96	*1.75*	2.68	*1.36*	3.75	*1.76*	3.44	*1.64*
	When faced with a problem there is no one I can ask to help*	5.21	*1.10*	5.18	*0.85*	5.54	*0.69*	5.12	*1.13*
	I value and use the opinion of others about my performance	5.29	*0.71*	5.45	*0.60*	5.36	*0.62*	5.08	*0.81*
FACTOR 6 - Active Coping (10 items)	I find it hard to push myself to overcome difficulties*	4.21	*1.17*	4.55	*1.26*	4.32	*1.22*	4.60	*1.26*
	If I encounter a problem I make a plan to get around it	4.39	*1.34*	4.59	*0.85*	4.71	*0.85*	5.16	*0.99*
	I like to take control when dealing with problems	4.93	*1.09*	5.23	*0.92*	4.79	*1.03*	4.96	*0.93*
	I can deal with whatever comes my way	3.96	*0.88*	4.36	*1.18*	4.61	*0.63*	4.60	*0.96*
	I am able to adapt and change when things aren't going right for me	4.29	*0.94*	4.36	*0.79*	4.64	*0.62*	4.40	*1.08*
	Failures do not distract me from my pathway to success	3.75	*1.08*	4.18	*0.91*	3.93	*1.15*	4.12	*1.05*
	When we need to work hard I am first in the queue	5.00	*1.05*	5.36	*0.73*	4.96	*0.74*	5.16	*1.03*
	My teammates would describe me as a consistent person	4.32	*1.02*	4.55	*1.01*	4.71	*1.15*	4.68	*1.14*

	I work through set backs	4.86	*0.59*	5.00	*0.76*	4.71	*0.76*	4.92	*1.00*
	When things seem hopeless, I still keep going	4.75	*0.89*	5.09	*0.75*	4.86	*0.71*	4.92	*1.00*
FACTOR 7 - Clinical indicators (9 items)	I often lack energy	3.21	*1.45*	3.32	*1.29*	3.21	*1.40*	3.12	*1.30*
	After eating, I sometimes feel guilty about its effect on my body shape	4.18	*1.66*	4.55	*1.37*	4.07	*1.33*	4.12	*1.36*
	I worry about putting weight on	4.25	*1.67*	4.55	*1.26*	3.93	*1.51*	4.24	*1.74*
	If something unexpected happens I find it really hard to adapt	2.89	*0.99*	3.14	*0.99*	2.71	*1.24*	2.40	*0.91*
	I socialise with my teammates much less than I used to	2.43	*1.57*	3.05	*1.59*	2.50	*1.40*	2.76	*1.27*
	Compared to my teammates I often fail to complete a heavy training session	2.07	*0.81*	2.14	*0.94*	2.14	*1.21*	1.80	*1.00*
	I struggle to get myself motivated	3.14	*1.43*	2.45	*1.18*	2.82	*1.36*	2.36	*1.19*
	I have lost interest in socialising with my training group	1.79	*1.07*	1.91	*1.27*	1.82	*0.98*	2.28	*1.34*
	I feel tired and have little energy more often than my peers	2.79	*1.42*	3.32	*1.17*	2.89	*1.34*	3.00	*1.53*

The three highest scored items in each factor per playing group are highlighted (grey) for comparison.

6.4 Discussion

This chapter investigated the PCDEs across playing groups (U16, U18, U21 and senior) in the same national amateur hockey organisation TDE used in Chapter 4 and 5 and compared the results between the groups and to the 'ideal score'. Reflecting the objectives outlined in Chapter 1 this study analysed quantitative data measured using the PCDEQ2 (Hill et al., 2018) of each playing group (objective 3a) and explored the results to understand any differences or gaps between the NJAG athletes and the senior elite athletes (objective 3b). The results of this study not only detail the differences between playing groups but more importantly provide insight regarding the PCDEs that require additional attention and support and at which stage of the pathway.

Although the results indicate there were no significant differences between the playing groups for factor 2 – Imagery and Active Preparation, factor 3 – Self Directed Control and Management and factor 6 – Active Coping, there seemed to be a trend in the results where the youngest playing group scored among the lowest and furthest from the 'ideal score' unlike the senior playing group who scored closest to the 'ideal score' suggesting those who progress to the top possess these important psychological skills. This contrasts with findings from Edwards and colleagues who showed junior players scored higher for factor 2 - Imagery and Active Preparation compared to senior players (Edwards et al., 2022). Of particular interest, the U18 playing group scored similarly to the senior playing group in all three factors, with a reduced mean in the U21 playing group. This suggests that in this TDE there is no clear alignment on the inclusion and systematic development of PCDEs. It appears to be happening at some stages in some capacity but without systematic development of what or how much is being developed and when. This is interesting as it mirrors results from Chapters 4 and 5 further indicating a lack of coherence and clear alignment in the pathway,

again contradicting recommendations in the literature (Taylor & Collins, 2020; Webb et al., 2016). As mentioned previously in earlier chapters, the NGB could use the POP principle to map out the performance goals and outcomes at each pathway stage depicting PCDEs as an important set of skills requiring inclusion in the pathway (Collins et al., 2019). Reflecting on the SMM approach outlined in Chapter 2, educating other coaches, parents and stakeholders across the TDE in understanding the need for PCDEs, what they include and how to support their development is key to assisting with the systematic and coherent development of these skills and behaviours (Collins & MacNamara, 2017; Taylor, MacNamara & Taylor, 2022; Webb et al., 2016).

Interestingly, the only factor where a significant difference between playing groups was observed was factor 1 - Adverse Response to Failure. The younger players in this development pathway (U16, U18) had scores leaning more towards an adverse response to failure, whereas players on the latter end of the pathway (U21) seemed to report better responses to failure. In Chapter 5 it was noted by players and coaches that psycho-behavioural skill development is lacking in this national hockey organisation's TDE, albeit with some inclusion in the U21 playing group, therefore it is not surprising that this group scored closer to the 'ideal score' in this factor. This seems a desirable skill for players transitioning towards the senior playing group as the senior players scored the lowest in this factor (i.e. less adverse response to failure) compared to all other playing groups, showcasing an ability to respond positively or proactively to failure. An ability to cope with failure is an important skill considering those athletes who do 'make it' must navigate a bumpy, challenge-full route to the top (Collins et al., 2016; Collins & MacNamara, 2012; Taylor, Ashford & Collins, 2022; Taylor & Collins, 2019). It is a big step up when transitioning towards the elite senior level accompanied by emotional and psychological disturbance, where coaches suggest motivation

is key in assisting young athletes to deal with setbacks and cope with failure because often at the latter end of the pathway the athlete is expected to become more autonomous and responsible for their own development (Lundqvist et al., 2022).

Further and crucially, when considering the results for factor 4 – Perfectionistic Tendencies, though no significant difference occurred between playing groups and with all groups scoring close to the 'ideal score', the younger playing groups had a higher mean score than the U21 and senior players suggesting a greater indication of perfectionistic tendencies in the younger playing groups (U16, U18). These results also contradict those depicted in Edwards et al's study of a female national pathway where senior players scored higher than junior players on this factor (Edwards et al., 2022). Edward et al's results suggest that the older players likely exude this characteristic in a 'goldilocks' manner, enough to push their performance standards yet not leaning into the negative implications of too much perfectionism (Hill, Mallinson-Howard & Jowett, 2018).

Given athletes will use PCDEs in combination (Collins & MacNamara, 2017) it is important in this study to consider factor 4 – Perfectionistic Tendencies, in combination with other factors; the U16 playing group scoring lowest on factor 6 – Active Coping, and the U18 playing group scoring highest on factor 1 – Adverse Response to Failure. It's clear the TDE should place more emphasis on incorporating PCDE development in the younger playing groups to support them develop skills to deal with failures, setbacks, poor performances and an understanding of realistic performance evaluations (Hill, et al., 2018; Saward et al., 2017). The research is clear in suggesting that setbacks, challenges and failures are an inevitable part of the route to the top (Hill et al., 2018; Larsen et al., 2014; Savage et al., 2017; Taylor & Collins, 2020), thus it is crucial the TDE creates opportunities for young developing athletes to learn and grow from challenges, failings and low experiences, e.g., a failure to perform,

failure to be selected, failure to win. The ability of young high potential athletes to meet, respond and grow from such failures or low experiences is desirable (Taylor, Ashford & Collins, 2022; Taylor & Collins, 2021b). If they are unable to cope with such setbacks they risk losing motivation or want to experience a similar situation in the future, conversely, if they learn the requisite PCDEs to assist in navigating the experience they will be encouraged to continue to develop and progress (Taylor & Collins, 2021b; Taylor & Collins, 2020).

A research study that interviewed pathway coaches has suggested the coaches felt a need to be better supported in understanding a means to incorporate psycho-behavioural skill learning with development athletes (Morley et al., 2022). One such method is using the teach-test-tweak-repeat approach (Collins et al., 2016). Using this approach coaches could plan for upcoming challenges in the pathway and incorporate or simulate challenge as a precursor for young athletes to practice pre-determined PCDEs, thereby assisting them to cope with challenges when they occur later. For example, coaches could implement difficult training drills to simulate failure, play more difficult opposition or engage players in performing skillsets under pressure such as penalties, corners etc. (Nash & Taylor, 2021; Saward et al., 2020). Prior to simulating this challenge or prior to any expected natural challenge, the briefing of PCDEs deemed appropriate in facing such experiences is important e.g., focus and distraction control, coping with pressure and actively seeking social support. These periods of increased challenge must be coupled with feedback, debriefing and reflection post event to encourage learning and understanding of the likely negative emotions endured (Collins et al., 2016; Taylor & Collins, 2021b) which in time can lead to positive emotional outcomes when players experience progress. It is important the NGB seeks the assistance of a sport psychologist to educate pathway coaches annually on PCDEs, what they are, why they are important and how they’re development can be implemented in training

practices. The support of a sport psychologist is central to supporting coaches to feel more confident in using the teach-test-tweak-repeat approach (Taylor, Ashford & Collins, 2022).

Experiences of difficulty must be supported by coaches and the athlete's support network and the extent of reflection used should be tailored to the group or individual's ability (Taylor et al., 2021). The SMM becomes important here. Communication is necessary across the TDE of the intention to create difficulty or possible times where a challenge is expected as a natural consequence of competition or selection scenarios, for instance, will help the athletes' support network be aware of the athletes' upcoming experiences across other contexts (Taylor, Ashford & Collins, 2022; Taylor MacNamara & Taylor, 2022). Educating stakeholders (other coaches, parents) of the PCDEs that could assist the young athlete to navigate the experience and encouraging them to support in their development will allow for the coherent and aligned progression of the requisite skills, support through the challenging experience and reflection and growth post (Bjørndal & Ronglan, 2018; Collins & MacNamara, 2017; Webb et al., 2016). Further, the NGB could lean on a sport psychologist to develop educational resources and information that can be shared with these important stakeholders and the support network that will share in the development of the young players.

Noteworthily for factor 5 – Seeking and using Social Support, the older playing groups scored higher and closer to the 'ideal score' when compared with the younger playing groups (U16, U18). This indicates that further along the pathway these players are more likely to lean on significant others for support through their development. When faced with difficult or challenging experiences they feel they are supported more and can approach people more easily for this support, further indicating the need for this TDE to provide better support in line with PCDE development at earlier stages in the pathway. It is often the skills brought to the experience and the tools employed by the athletes that determine the outcome when

faced with challenges on the pathway (Collins & Cruickshank, 2017). Therefore forward planning of expected challenges, emotional disturbance and potential difficulties that will come later in the development pathway should be prepared for at earlier stages so that athletes are better equipped to cope with the more difficult challenges when they inevitably occur (Collins & Cruickshank, 2017; Taylor & Collins, 2020; 2021). Additionally the NGB can seek the assistance of a sport psychologist to educate the younger players to lean on their support network effectively, why it is important and thereby normalising the seeking of support. There may be benefit in using the older players in the TD pathway to share their experiences of using their support network and the associated benefits, creating shared learning and better proximity to role models (Henriksen et al., 2010).

Lastly and positively, all playing groups scored low and closer to the 'ideal score' for factor 7 – Clinical Indicators. However at an item level similarities across all playing groups indicate some level of body conscious thinking, a more common feature among female adolescents compared to males (Sabiston et al., 2007) and an identified occurrence in higher level sport participation (Varnes et al., 2013). The psychological well-being of the players must always be at the forefront of the minds of the coaches and support staff (Hauser et al., 2022). It would be highly valuable for this TDE to place some emphasis on supporting the coaches and support staff in how best to actively recognise alarming behaviours that might require professional assistance with a predetermined process of how best to deal with such a situation.

6.5 Conclusion

This chapter has explored the PCDEs present at each pathway stage in this TDE. The results suggest a need for a planned and aligned development process for including PCDEs that will better equip the young high potential athletes with the requisite skills when meeting

challenging experiences and making the most of limited opportunities afforded to them. It is important the NGB uses a sport psychologist to help educate the pathway coaches on the importance of PCDEs, how they can be developed in young athletes, and assist coaches in learning to use the teach-test-tweak-repeat approach. Reflecting the results in this chapter the younger playing groups, U16 and U18, scored furthest from the ideal score compared to the older playing groups, U21 and senior, for factor 1, 3, 5, 6, and 7 indicating it is the younger playing groups that require the most PCDE development. As a starting point the NGB could begin implementing an educational programme through the use of a sport psychologist with the coaches and support staff working with the U16 and U18 playing groups.

Critically, it is important to recognise that in this study the mean score for each factor was used to understand the PCDEs present in each playing group. Reflecting the pragmatic philosophy undertaken this gives coaches and practitioners working with these groups an awareness of the level of PCDEs present in these playing groups. However, recognising the mean score for each factor was accompanied by expected within-group variations it fails to give insight regarding the individual. Individual development is an important feature of effective TDEs (Martindale et al., 2005). Similarly, athletes will respond differently to various challenging experiences. Previous mental states and individual prior experiences can influence the attitude and responses of individuals (Edwards et al., 2022; Taylor & Collins, 2020). Therefore as a pragmatist aiming to inform practice, it would seem more appropriate for coaches to analyse the PCDEQ2 results at an individual level in addition to (similar to Edwards et al., 2022) or instead of at a group level. This would provide a more individualised approach to PCDE development and inform coaches of the skillset within their group, the strengths and weaknesses of the group and identify those individuals that may require extra support and education. Reflecting the aim of this study to investigate the profile of PCDEs

throughout the TD pathway stages between female playing groups (U16, U18, U21 and senior) using the PCDEQ2, it was beyond the scope of this chapter's study to detail individual athlete profiles or differences. However, the NGB is encouraged to upskill coaches in the interpretation of the PCDEQ2 results to further support individual athletes that require attention in specific areas. At a group level, the results indicate the trends within this TD pathway and coaches can interpret these trends or further investigate certain athletes for a more comprehensive analysis of their specific playing group.

The multidisciplinary approach to young athlete development (Elferink-Gemser et al., 2004) encourages holistic, individual and progressive development. This study has explored the PCDEs that can influence development and progression towards the senior elite level. However, measures of physical performance must also be considered in the TD curriculum as physical performance can contribute towards superior athlete performance progression (Clarke et al., 2017; Jones et al., 2018). Given the increase in physical playing demands from youth to senior level (Burgess et al., 2012) and appreciating the final transition to the senior elite level appears to be the most difficult (Gledhill, et al., 2017; Larsen et al., 2014; Taylor & Collins, 2021b), it is necessary to support athletes in their physical development as well as assist psycho-behavioural skill development. Therefore Chapter 7 will discuss a framework using GPS data that could be used to better inform how to support athletes to handle bridging the gap in game locomotor demands at the final hurdle of the pathway; the step up to the senior elite level.

Chapter 7: Supporting the vertical transition towards senior elite level; assessing physical preparedness using measures of variability in GPS locomotor activity

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7.1 Introduction

Understanding the means by which the TDE could encourage psycho-behavioural skill development to assist high potential young athletes to cope psychologically with challenging experiences on the journey towards the senior elite level (Collins & MacNamara, 2017; Taylor & Collins, 2020) is undoubtedly an important consideration within TD pathways (as highlighted in Chapter 6). The transition to the senior elite level is also met with increased game or competition physical locomotor demands (Burgess et al., 2012; Clarke et al., 2017). Consequently, young high potential athletes can experience simultaneous challenges reflecting physical and psychological disturbance when progressing through the TD pathway (Williams & MacNamara, 2022). Increased physical game locomotor activity demands that accompany the transition towards higher playing levels could also increase perceived performance pressure (Burgess et al., 2012; Cunningham et al., 2016; Taylor, Ashford & Collins, 2002; Vescovi 2016). Therefore reflecting the multidimensional nature of TD (Baker et al., 2019) the TDE is responsible for preparing athletes to cope physically as well as psychologically as they navigate the path to the senior elite level.

Chapter 2 highlighted how the literature commonly reflects average game locomotor demands providing a limited picture of the full physical locomotor demands of a game and proposed instead that analysis of the variability in game locomotor demands may be more appropriate in TD settings. This would allow practitioners to better determine game locomotor activity over time and assess any changes in performance to more practically inform an athlete's readiness or preparedness to transition to higher playing levels (Doncaster & Unnithan, 2019).

Understanding game-to-game variability is not a new concept, considerable game-to-game variability has been reported in senior male hockey (Sunderland & Edwards, 2017), rugby league (Dalton-Barron et al., 2021; Kempton et al., 2014), rugby union (McLaren et al., 2016), and most frequently in soccer (Carling et al., 2016; Gregson et al., 2010; Liu et al., 2016; Oliva-Lozano et al., 2021). These studies have generally reported much lower game-to-game variability for total distance and low speed movement compared to higher speed movements and this variability can differ between positions (Carling et al., 2016; Gregson et al., 2010; Kempton et al., 2014; McLaren et al., 2016; Sunderland & Edwards, 2017). In soccer, for example, greater game-to-game variability was reported in high-speed running distances (>19.8km/h: %Coefficient of Variation, %CV, 19.8, Carling et al., 2016; %CV, 16.2, Gregson et al., 2010) and very high-speed running distances (>25.2km/h, %CV, 37.1, Carling et al., 2016; %CV, 30.8, Gregson et al., 2010) compared to lower speed movement. In rugby league, greater game-to-game variability was found for very high-speed running (>21km/h, %CV, 37.9) (Kempton, Sirotic & Coutts, 2014). In male hockey, similar variabilities have been observed, including large game-to-game variabilities in high-speed running (>15.5kmh; %CV,

13-13.7) and sprinting (>20kmh; %CV, 20.9-22) (Sunderland & Edwards, 2017). There remain, however, comparatively few studies exploring these variability data in a female or junior athlete population which this thesis will attempt to address.

Contextual factors, for example, tactical approaches (Paul et al., 2015), opposition rank (White & MacFarlane, 2015) and ball possession (Cunniffe et al., 2022) can understandably influence game locomotor activity, increasingly highlighting that game-to-game and within-game variabilities are unpredictable yet inherent. In a development context, where players are still developing their technical and tactical ability (Doncaster & Unnithan, 2019), quantifying, and interpreting the random effect on game-to-game and within-game variability whilst controlling for fixed contexts (such as result, location, type of game and opposition rank) allow practitioners to understand the random level of variability that occurs during game play of junior international team sport games. If the smallest worthwhile change (SWC) and corresponding effect sizes of between- and within-game variability are known, then game locomotor activity data (measured by GPS) can be more accurately interpreted to support coaches' understanding of the demands of competition and the relative threshold required in determining if physical performance progression has occurred over time in their playing group (Gregson et al., 2010; Kempton et al., 2014; McLaren et al., 2016).

Participation in the U21 age grade (junior) rather than younger age grades (U17-U19) was found to be a stronger predictor of elite senior level representation in a team sport (football; Herrebrøden & Bjørndal, 2022). This highlights the importance of understanding how best to support this junior cohort of athletes to prepare for the transition towards the senior elite level. Additionally there is limited knowledge in the literature about game-to-

game or quarter-to-quarter variabilities for junior national level female team sport athletes. The primary aim of this study was therefore to estimate the between- and within-athlete variability to form threshold values for the interpretation of game-to-game changes in physical performance in female junior national hockey, to help inform a preparedness for increased locomotor demands. Secondly, this study aimed to estimate the degree of quarter-to-quarter variability for an athlete, on average within the three primary positional units (defender, midfielder and forward), to inform practitioners of the inherent fluctuations in locomotor activity throughout a game in a development cohort. This would then allow for studies to replicate this approach in environments (i.e. club, provincial, national) that currently support the physical preparation of junior athletes towards senior representation.

7.2 Methods

7.2.1 Participants

Thirty three female national hockey players (Table 7.1) participated in this study. Participants were selected from a single national junior hockey team and were grouped by position into defenders (n=13), midfielders (n=8) and forwards (n=12). Ethical approval was obtained from the university's ethical review board. Each participant provided informed consent to participate in the study. In the case of participants under 18 years of age, participant assent was obtained in conjunction with consent from a parent or guardian (Appendix A10).

7.2.2 Procedure

The current study was designed to explore the variability in locomotor activity in junior age grade (U21) female international hockey games and to estimate the degree to which

differences exist in this variability between positional groups. Over the course of two international hockey seasons, game locomotor activity data were collected using GPS technology. Game data were interpreted as the relative distance for each quarter of a game and per speed zone to account for the differences in playing time between players. Before the gameplay, participants were advised to abstain from any strenuous activity and recommended to maintain their normal pre-game routine and diet.

Game movement data to assess locomotor activity were collected as part of the players' normal training and game routine using GPS units throughout the entirety of all national level games (n=34) and analysed retrospectively to include players' time on the pitch. This data was collected by fitting participants with the same 10Hz GPS unit worn consistently throughout each season to minimise inter-unit variability. The data were collected using a validated and reliable system (VX Sport System, Lower Hutt, New Zealand). The typical error for these devices was reported at 3.4% for peak velocity and a coefficient of variation of 3.3% for high speed running (19.8km/h), which are within the acceptable range for use within team sport activities (Buchheitt et al., 2014). The number of satellites and horizontal dilution of position (HDOP), reflecting the geometrical arrangement of satellites was not collected, which is a limitation.

All participants were familiar with the data collection procedure. Data were collected for thirty four national level hockey games over a period of two international seasons (289 individual game observations, mean 9 games per player, range 3-19; 1,156 individual quarter observations, mean 35 quarters per player, range 8-72). Games were played against international opposition who ranged in world ranking between 1 and 26, with the nation under consideration in this study ranked 8th at the time of data collection (FIH, 2021). Game locomotor activity metrics were quantified by deriving the relative distance (m.min^{-1}) covered

for each quarter of a game and in three separate speed zones (low speed movement, LSM: 0-16km/h, high speed running, HSR: 16-19.9km/h and very high speed running, VHSR: >20km/h). These speed zones were chosen based on previously published data in female international hockey (McGuinness, Malone, Petrakos et al., 2019; McGuinness, Malone, Hughes et al., 2019; McGuinness et al., 2020).

7.2.3 Data Analysis

Data were analysed in the Statistical Analysis System (SAS Institute Inc., Cary, NC). Linear mixed models (Hopkins & Hewson, 2001) were used to estimate the variabilities (i.e., random effects) for each locomotor activity metric whilst controlling for: (i) changes in the means between repeated measurements (i.e., means of 1156 individual quarters across 289 games), (ii) differences in changes in means between positional units (i.e., between defenders, midfielders, and forwards), and (iii) contextual factors, i.e. differences in the results (win n=12, loss n=17, draw n=5), location (home n=12, away n=22), and type (tournament n=19, friendly n=15) of game, and opposition ranking (FIH, 2021). For each metric, the between- and within-athlete variability was estimated (the latter representing game-to-game variability for an individual athlete, on average). The within-athlete variability from a quarter-to-quarter perspective (representing the variability for an individual athlete between quarters of a game, on average) was also estimated. The extent to which this within-athlete quarter-to-quarter variability differed between positional units was also estimated.

Relative distances for each metric were log transformed to reduce non-uniformity of error (Hopkins, Marshall, Betterham et al., 2009) and express effects in percentage units after back-transformation (Hopkins, 2000). The resulting variabilities therefore represented coefficients of variation (CV). The fixed effects associated with points (i), (ii) and (iii) above represent percentage changes in relative distances covered across a game, on average (i.e.,

percentage linearised performance increment or decrement) and differences in these changes between positional units (i.e., differences in the percentage linearised performance decrement across a game, on average), respectively.

Uncertainties are presented as 95% confidence intervals alongside p values. Effect sizes were based on SWC values, which were derived using the principle of standardisation (Cohen, 1988). Thresholds for CVs were calculated by multiplying the observed between-athlete CV (i.e., sum of estimated between- and within-athlete CVs) by: <0.1, trivial; ≥0.1 to <0.3, small; ≥0.3 to <0.6, moderate; ≥0.6 to <1.2, large; and ≥1.2, very large (Hopkins, 2015). For fixed effects, thresholds were calculated by multiplying the observed between-athlete CV by: <0.2, trivial; ≥0.2 to <0.6, small; ≥0.6 to <1.2, moderate; ≥1.2 to <2.0, large; and ≥2.0, very large (Hopkins et al., 2009). Differences in the CV which represented the within-athlete variability between quarters of a game, on average were regarded as substantial when the CV differed between positional units by a factor of 1.15, or 15% (Hopkins & Hewson, 2001). All estimates were deemed to be decisively substantial when the chances of a trivial effect size were ≤5%.

7.3 Results

7.3.1 Relative Total Distance (TDist)

The observed between-athlete standard deviation (SD) for relative total distance (TDist) covered was 24%. This resulted in a SWC of 2.1% and 4.3% for the corresponding random and fixed effects respectively.

Random effects

TDist covered in a game differed between athletes by 9%, on average. The game-to-game variability for an individual athlete was not decisively substantial (see Table 7.2 and

Figure 7.1a). TDist covered between quarters of a game differed within individual athletes by 22% (see Table 7.3 and Figure 7.2). Variability between quarters was greater for midfielders than defenders and forwards by approximately 35% (95%CI, 19-52) ($p < 0.001$) and 60% (95%CI, 39-82) ($p < 0.001$), respectively.

Fixed effects

TDist covered per quarter of a game was 111 $m.min^{-1}$ (95%CI, 105-117), with an approximate 14% difference between defenders and forwards (see Table 7.4 and Figure 7.3). None of the fixed effect estimates representing performance decrement for TDist covered (i.e., mean performance decrement for individual positional units, and comparisons of mean performance decrement between positional units) were decisively substantial (Table 7.5).

7.3.2 Relative Low Speed Movement (LSM)

The observed between-athlete SD for relative low speed movement (LSM) distance covered was 23%. This resulted in a SWC of 2.1% and 4.3% for the random and fixed effects respectively.

Random effects

LSM distance covered in a game differed between athletes by 8%, on average. The game-to-game variability for an individual athlete was not decisively substantial (see Table 7.2 and Figure 7.1c). LSM distance covered between quarters of a game differed within individual athletes by 22% (see Table 7.3 and Figure 7.2). This variability between quarters was greater for midfielders than defenders and forwards by 37% (95%CI, 20-57) ($p < 0.001$) and 50% (95%CI, 31-72) ($p < 0.001$), respectively.

Fixed effects

LSM distance covered per quarter of a game was 98 $m.min^{-1}$ (95%CI, 90-107). Differences in this LSM distance covered between positional units were not decisively

substantial (see Table 7.4 and Figure 7.3). None of the fixed effect estimates that represented performance decrement for LSR distance covered were decisively substantial (Table 7.5).

7.3.3 Relative High Speed Running (HSR)

The observed between-athlete SD for relative high speed running (HSR) distance covered was 56%. This resulted in a SWC of 4.6% and 9.3% for the corresponding random and fixed effects respectively.

Random effects

HSR distance covered in a game differed between athletes by 17%, on average. The game-to-game variability for an individual athlete was 22% (see Table 7.2 and Figure 7.1b). HSR distance covered between quarters of a game differed within individual athletes by 45% (see Table 7.3 and Figure 7.2). This variability between quarters was greater for defenders than midfielders by 32% (95%CI = 14-52) ($p < 0.001$); however, the difference between defenders and forwards (ΔCV, 21%, 95%CI, 1-40) ($p = 0.013$) and midfielders and forwards (ΔCV, 9%, 95%CI, 1-27) ($p = 0.269$) was not decisively substantial.

Fixed effects

HSR distance covered per quarter of a game was 9.7 $m.min^{-1}$ (95%CI, 8.6-10.9). There was an approximate 42% difference in this HSR distance covered between defenders and forwards, and a 34% difference between defenders and midfielders (see Table 7.4 and Figure 7.3). The difference between midfielders and forwards was not decisively substantial. The average performance decrement for HSR distance covered across a game was only decisively substantial for forwards (16% performance decrement) (Table 7.5). None of the remaining estimates representing average performance decrement for HSR distance were decisively substantial.

7.3.4 Relative Very High Speed Running (VHSR)

The observed between-athlete SD for relative very high speed running (VHSR) distance covered was 153%. This resulted in a SWC of 9.7% and 20.4% for the corresponding random and fixed effects respectively.

Random effects

VHSR distance covered in a game differed between athletes by 36%, on average. The level of game-to-game variability for an individual athlete was 35% (see Table 7.2 and Figure 7.1d). VHSR distance covered between quarters of a game differed within individual athletes, by 130% (see Table 7.3 and Figure 7.2). This variability between quarters was greater for defenders than forwards by 49% (95%CI, 23-79) ($p < 0.001$); however, the difference between defenders and midfielders (ΔCV, 26%, 95%CI, 6-51) ($p = 0.011$) and midfielders and forwards (ΔCV, 18%, 95%CI, 1-43) ($p = 0.091$) was not decisively substantial.

Fixed effects

VHSR distance covered per quarter of a game was 2.4 $m.min^{-1}$ (95%CI, 1.9-3.1). There was an approximate 36% difference in this VHSR distance covered between defenders and midfielders, and an approximate 47% difference between defenders and forwards (see Table 7.4 and Figure 7.3). The difference between midfielders and forwards was not decisively substantial. None of the remaining estimates representing performance decrement for VHSR distance were decisively substantial (Table 7.5).

Table 7.1

Participant characteristics at junior national level

	All	Defenders	Midfielders	Forwards
	n=33	n=13	n=8	n=12
Height (cm)	166.1 ± 4.4	168.2 ± 4.4	161.7 ± 2.4	167.1 ± 4.5
Body mass (kg)	62.5 ± 6.2	66.7 ± 7	59.7 ± 3.8	60.3 ± 4.6
Age (y)	20 ± 0.9	20 ± 1	20 ± 0.9	20 ± 0.6

Data represent means ± SDs.
Abbreviations: cm, centimetres; kg, kilogrammes; y, years; SD, standard deviation.

Table 7.2

Between and within athlete variabilities at junior national level expressed as a CV

	Between			Within		
m.min^{-1}	**CV[a] (95% CI)**	**MBD[b]**	**P**	**CV[c] (95% CI)**	**MBD**	**p**
TDist	8.6 (3.3 to 11.9)	moderate*	0.021	4.9 (-0.3 to 7.0)	small	0.051
LSM	7.8 (2.4 to 10.8)	moderate*	0.029	5.0 (-0.2 to 7.1)	small	0.051
HSR	17 (8 to 23)	moderate*	0.010	22 (17 to 26)	moderate*	< 0.001
VHSR	36 (17 to 50)	moderate*	0.008	35 (20 to 46)	moderate*	0.002

[a]This CV represents the average difference in the distance covered of an average game between individual athletes.
[b]Effect sizes for these random effects were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.1, small; 0.3, moderate; 0.6, large; 1.2, very large. Asterisks indicate effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.10).
[c]This CV represents the average game-to-game variability for an individual athlete.
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; CV, coefficient of variation; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

Table 7.3

Within athlete quarter-to-quarter variabilities at junior national level expressed as a CV

	Overall		Defenders		Midfielders		Forwards	
	CV[a] (95% CI)	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**
TDist	22 (20 to 23)	large*	21 (19 to 23)	large*	28 (26 to 31)	very large*	17 (16 to 19)	large*
LSM	22 (20 to 23)	large*	20 (18 to 22)	large*	27 (25 to 30)	very large*	18 (17 to 20)	large*
HSR	45 (42 to 48)	large*	52 (48 to 57)	large*	40 (36 to 44)	large*	43 (39 to 49)	large*
VHSR	130 (121 to 140)	large*	161 (143 to 183)	very large*	127 (113 to 146)	large*	108 (95 to 125)	large*

[a]This CV represents the extent to which the distance covered by an individual athlete differs between quarters of an individual game.
[b]Effect sizes for these random effects were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.1, small; 0.3, moderate; 0.6, large; 1.2, very large. Asterisks indicate effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.10). All p values were < .001 and are therefore not shown.
[c]This CV represents the extent to which the distance covered by the given positional group differs between quarters of an individual game.
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; CV, coefficient of variation; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

Table 7.4

Positional groups differences in distance covered in an average quarter at each speed zone

	Defender v Midfielder			Defender v Forward			Midfielder v Forward		
	%Diff[a] (95% CI)	**MBD[b]**	**p**	**%Diff[a] (95% CI)**	**MBD[b]**	**p**	**%Diff[a] (95% CI)**	**MBD[b]**	**p**
TDist	-8.5 (-14 to -2)	small	0.01	-14 (-19 to -8)	moderate*	< 0.001	-5.8 (-12.1 to 0.9)	small	0.086
LSM	-4.0 (-9.8 to 2.3)	trivial	0.207	-8.6 (-14.3 to -2.6)	small	0.007	-4.9 (-10.9 to 1.7)	small	0.137
HSR	-34 (-43 to -24)	moderate*	< 0.001	-42 (-50 to -33)	large*	< 0.001	-12.2 (-24.5 to 2.1)	small	0.09
VHSR	-36 (-52 to -16)	small*	0.002	-47 (-61 to -30)	moderate*	< 0.001	-18 (-38 to 10)	small	0.181

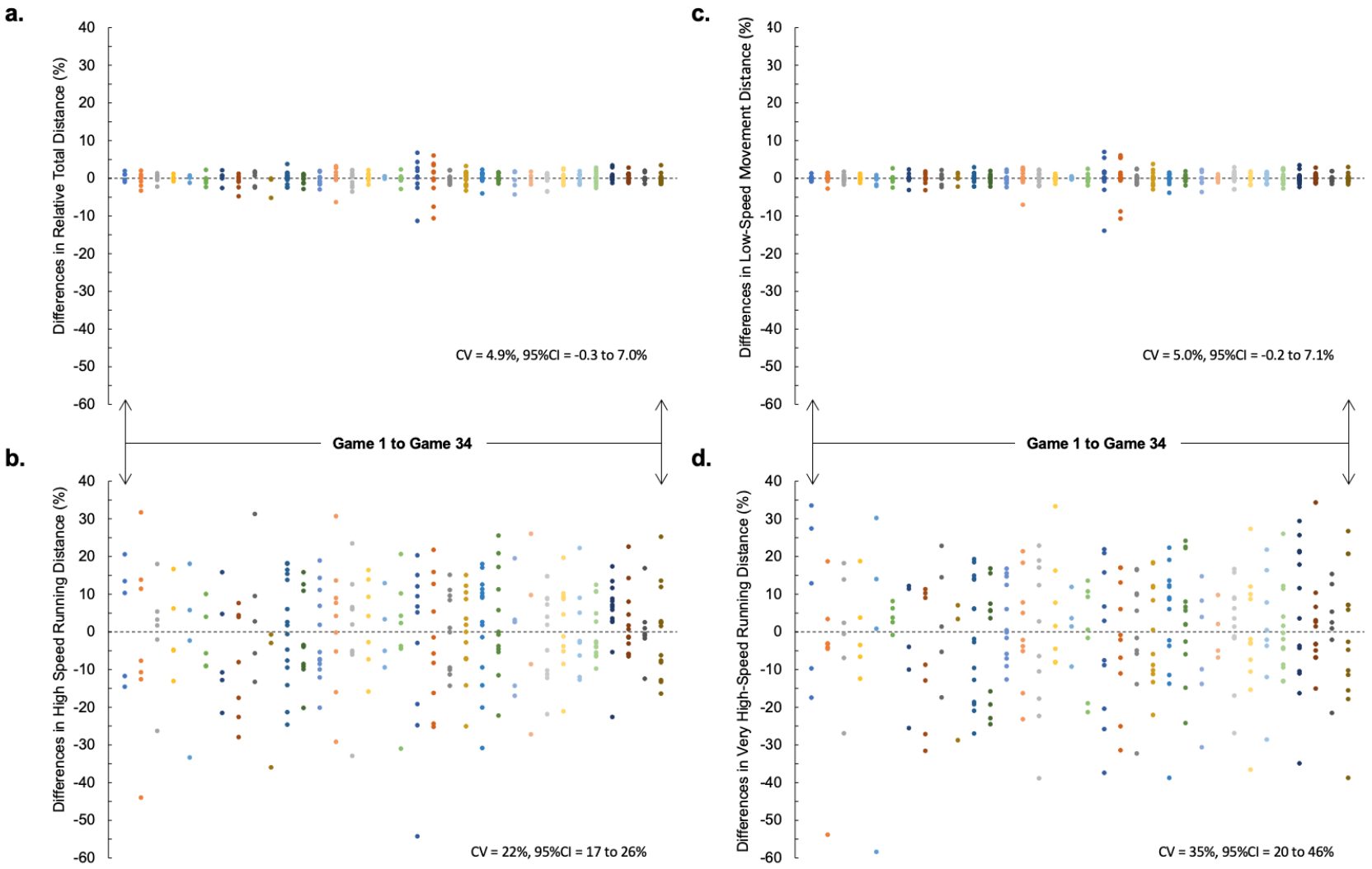
[a]Data represent percentage differences in the distance covered between positional groups.
[b]Effect sizes for these % differences in means were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.2, small; 0.6, moderate; 1.2, large; 2.0, very large. Asterisks indicate effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.20).
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

Table 7.5

Mean performance decrement across an average junior national level game for each positional group

	Overall			Defenders			Midfielders			Forwards		
	%↓[a] (95% CI)	**MBD[b]**	**p**	**%↓[a] (95% CI)**	**MBD[b]**	**p**	**%↓[a] (95% CI)**	**MBD[b]**	**p**	**%↓[a] (95% CI)**	**MBD[b]**	**p**
TDist	-3.9 (-9.8 to 2.3)	unclear	0.168	-1.3 (-9.1 to 7.1)	unclear	0.683	-9.4 (-18.1 to 0.1)	small	0.055	-0.9 (-8.8 to 7.8)	unclear	0.856
LSM	1.6 (-6.6 to 10.5)	unclear	0.626	3.9 (-5.2 to 13.9)	small	0.351	-4.9 (-10.9 to 1.7)	small	0.318	6.0 (-3.6 to 16.5)	small	0.196
HSR	-10.3 (-17.4 to 53)	unclear	0.024	-5.6 (-15.9 to 5.9)	small	0.307	-8.6 (-18.9 to 3.1)	small	0.125	-16.3 (-25.7 to -5.8)	small*	0.006
VHSR	12.5 (-21 to 60)	unclear	0.457	14 (-21 to 65)	unclear	0.457	32 (-10.2 to 95)	small	0.140	-5.7 (-34.6 to 36.1)	unclear	0.729

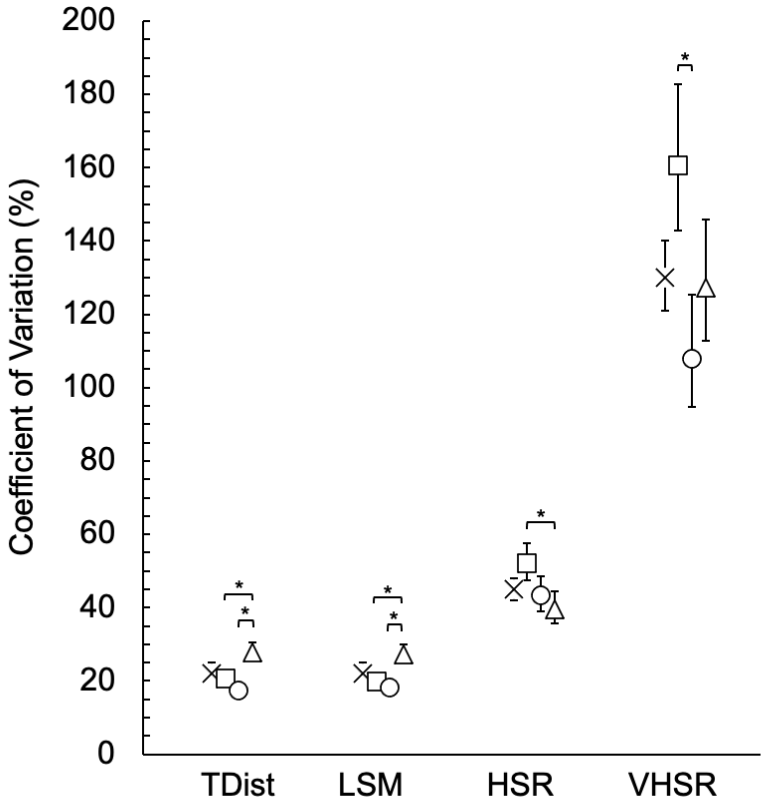
[a]Data represent the average performance decrement for each positional group across an average game – i.e. linearised performance decrement quantified as a percentage.
[b]Effect sizes for these % performance decrement values were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.2, small; 0.6, moderate; 1.2, large; 2.0, very large. Asterisks indicate % performance decrement effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.20).
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.



Legend:
Figures 7.1a. to d. show differences in game-to-game variabilities for individual athletes. The variabilities for individual games are centered to a value of zero on the y-axis. Each data point represents and individual deviation from these mean values within each game.

Figure 7.1

Game-to-game variabilities in TDist (7.1a), LSM (7.1b), HSR (7.1c) and VHSR (7.1d)



Key:
×Mean
□Defender
○Forward
△Midfielder

Legend:
Figure 7.2 shows the mean and position-specific quarter-to-quarter variabilities (%CV) for relative total distance and for relative distances covered within three different speed zones. Error bars represent 95%CIs. Asterisks represent decisively substantial differences between positional units.

Abbreviations:
CI, Confidence Interval.
CV, Coefficient of Variation.
TDist, Relative Total Distance.
LSM, Relative Low-Speed Movement Distance.
HSR, Relative High-Speed Running Distance.
VHSR, Relative Very High-Speed Running Distance.

Figure 7.2

Mean and position specific quarter-to-quarter variabilities in each speed zone

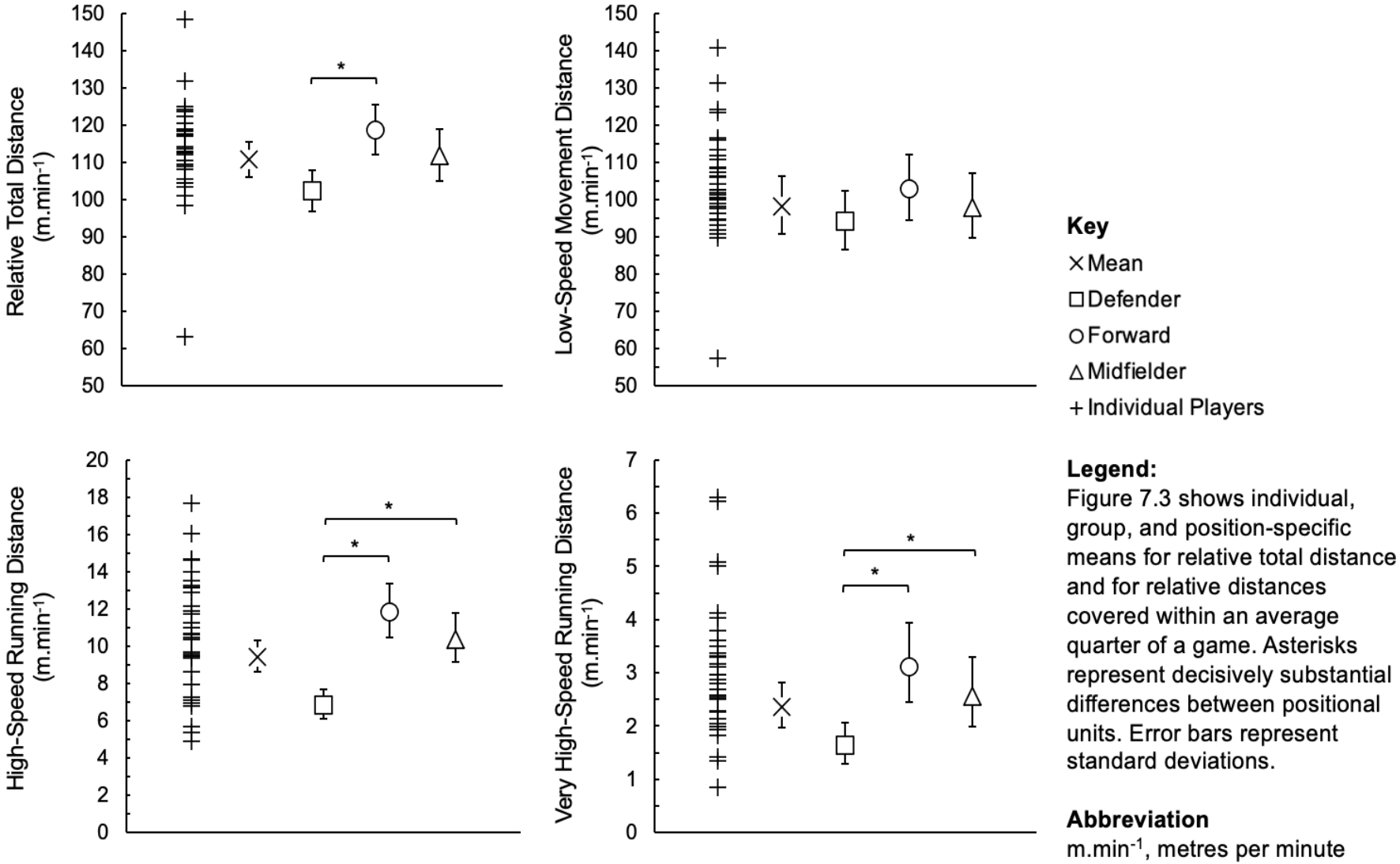


Figure 7.3

Individual, group and position specific means for relative distances in each speed zone

7.4 Discussion

Using the between- and within-athlete variability data to form threshold values for the interpretation of changes in physical game locomotor activity over time and in line with objective 4a) the aim of this study was to analyse the level of game-to-game variability using GPS data from junior international hockey games to better inform decision making on the physical preparedness of young high potential athletes to transition to the senior international level (i.e., vertically on the pathway). Reflecting objective 4b, this study also aimed to estimate the degree of within-game variability for an athlete, on average within the three primary positional units (defender, midfielder and forward), to inform practitioners of the inherent fluctuations in locomotor activity throughout a game in a development cohort. To my knowledge, this is the first study using GPS data from hockey games to estimate the game-to-game and quarter-to-quarter variability for junior female national players. These findings provide a novel contribution to the existing literature (which has primarily reported on the demands of elite senior level game play (Kempton et al., 2014; McLaren et al., 2016; Sunderland & Edwards, 2017). This study provides critical insights for the coaches of development teams to better understand how to determine threshold values for the interpretation of game-to-game and quarter-to-quarter variability in game locomotor activity.

The main findings of this study show that the game-to-game variability for a junior national hockey player in this population was small for TDist and LSM (5%) but had a moderate effect size for HSR (22%) and VHSR (35%). These findings are consistent with previously published studies where larger game-to-game variabilities have been reported for higher

speed movements (Kempton et al., 2014; McLaren et al., 2016; Sunderland & Edwards, 2017; Trewin et al., 2018). Since this variability represents changes in these metrics over time, whilst accounting for the fixed effects of contextual factors (i.e., position, result, location, game type, opposition rank), it indicates that TDist and LSM are stable metrics between games in this cohort of players and could be used to monitor load in this population (Doncaster & Unnithan, 2019). However, the greater between-game variability in HSR (22%) and VHSR (35%) highlights the increased fluctuations in these locomotor activities from game-to-game. In these higher speed zones, the between-game HSR and VHSR variabilities become important information for coaches to help provide thresholds to interpret game-to-game changes in performance for development players. Understanding the SWC for determining the magnitude of the game-to-game variability in this population allows coaches to analyse specific game data with a more informed picture before determining if changes in performance have occurred (Doncaster & Unnithan, 2019; McLaren et al., 2016).

For the population considered in this chapter and TDE, a SWC of 4.6% and 9.7% estimated average game-to-game variabilities of moderate effect size (22% and 35%) for HSR and VHSR respectively. This indicates the magnitude of change in locomotor activity required before determining if a change and improvement in performance has occurred over time. Game scenarios in addition to the contexts accounted for in this study will influence these variability measures. However, quantifying such variabilities for development athletes is beneficial as the athletes prepare to transition to higher standards of play because this variability range provides a threshold to better interpret whether a worthwhile change in physical performance over time has occurred for this population (Doncaster & Unnithan,

2019; McLaren et al., 2016). The current study provides a framework for the analysis and interpretation of such between-game variability and development coaches are encouraged to carry out analysis on their specific populations for more accurate thresholds.

The major finding of this study was that the greatest source of observed variability for a player from this population occurs between quarters of a game, rather than between games. To my knowledge, there are no other studies that provide such precise estimates of within-athlete variability during an elite-level hockey game – i.e., estimates of variability for an athlete within an individual game, from a quarter-to-quarter perspective. Early work on female, club level hockey by Espenschade (1936) provided manually derived estimates of distances covered and speeds achieved within a game for different positional units. Building on Espenschade's work, this data now also provides objectively measured evidence of positional differences in quarter-to-quarter variability for junior female national hockey athletes. Like Espenschade this study also found that these differences were larger for the midfield positional unit. Midfielders exhibited very large quarter-to-quarter variability in both TDist and LSM, which was 35% and 37% greater than for defenders, respectively and was 60% and 50% greater than for forwards, respectively. This higher level of quarter-to-quarter variability in TDist and LSM for midfielders is possibly due to the nature of the demands of this playing position. Midfielders are required to transition between defending and attacking throughout the game, which in turn requires frequent transitions between low and high speed running (depending on the given quarter context). This contrasts with the demands of the average defender, who covers larger distances throughout the game, but spends more

time in the lower speed zones (McGuinness, Malone, Petrakos et al., 2019; McGuinness, Malone, Hughes et al., 2019; Macutkiewicz & Sunderland, 2011).

Both midfielders and forwards had large variability in quarter-to-quarter HSR and VHSR, with no decisively substantial difference between these positions. The variabilities in HSR distances imply that there are times during the game when one quarter more than another might demand less recovery time between high intensity efforts, which is common for both positions (McGuinness, Malone, Hughes et al., 2019; Sunderland & Edwards, 2017). The quarter context will likely influence the greater variabilities in quarter-to-quarter HSR and VHSR. For example, whilst it was beyond the scope of the data collected in this study, research has shown that contextual factors such as possession status in hockey (Cunniffe et al., 2022) can impact the locomotor activity demand on players. The data showed that defenders had higher levels of quarter-to-quarter HSR variability than midfielders (by 32%), and higher levels of quarter-to-quarter VHSR variability than forwards (by 49%). This higher variability compared to forwards and midfielders could imply that defenders are required to produce fewer high and very high intensity bouts within a quarter, similar to other position specific research (McGuinness, Malone, Petrakos et al., 2019). Comparatively smaller variabilities for midfielders and forwards highlight the anaerobic demand on players within these positional units to more continuously produce high intensity efforts across a game (McGuinness, Malone, Petrakos et al., 2019; McGuinness, Malone, Hughes et al., 2019).

This information provides knowledge on the position specific differences in average quarter-to-quarter variabilities further clarifying the positional specific locomotor activities in a hockey game. Coaches could interpret this information to assist with informing substitution

decisions to allow players to perform to a greater capacity within a game depending on the quarter and game context. Additionally, this information provides key information for training regimes at this level to ensure accurate preparation of players to withstand the position specific game locomotor activity while progressing them towards senior level.

Though the model used controlled for the fixed effects of result, location, game type and opposition rank on the measures of variability, other game scenarios such as time in possession (Carling et al., 2016), technical performances (Lui et al., 2016) and phase of play (Dalton-Barron et al., 2021) could all influence the variability of the game locomotor activity. However, these measures were beyond the scope of this study where the development population considered was still mastering technical abilities and tactical awareness. The inclusion of such information would further inform our understanding of game play variability.

The final and novel finding of this study relates to the estimating of the linearised performance decrement for junior female national hockey athletes. The data highlighted that the only decisively substantial quarter-by-quarter performance decrement was observed for forwards' in the context of HSR. This performance decrement was 13% and 9% larger than what was estimated for defenders and midfielders, respectively, which provides evidence that forwards HSR reduced the most consistently (i.e., linearly) across a competitive game. However, it is not possible from the data to determine if this is due to fatigue or other game situational contexts.

7.5 Conclusion

Reflecting my position as a pragmatist it is important to note the practical implications of this chapter's study. Firstly the information presented in this chapter could be applied to training practices, for example creating times where midfielders and forwards must carry out high intensity efforts repeatedly in game scenarios with little recovery to help develop their anaerobic repeatability specific to the game. Secondly, and of greater interest to team sport development coaches and other practitioners (sport scientists, strength and conditioning coaches etc.), the framework used in this current study could be used elsewhere to interpret changes in game HSR and VHSR over time, representing a means to more accurately understand if worthwhile changes in game locomotor performance have occurred for a development player. This can form part of the jigsaw to assist coaches to determine whether athletes are physically ready to withstand a transition to higher training and competition levels i.e., vertically along the pathway. The SWC and threshold data can also be analysed to estimate reductions in variability measures over time. If the degree of variability is reduced without increased mean game locomotor output on specific metrics, then it could be interpreted that the players' locomotor activity of the given metric is more consistent and could be considered an improvement in performance. Similarly, if the mean game locomotor output is increased with a reduced variability range, an important improvement has also occurred.

Notably, as in previous chapters, the NGB could use this framework and analysis to create a shared understanding among practitioners working in the TDE as a means to assist them to assess the physical preparation of players for the inevitable increases in game locomotor demand as they transition through the pathway stages. However, it is essential that practitioners remember that the TD process is *complex,* particularly in a national level

team sport TDE. Chapters 2, 4 and 5 detailed the complexity of the TDE where multiple contexts exist, simultaneously influencing the development players' trajectory and experiences along the way.

Subsequently and critically, understanding national level game locomotor demands and the game-to-game variability thresholds young athletes should surpass over time to determine physical readiness to progress does not depict the whole picture. If we are to best support young high potential athletes in such complex TDEs using evidence informed practice we must also understand the game locomotor demands and variability in game-to-game data at other playing levels (e.g. club) horizontally across the TDE. It is important to establish if there is a difference in this variability compared to national level data to best determine the value these other playing contexts in the TDE are adding to the overall physical development of the athletes.

It is important to remember that the female athletes in the team sport TDE used throughout this thesis will often transition directly from the domestic playing level to the national playing level contrasting the male professional athlete that experiences high performance academies to help prepare the athlete for the higher demands of the elite senior level (Costello, et al., 2022; Morely et al., 2022). Therefore Chapter 8 applies a similar analysis and framework on club level GPS data using the same cohort of players to better understand this context within the TDE in which these athletes are simultaneously playing. This would subsequently assist in determining if they are positively influencing their physical development towards the senior elite level.

Chapter 8: Supporting the horizontal transition towards elite level; assessing physical preparedness using measures of variability in GPS locomotor activity

8.1 Introduction

The increase in physical game locomotor demands from lower to higher playing or competition levels has been highlighted in the literature (Burgess et al., 2012; Jennings et al., 2012). Progression to higher playing levels can require a transition from one age group to the next e.g., junior to senior vertically along the TD pathway, as explored in Chapter 7. Alternatively, this could also imply a step up from a lower to higher playing level or competition e.g., domestic to national level or horizontally across the TD pathway, reiterating the complexity of the TD process and the TDE. The literature presented in Chapter 2 (Section 2.3) pointed to the increase in game locomotor activity demands as athletes make the jump from lower to higher playing levels. This determined the need for players to be able to perform at a greater intensity when progressing to higher standards of play (Andersson et al., 2010; Brewer et al., 2010; Burgess et al., 2012).What is key then is that the TDE collectively supports this transition to higher playing demands. Often this is a more difficult task in a female team sport TDE because athletes can move from domestic level where resources and specialist staff are scarce (Emmonds et al., 2019) to national level without much time spent at provincial (regional) level to help bridge the gap, unlike other male team sport TDEs (Costello et el., 2022).

Chapters 2, 4 and 5 highlighted the complex jigsaw that exists in a national team sport TDE where multiple contexts exist, i.e., school, club, regional, national, and athletes will often simultaneously play across more than one context and therefore competition levels and

playing intensity. High potential young athletes are thereby exposed to different playing intensities regularly that may not be conducive towards physical progression (Phibbs et al., 2018). To support high potential young athletes to prepare for competition and simultaneously prepare for a possible transition towards higher playing levels coaches outside the national context must be aware of the physical game locomotor demands of their playing level and appreciate the difference in physical game locomotor demands of the next playing level. Additionally, some young athletes will enter, exit and re-enter the national TD pathway, some will enter the pathway late and some might be encouraged to progress more rapidly (Sweeney et al., 2021). It is important that TD pathway coaches have knowledge of the physical game locomotor demands of the domestic or lower playing level contexts to fully comprehend the physical demands players have previously been exposed to. Coaches can use this information to better support athletes when they transition to the national context.

Current literature is available to help practitioners understand the average game locomotor demands of domestic playing levels, using such knowledge to assist them to prepare athletes for their respective expected competition intensities (Andersson et al., 2010; Brewer et al., 2010; Vescovi, 2016). However, reflecting the analysis framework used in Chapter 7, practitioners need to question whether this information is enough to inform a decision to promote an athlete to the next playing level. Chapter 7 detailed the variability between- and within-games at the latter end of a team sport national TD pathway, assisting practitioners to better determine a young high potential athlete's physical readiness to transition from junior national to senior national level. Chapter 7 also noted that within-game variability in club level hockey has previously been explored in one study by Espenschade in

1936. This study suggested different playing levels can exhibit diverse game movements. For example, at the lower competition level forwards covered greater distances, while defenders covered less distances than their counterparts playing at the higher standard of competition, and midfielders exhibited the greatest within-game variability (Espenschade, 1936). Other literature has highlighted young TD pathway athletes concurrently playing across multiple teams and contexts experience a large variability in week-to-week training and playing loads mirroring the chaotic nature of team sport TDEs (Phibbs et al., 2018). This information reiterates the need to understand the variability in game locomotor activity of playing levels other than the national level alone. Furthermore, as exit and re-entry or later entry points can feature in a national TD pathway (Sweeney et al., 2021) knowledge of game locomotor variability could assist practitioners in understanding the average game-to-game variability thresholds and within-game variability athletes are exposed to at the lower playing level. If specific between-game locomotor activity thresholds at a lower playing level are established as in Chapter 7, an individual's data can be analysed to assist in a decision regarding their ability to cope physically with a progression to higher playing levels, i.e. from club to national level, and provide an appreciation of the necessary support to help with the increase in physical demands (Doncaster & Unnithan, 2019).

Understanding the between- and within-game variability at the lower playing levels should inform practitioners of the thresholds that development athletes are exposed to across other playing contexts. Practically this would support practitioners to understand and assist with better planning of physical training to complement these athletes' development and benefit their adaptation to demands in order to ensure appropriate preparation for

international competition intensity, the aim of most TDEs. A SMM approach where coherence and effective communication are key features can assist practitioners in mapping out pathway players' periodised plans that allow for simultaneous and competing playing levels to be prioritised at different periods of the year/season and complement a holistic approach to players' long term development (Hauser et al., 2022; Taylor & Collins, 2021; Webb et al., 2016). Performance development and athlete progression require a degree of individualisation. It is important to quantify the exposed locomotor demands along the national TD pathway as well as at the lower domestic levels if complex national TD programmes are to strategically and successfully develop youth players.

The aim of the current study was to estimate between- and within-athlete variability data to form threshold values for the interpretation of changes in physical game locomotor activity over time in a domestic club level context, using the same framework used in Chapter 7. This same framework allows interpretation of game-to-game changes in physical performance, and comparing the results of this study to the results in Chapter 7 aims to support our understanding of athletes' physical preparedness to transition towards the increased physical game locomotor demands of international competition (horizontally across the pathway) as per the aim of this thesis. This will facilitate an enhanced understanding of differences in game locomotor activity demands between domestic and national playing levels in which these players were simultaneously involved. This will enable a deeper understanding of whether the club game is facilitating the players' progression towards the national level and as such playing an important role in the TD of the participants.

8.2 Methods

8.2.1 Participants

Nineteen female junior national hockey players (Table 8.1) playing concurrently with their respective senior club level hockey team in a domestic competition participated in this study. Participants were the same participants used in Chapter 7 from a single national junior hockey team. The participants were grouped by playing position into defenders (n=8), midfielders (n=5) and forwards (n=6). Ethical approval was obtained from the university's ethical review board. Participants provided informed consent to participate in the study. In the case of participants under 18 years of age, participant assent was obtained in conjunction with consent from a parent or guardian (Appendix A10).

8.2.2 Procedure

The current study was designed to explore the variability in locomotor activity in female domestic senior club level hockey games and to estimate the degree to which there are differences in this variability between positional groups. Over the course of a domestic senior club level hockey season, game locomotor activity data were collected using GPS technology. Game data were interpreted as the relative distance for each quarter of a game and per speed zone to account for the differences in playing time between players. Before the game play, participants were advised to abstain from any strenuous activity and to maintain normal pre-game routines and diet.

Game movement data to assess locomotor activity were collected as part of the players' normal training and game routine using GPS units throughout the entirety of domestic club level games (n=129) and analysed retrospectively to include players' time on the pitch. This data was collected by fitting participants with the same portable GPS units

specified in Chapter 7. Participants were familiar with the data collection procedure as part of their usual match routine. Data were collected for one hundred and twenty nine club level hockey games over a period of one domestic senior club season (174 individual game observations, mean 9 games per player, range 3-23; 696 individual quarter observations, mean 37 quarters per player, range 12-91). Games were played against domestic club level opposition ranging in national club level rankings between number 1 and 12. Mirroring Chapter 7, game locomotor activity metrics were quantified by deriving the relative distance ($m.min^{-1}$) covered for each quarter of a game and in three separate speed zones (low speed movement, LSM: 0-16km/h, high speed running, HSR: 16-19.9km/h and very high speed running, VHSR: >20km/h). These speed zones were chosen based on previously published data in female international hockey (McGuinness, Malone, Petrakos et al., 2019; McGuinness, Malone, Hughes et al., 2019; McGuinness et al., 2020).

8.2.3 Data Analysis

Data were analysed in the Statistical Analysis System (SAS Institute Inc., Cary, NC). Linear mixed models (Hopkins & Hewson, 2001) were used to estimate the variabilities (i.e., random effects) for each locomotor activity metric whilst controlling for: (i) changes in the means between repeated measurements (i.e., means of 696 individual quarter observations across 129 games), and (ii) differences in changes in means between positional units (i.e., between defenders, midfielders, and forwards), and (iii) contextual factors, i.e. differences in the results (win n=69, loss n=34, draw n=26), location (home n=63, away n=55, neutral=11), and type (competition n=124, friendly n=5) of game, and opposition ranking. For each metric, the between- and within-athlete variability was estimated (the latter representing game-to-game variability for an individual athlete, on average). The within-athlete variability from a quarter-to-quarter perspective (representing the variability for an individual athlete between

quarters of a game, on average) was also estimated, as was the extent to which this within-athlete quarter-to-quarter variability differed between positional units.

Consistent with the methodology in Chapter 7, relative distances for each metric were log transformed to reduce non-uniformity of error (Hopkins, et al., 2009) and express effects in percentage units (after back-transformation) (Hopkins, 2000). The resulting variabilities therefore represented coefficients of variation (CV). The fixed effects associated with points (i), (ii) and (iii) above represent percentage changes in relative distances covered across a game, on average (i.e., percentage linearised performance increment or decrement) and differences in these changes between positional units (i.e., differences in the percentage linearised performance decrement across a game, on average), respectively.

Uncertainties are presented as 95% confidence intervals alongside p values. Effect sizes were based on SWC values which were derived using the principle of standardisation (Cohen, 1988). CVs thresholds were calculated by multiplying the observed between-athlete CV (i.e., sum of estimated between- and within-athlete CVs) by: <0.1, trivial; ≥0.1 to <0.3, small; ≥0.3 to <0.6, moderate; ≥0.6 to <1.2, large; and ≥1.2, very large (Hopkins, 2015). Fixed effects thresholds were calculated by multiplying the observed between-athlete CV by: <0.2, trivial; ≥0.2 to <0.6, small; ≥0.6 to <1.2, moderate; ≥1.2 to <2.0, large; and ≥2.0, very large (Hopkins et al., 2009). Differences in the CV representing within-athlete variability between quarters of a game, on average were regarded as substantial when the CV differed between positional units by a factor of 1.15, or 15% (Hopkins & Hewson, 2001). All estimates were deemed to be decisively substantial when the chances of a trivial effect size was ≤5%. Comparisons between club level data and national level data (presented in Chapter 7) were calculated using a spreadsheet resource recommended by Hopkins (2006).

8.3 Results

8.3.1 Relative Total Distance (TDist)

The observed between-athlete SD for relative total distance (TDist) covered by athletes competing in club level competition was 18%. This resulted in a SWC of 1.6% and 3.3% for the corresponding random and fixed effects, respectively.

Random effects

TDist covered in a club level game did not differ substantially between athletes (Table 8.2). The game-to-game variability for an individual athlete competing at club level was 7.5% (Table 8.2 and Figure 8.1a). TDist covered between quarters of a club level game differed within individual athletes by 14%, on average (Table 8.3 and Figure 8.2). There was a substantial difference in this quarter-to-quarter variability between forwards and defenders (approximately 44% [95%CI, 15-80, p = 0.001] larger for forwards).

Fixed effects

TDist covered per quarter of an average club level game was 92 $m.min^{-1}$ (95%CI, 84-100 $m.min^{-1}$) (Table 8.4), with no clear differences found between positional units. A 10% and 8% performance decrement for TDist covered across club level games was observed for midfielders and forwards respectively (Table 8.5). None of the remaining estimates that represented average performance decrement for TDist covered were decisively substantial.

8.3.2 Relative Low Speed Movement (LSM)

The observed between-athlete SD for relative low speed movement (LSM) distance covered by athletes competing in club level competition was 17%. This resulted in a SWC of 1.6% and 3.2% for the corresponding random and fixed effects respectively.

Random effects

LSM distance covered in a club level game did not differ substantially between athletes (Table 8.2). Game-to-game variability for an individual athlete competing at club level was 6.4% (Table 8.2 and Figure 8.1c). LSM distance covered between quarters of a club level game differed within individual athletes by 15%, on average (Table 8.3 and Figure 8.2). There was a substantial difference in this quarter-to-quarter variability between forwards and defenders (approximately 32% [95%CI, 62-90, p = 0.006] larger for forwards).

Fixed effects

LSM distance covered per quarter of an average club level game was 80 $m.min^{-1}$ (95% CI, 74-87 $m.min^{-1}$) (Table 8.4), with no clear differences between positional units. Performance decrement for LSM distance covered across club level games was observed for both midfielders and forwards (10% and 8% performance decrement respectively) (Table 8.5). None of the remaining estimates representing average performance decrement for distance covered were decisively substantial.

8.3.3 Relative High Speed Running (HSR)

The observed between-athlete SD for relative high speed running (HSR) distance covered by athletes competing in club level competition was 59%. This resulted in a SWC of 4.7% and 9.7% for the corresponding random and fixed effects, respectively.

Random effects

HSR distance covered in a club level game did not differ substantially between athletes (Table 8.2). The game-to-game variability for an individual athlete competing at club level was 18% (Table 8.2 and Figure 8.1b). HSR distance covered between quarters of a club level game differed within individual athletes by 47%, on average (Table 8.3 and Figure 8.2). There was a substantial difference in this quarter-to-quarter variability between midfielders and

defenders (approximately 71% [95%CI, 27-131, p < 0.001] larger for defenders), and between midfielders and forwards (approximately 68% [95%CI, 23-129, p = 0.001] larger for forwards).

Fixed effects

HSR distance covered per quarter of an average club level game was 6.7 $m.min^{-1}$ (95%CI, 5.3-8.5 $m.min^{-1}$) (Table 8.4), with no clear differences between positional units. None of the remaining estimates representing performance decrement for HSR distance were decisively substantial (Table 8.5).

8.3.4 Relative Very High Speed Running (VHSR)

The distribution of very high speed running (VHSR) data across club level games were zero inflated and over-dispersed. This is primarily because a large proportion of the sample did not achieve running speeds over 20km per hour at the club level of competition.

Table 8.1

Participant characteristics at senior club level

	All	Defenders	Midfielders	Forwards
	n=19	n=8	n=5	n=6
Height (cm)	166.4 ± 5.4	169.3 ± 4.5	161.6 ± 2.9	166.5 ± 5.6
Body mass (kg)	63.5 ± 7.0	68.4 ± 7.0	60.02 ± 4.9	59.9 ± 4.7
Age (y)	20 ± 0.9	20 ± 0.9	20 ± 1.1	20 ± 0.6

Data represent means ± SDs.
Abbreviations: cm, centimetres; kg, kilogrammes; y, years; SD, standard deviation.

Table 8.2

Between and within athlete variabilities at senior club level expressed as a CV

	Between			Within		
m.min^{-1}	**CV[a] (95% CI)**	**MBD[b]**	**p**	**CV[c] (95% CI)**	**MBD**	**p**
TDist	6.6 (-3.8 to 10.3)	unclear	0.149	7.5 (3.6 to 10.1)	moderate*	0.009
LSM	6.3 (-2.9 to 9.5)	unclear	0.114	6.4 (1.9 to 8.9)	moderate*	0.031
HSR	26.2 (-9.6 to 41.1)	unclear	0.099	18 (-3.5 to 27)	moderate*	0.061

[a]This CV represents the average difference in the distance covered of an average game between individual athletes.
[b]Effect sizes for these random effects were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.1, small; 0.3, moderate; 0.6, large; 1.2, very large. Asterisks indicate effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.10).
[c]This CV represents the average game-to-game variability for an individual athlete.
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; CV, coefficient of variation; TDist, total distance; LSM, low speed movement; HSR, high speed running.

Table 8.3

Within athlete quarter-to-quarter variabilities at senior club level expressed as a CV

	Overall		Defenders		Midfielders		Forwards	
	CV[a] (95% CI)	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**	**CV[c] (95% CI)**	**MBD[b]**
TDist	14 (13 to 16)	large*	12 (10 to 14)	large*	14 (12 to 16)	large*	17 (15 to 20)	large*
LSM	15 (13 to 16)	large*	12 (11 to 14)	large*	15 (13 to 18)	large*	16 (14 to 19)	large*
HSR	47 (42 to 53)	large*	57 (49 to 67)	large*	33 (26 to 44)	large*	55 (47 to 67)	large*

[a]This CV represents the extent to which the distance covered by an individual athlete differs between quarters of an individual game.
[b]Effect sizes for these random effects were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.1, small; 0.3, moderate; 0.6, large; 1.2, very large. Asterisks indicate effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.10). All p values were < .001 and are therefore not shown.
[c]This CV represents the extent to which the distance covered by the given positional group differs between quarters of an individual game.
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; CV, coefficient of variation; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

Table 8.4

Relative distance covered in an average quarter at each speed zone at club level

	Overall	Defenders	Midfielders	Forwards
	m/min[a] (95% CI)	**m/min[b] (95% CI)**	**m/min[b] (95% CI)**	**m/min[b] (95% CI)**
TDist	92 (84 to 100)	91 (82 to 100)	92 (82 to 103)	92 (83 to 102)
LSM	80 (74 to 87)	81 (74 to 89)	81 (73 to 90)	79 (72 to 87)
HSR	6.7 (5.2 to 8.5)	5.6 (4.2 to 7.5)	6.8 (4.8 to 9.6)	7.9 (5.8 to 10.8)

[a]Data represent the average relative distance for the team in an average quarter of a game
[b]Data represent the average relative distance for each positional group in an average quarter of a game
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

Table 8.5

Mean performance decrement across an average senior club level game for each positional group

	Overall			Defenders			Midfielders			Forwards		
	%↓[a] (95% CI)	**MBD[b]**	**p**	**%↓[a] (95% CI)**	**MBD[b]**	**p**	**%↓[a] (95% CI)**	**MBD[b]**	**P**	**%↓[a] (95% CI)**	**MBD[b]**	**p**
TDist	-8.1 (-20 to 5.6)	unclear	0.099	-5.8 (-29 to 25)	unclear	0.235	-10.3 (-17.2 to -2.8)	moderate*	0.015	-8.1 (-15 to -0.7)	small*	0.036
LSM	-8.3 (-13.6 to -2.7)	small	0.019	-5.9 (-10.9 to -0.6)	small	0.037	-10.8 (-16.7 to -4.6)	moderate*	0.002	-8.2 (-13.8 to -2.2)	small*	0.011
HSR	-3.4 (-26 to 27)	unclear	0.627	1.3 (-20 to 28)	unclear	0.896	-11.7 (-32 to 14.2)	unclear	0.273	0.8 (-21 to 29)	unclear	0.944

[a]Data represent the average performance decrement for each positional group across an average game – i.e. linearised performance decrement quantified as a percentage.
[b]Effect sizes for these % performance decrement values were derived by multiplying the % between athlete SD for each speed zone by the following values: 0.2, small; 0.6, moderate; 1.2, large; 2.0, very large. Asterisks indicate % performance decrement effects sizes that are decisively substantial, which means that the 95% CI did not cross the threshold demarcating either a substantial negative or positive effect magnitude (i.e., the % between athlete SD multiplied by ±0.20).
Abbreviations: CI, confidence interval; MBD, magnitude-based decision; TDist, total distance; LSM, low speed movement; HSR, high speed running; VHSR, very high speed running.

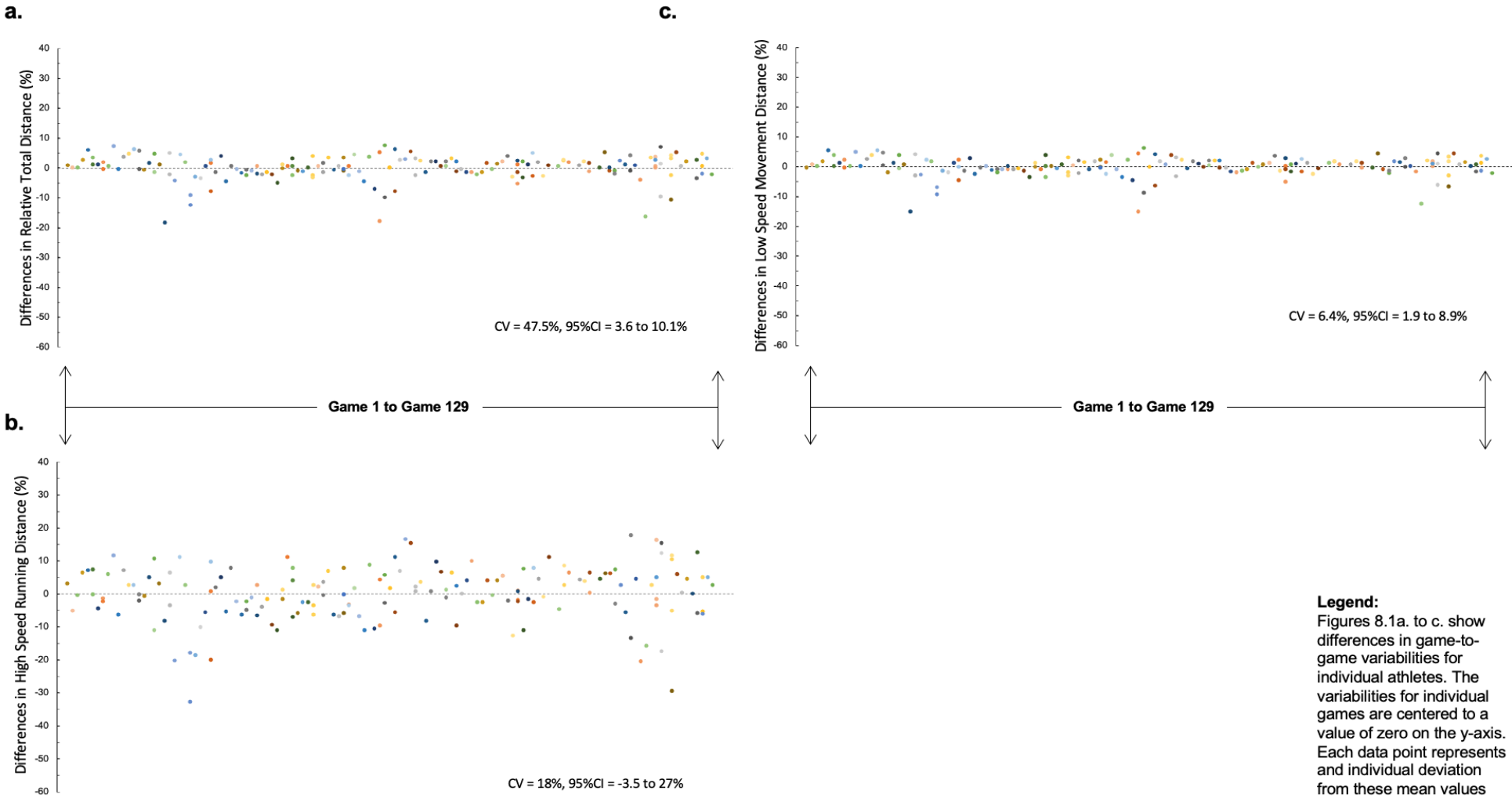
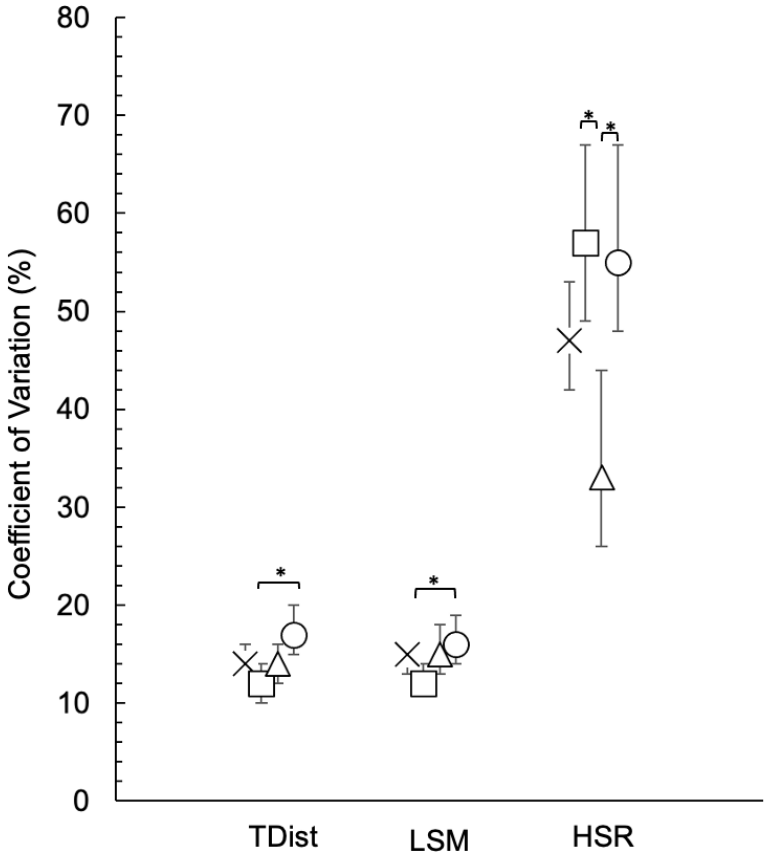


Figure 8.1

Game-to-game variabilities in TDist (8.1a), LSM (8.1b) and HSR (8.1c)



Key:
×Mean
□Defender
○Forward
△Midfielder

Legend:
Figure 8.2 shows the mean and position-specific quarter-to-quarter variabilities (%CV) for relative total distance and for relative distances covered within two different speed zones. Error bars represent 95%CIs. Asterisks represent decisively substantial differences between positional units.

Abbreviations:
CI, Confidence Interval.
CV, Coefficient of Variation.
TDist, Relative Total Distance.
LSM, Relative Low-Speed Movement Distance.
HSR, Relative High-Speed Running Distance.

Figure 8.2

Mean and position specific quarter-to-quarter variabilities in each speed zone

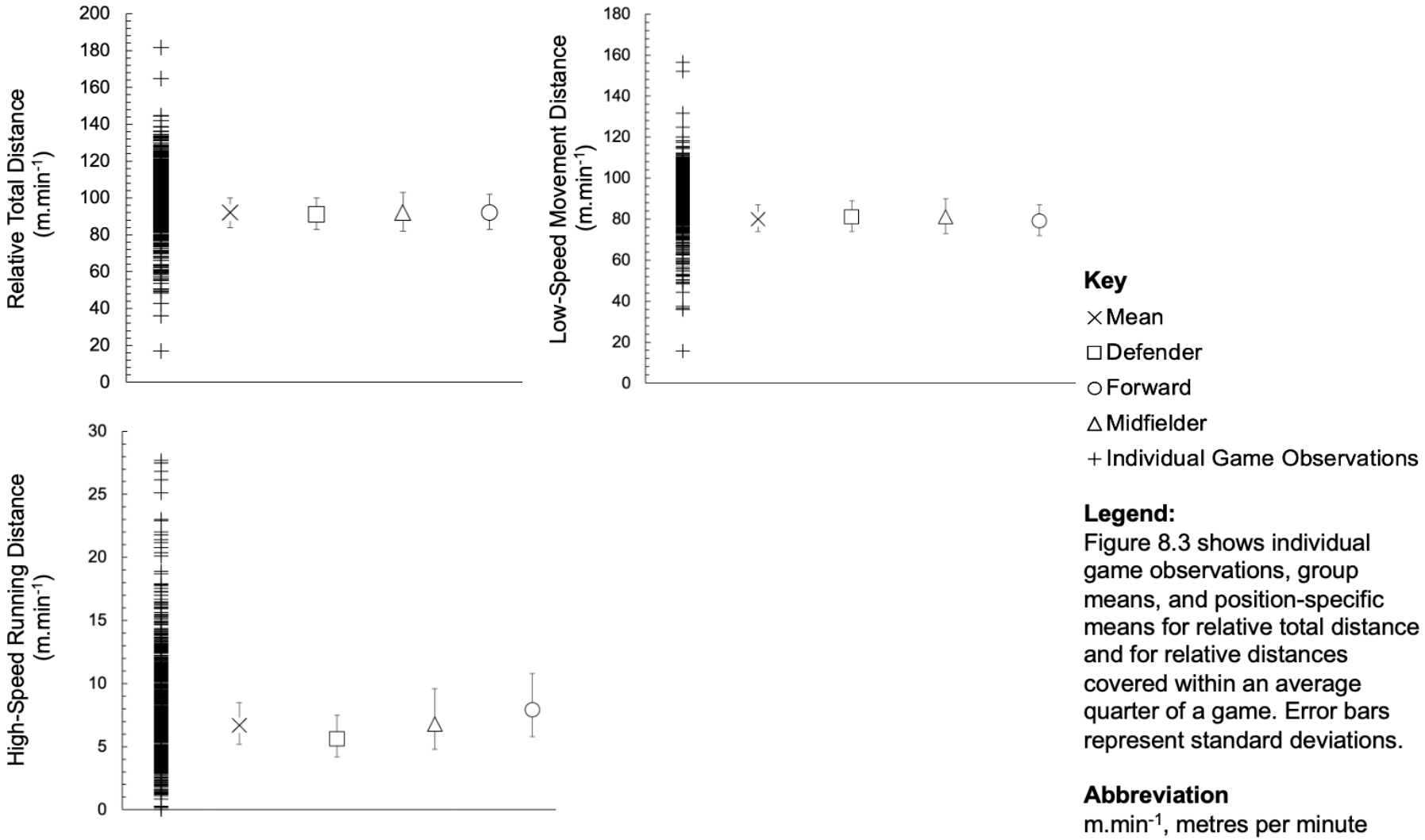


Figure 8.3

Individual, group and position specific means for relative distances in each speed zone

8.4 Discussion

Using between- and within-athlete variability data to form threshold values for the interpretation of changes in physical game locomotor activity over time, the aim of this chapter's study was to analyse the variability data using GPS locomotor activity metrics from senior club level domestic hockey games with players from the same junior national age grade team used in Chapter 7. Using the same framework as Chapter 7 and in line with objective 4c, this chapter aimed to understand comparisons between this variability data and the results from Chapter 7 to better inform decision making on the physical preparedness of young high potential athletes to transition towards the increased physical game locomotor demands of national level (i.e. horizontally across the TD pathway). Between- and within-game variability data provides a more detailed picture of the game locomotor activity demands. This information could support coaches to acknowledge if players progressing from the club level context are being prepared to withstand the game movement demands they are likely to experience if they transition to higher competition standards. This is important to understand given high potential young athletes will often co-exist across multiple playing contexts, as was the case in this study (see Figure 1.4). Both the national and club level playing contexts are necessary cogs in a national team sport TDE and as highlighted previously young athletes that show promise for future senior national representation can regularly be exposed to varied and inconsistent playing loads whilst part of a TD pathway (Phibbs et al., 2018).

The comparison of national and club level results seeks to support practitioners' understanding of the game locomotor activity demands in a lower playing level and better estimate if the club competition is preparing players towards similar game locomotor

fluctuations they would experience at national level (Chapter 7). As mentioned in the introduction, one study has previously explored the within-game variability of club level hockey games (Espenschade, 1936). Though Espenschades (1936) manually derived data predates the use of GPS, it provides an initial insight into the within-game variability across a club level hockey game, on average and the positional differences that exist. This study adds to Espenschades findings and to my knowledge is the first study using objective GPS data from female senior club level hockey games to estimate the between- and within-game variability, and provides a novel and important contribution to the existing literature.

Firstly, and in line with previous findings from other sports (female soccer, Andersson et al., 2010; male hockey, Jennings et al., 2012) the results in this study show a disparity in game locomotor activity demands where club level games are played at a slower pace than the higher standard national level depicted in Chapter 7. The mean relative distances covered ($m.min^{-1}$) per quarter in club level games on average (Table 8.4) were lower for TDist (92 v 111 $m.min^{-1}$), LSM (80 v 98 $m.min^{-1}$) and HSR (6.7 v 9.7 $m.min^{-1}$) than in an average national level game for the same athlete population as Chapter 7. This is an important finding in understanding the contribution club level hockey is/is not playing in this TDE to prepare the athletes for higher level competition. While there were no substantial differences between playing levels for defenders in each speed zone the greatest difference in mean quarter relative distance between playing levels was for HSR for both midfielders (6.8 v 10.4 $m.min^{-1}$) and forwards (7.9 v 11.8 $m.min^{-1}$) and VHSR for all positions highlighting less distance covered in high speed movements at club level.

Mirroring results in Chapter 7 from national level games, and adding to Espenschades work (1936) the greatest source of variability for a player from this population playing at the club level happens within-game i.e., between the quarters of a game rather than between-games. Hopkins (2006) spreadsheet to compare differences in changes in means between groups allowed for the comparison of national level data (Chapter 7, Table 7.3) and club level data (Table 8.3). All positional units exhibited large quarter-to-quarter variability in all speed zones in club level games (Table 8.3). Unlike national level results (Chapter 7, Table 7.3) and data supplied by Espenschade (1936) where quarter-to-quarter variability was highest for midfielders, forwards had the greatest within-game variability for TDist and LSM at club level which was substantially greater than defenders by a factor of 1.4 and 1.3 respectively (Hopkins, 2006). Though forwards quarter-to-quarter variability did not differ substantially from national level (Chapter 7, Table 7.3), defenders quarter-to-quarter variability for TDist and LSM was higher at national level compared to club level by a factor of 1.7 and 1.6 respectively. This variability represents changes in these metrics between quarters whilst accounting for the fixed effects of contextual factors (i.e., position, result, location, game type, opposition rank), suggesting defenders experience less fluctuations in locomotor activity from quarter-to-quarter in club level games. Similarly, national level quarter-to-quarter variability for midfielders (Chapter 7, Table 7.3) was higher than club level games by a factor of 1.8 and 2.0 for TDist and LSM respectively. This important finding clearly suggests a difference in within-game positional locomotor demands between playing levels, where national level games demand higher fluctuations in game locomotor activities from one quarter to the next.

Importantly, considering hockey is a fast-paced intermittent team sport primarily comprised of low to moderate intensity running interspersed with frequent bouts of high velocity locomotor activity (FIH, 2019; Gabbett, 2010), understanding the quarter-to-quarter variability in the higher speed zones is key. For HSR there was a trivial difference in the within-game variability between playing levels for defenders. However, in national level games midfielder participants exhibited a higher within-game variability than club level (1.2 factor difference) and contrastingly, forwards showed a higher within-game variability for HSR at club level than national level (1.28 factor difference). As described in Chapter 7 the very large quarter-to-quarter variability for midfielders and forwards at national level depicts these positions' frequent transitions between low and high-speed running where one quarter more than another might demand less recovery time between high intensity efforts (depending on the given quarter context, Cunniffe et al., 2022). Accompanied by the lower HSR mean quarter $m.min^{-1}$ value portrayed earlier, the lower quarter-to-quarter variability for midfielders and forwards presented here suggests these players do not cover the same distance or experience the same fluctuations in locomotor activity in this speed zone when playing club level versus national level games.

Forwards possibly experience more fluctuations in HSR locomotor demands in different quarters whilst midfielders experience less. Both positions spend less time in HSR per quarter overall. This information provides important insights for TD coaches suggesting high potential young athletes may not be exposed to the same threshold of intensity or high speed locomotor activity during a club game than would be expected when progressing to international competition levels (McGuinness, Malone, Petrakos et al., 2019; McGuinness,

Malone, Hughes et al., 2019; Macutkiewicz & Sunderland, 2011). This is an important consideration for practitioners when a young promising player is preparing for international play, they may need to be supplemented with a conditioning programme to help develop their anaerobic repeat endurance (McGuinness, Malone, Petrakos et al., 2019).

It is important to reiterate that the population used in this study were the same young high potential athletes that simultaneously competed in the national level games explored in Chapter 7. The slower pace of the club level game and divergent quarter-to-quarter high speed locomotor activity suggests the game locomotor demands are not as strenuous or physiologically demanding as players would experience in national level competitions. The data further illustrates a decisively substantial small and moderate quarter-by-quarter performance decrement across a game for defenders and forwards respectively for both TDist and LSM (Table 8.5). Since these are the same players competing in both playing levels this result possibly indicates fatigue is not the causative factor and it proposes that the pace of the game further slows from quarter one to quarter four at the lower playing standard. This is consistent with the data presented by Espenschade (1936) and contrasts national level game data from Chapter 7 (Table 7.5). This information further adds to the argument that club level competition is not representative of the game movement demands athletes are likely to experience when playing at higher standards of play and as such adds less value to their physical development towards the higher playing level.

Another key finding of this study highlights that game-to-game variability for a junior national hockey player in this population competing in a senior club level hockey competition was moderate for TDist (7.5%), LSM (6.4%) and HSR (18%). These results are unlike national

game data (Chapter 7, Table 7.2) where the observed between-game variability for an individual athlete was small for TDist (4.9%) and LSM (5.0%) and moderate for higher speed movements (HSR, 22% and VHSR, 35%). This is consistent with other studies in elite level populations where the between-game variability is greater in the higher speed zones (Kempton et al., 2014; McLaren et al., 2016; Sunderland & Edwards, 2017; Trewin et al., 2018).

Club level games had a higher between-game variability than national level by a factor difference of 1.5 and 1.3 for TDist and LSM respectively for the same players competing in both competition levels (Hopkins, 2006). Practically this factor difference highlights that players will experience greater fluctuations in the average total distance they will cover in a game when they play multiple games at club level compared to the national level. The observed small between-game variability for TDist and LSM in national level games presented in Chapter 7 allows for these metrics to be used for tracking load measurements as they seem to be stable and consistent indicators of these specific game locomotor demands at national level (Doncaster & Unnithan, 2019). Research has depicted young TD pathway athletes experience high variability in playing load on a weekly basis (Phibbs et al., 2018) therefore it is important to track and manage these players' training and game load to ensure they are not at increased risk of overload, undue fatigue and possible resulting underperformance (ACSM, 2019). Comparatively the higher between-game variability at club level for these same metrics suggests they are not as consistent and less reliable if being used to track, manage and predict load for athletes from this population when playing at club level. For the athletes in the TDE studied in this chapter and throughout this thesis, a SWC of 1.6% and 4.7% estimated average game-to-game variabilities of moderate effect size (7.5% and 18%) for

TDist and HSR respectively. Whilst accounting for the fixed effects mentioned earlier this moderate game-to-game variability for TDist indicates this metric is not as stable or reliable for tracking load in players who co-exist across both playing contexts and requires caution when being used for predicting or planning out pathway player load plans (Doncaster & Unnithan, 2019).

Contrastingly, the observed between-game variability for HSR was higher for national level games than club level by a factor difference of 1.2. Considering the VHSR distance covered in club level games were zero inflated, the data from this study indicate time spent in the higher speed zones is less at the lower playing level. Therefore when playing at national level athletes will experience greater fluctuations between-games in the distance they will accumulate in the higher speed zones. Since the relative intensity ($m.min^{-1}$) at club level is lower for HSR compared to national level (6.7 v 9.7 $m.min^{-1}$) and with lower between-game fluctuations in this zone, the club level competition is not preparing players for the higher intensity they will experience at national level (Doncaster & Unnithan, 2019).

In practical terms Chapter 7 uses a framework of analysis to determine threshold values for the indicated GPS metrics to better estimate a real change in performance over time for young development athletes. In Chapter 8, the between-game variability data from the club level competition can similarly be used to determine a change in performance over time for an athlete who is competing at the club level only with the potential to transition towards the national TD pathway (Doncaster & Unnithan, 2019). Furthermore, using this same framework in the club level data allows us to better understand differences in the physical locomotor demands between the domestic club competition and national level

competition. More specifically comparing the relative intensity of an average quarter along with the within-game quarter-to-quarter variabilities allows for a more in depth understanding of the difference in game locomotor movement experienced by athletes when competing in these different playing levels. This information should assist practitioners understanding of the support club level athletes will need to better develop their physical capacity and prepare them for the higher intensities they are likely to experience if they transition to the national level as depicted by the differences between the data from Chapter 7 and 8.

8.5 Conclusion

In line with the pragmatic philosophy employed in this research and building on findings from Chapter 7 it is important to acknowledge how the information presented in these chapters can benefit a national team sport TDE. It is clear a disparity in game locomotor activity demands exists between the club and national playing levels which is crucial given young high potential athletes will compete in both playing levels, often simultaneously. Though the greater between-game variability makes it more difficult to monitor and guestimate expected game load measures, it can be expected that young athletes already part of the national level programme will cope physically with the club level game locomotor demands. Considering the game-to-game variability is greater, yet the pace of the game and quarter-to-quarter variability is mostly lower at club level, junior national team athletes *should* cope physically in club level games more comfortably than at national level.

Knowledge of these findings assists practitioners when organising and planning the playing and training calendar for junior national team athletes. Understanding that club level

games are not as physically demanding for these players, this competition can be used in windows where coaches might want a reduced playing intensity while still maintaining a sport specific stimulus. On the other hand, coaches could interpret this information to use the club level competition as a better alternative when a junior national athlete is not psychologically handling the high performance environment of the national level well.

Chapter 6 explored PCDEs, key psychological skills required in the development and progression of talented athletes along the TD pathway (Collins & MacNamara, 2017). At times when a young high potential athlete is not coping psychologically with the demands of the junior national level programme, exiting the pathway and spending more time at the club level may provide a better context for them to grow and develop PCDEs such as realistic performance evaluation, goal setting, actively seeking social support (Collins & MacNamara, 2017). As such the NGB should encourage and support a SMM approach throughout the TDE (explored in Section 2.1.6) across the playing contexts. The SMM would encourage sharing knowledge and learnings to support coaches in other contexts (Mathieu, et al., 2000; Gershgoren, et al., 2013; Taylor, Ashford & Collins, 2022; Taylor, MacNamara & Taylor, 2022) with for example the PCDEs that a player may lack when they exit the national TD pathway. Collaboratively working to holistically develop young high potential players is key to ensure success across complex TDEs where multiple stakeholders are responsible for athlete development. This would then best prepare athletes to re-enter the national context when ready (Bjørndal & Ronglan 2018; Bjørndal et al., 2017).

Lower competition levels also provide a platform for potential athletes not yet recognised to be identified as future prospects. The information gathered in this study is

critical for such athletes, particularly those making the transition from senior club level competition to junior national level where a clear step up in physical game locomotor demands is evident. Supporting late developers or late entry points for athletes into TD pathway programmes is recommended (Sweeney et al., 2021). While recognising club level competition is an essential part of a young athlete's development and progression to higher playing levels, the data presented in this chapter suggests it is not sufficient in developing an athlete's physical capacity to meet the demands of higher level competition. It appears the transition from senior club level to national level is one that athletes must be supported physically with in order to prepare them for the transition to higher playing standards. Conversely, whilst the young athlete who may exit the national TD pathway programme *should* cope physically with the lower intensity club level competition it is important this athlete can physically transition back to the higher playing demands at national level.

The SMM approach would encourage strength and conditioning practitioners to share information regarding the type of training used at the higher competition level to assist with maintaining and increasing anaerobic capacity in players. Practitioners can use the framework from this and the previous chapter to determine threshold values for the individual's between- and within-game variability. Since higher speed movements are an important element of the game, specifically for athletes playing in midfield and forward positions (McGuinness, Malone, Hughes et al., 2019; Sunderland & Edwards, 2017), tracking these metrics over time for individuals would assist with determining when an athlete can consistently produce high speed movements at the upper end of their specific between-game variability threshold. Such information could be determined as an improved physical

anaerobic capacity (Doncaster & Unnithan, 2019), assisting decisions of an individual's readiness for a national level programme.

8.6 Practical Guideline

This analysis framework from both Chapter 7 and 8 could be used to determine between-game variability measures once or twice per season whilst still allowing for the 'normal' everyday collection of GPS data to be continually used for understanding training intensities and preparation for competition. Using SPSS or SAS a linear mixed model (LMM) programme can be developed to analyse longitudinal log-transformed GPS data as it's commonly collected in team sports (i.e., individual game data per metric). This programme can be re-run multiple times over a number of seasons adding new data each season to reanalyse the thresholds each time as this will change in line with a change in playing groups at the junior development age. However the LMM programme once developed can be saved and re-run in the online statistical software determining threshold values each year or season. The residual (or random variability) found in the model calculated as a CV% is considered the threshold. To estimate the size of this threshold, the CV% is multiplied by 0.1 (explained further in section 7.2 and 8.2) to determine the SWC and relative effect sizes indicating if it is a small, medium or large threshold i.e., relatively how much change is required before determining it as a real change in performance over time.

Chapter 9: Discussion, Practical Implications and Future Directions

9.1 Introduction

This thesis was guided by my pragmatic approach to research (Giacobbi et al., 2005) recognising that in a data informed and often data driven world research studies should provide means to support evidence informed decisions and approaches to practice in TD. As an experienced practitioner working at both elite and development levels across a number of national female TD pathways, I recognise the importance of using research to guide practice and inform decisions. However, my experiences in applying research to practice in female elite team sport and TD pathways have been limited by the paucity of research using female athletes in comparison to the large quantity of research reflecting male only populations (Curran et al., 2019). Of course, the available research on male athletes can be interpreted and learnings applied to female athletes; however, this can be difficult as it often does not reflect female sport contexts (Emmonds et al., 2019; Simpson et al., 2022) and conflicts with my scientist-practitioner views and approach.

Reflecting the importance of considering and understanding the context of the sport, both the research and my applied practice point to the complex nature of team sport TDEs. Interestingly, as noted in Chapter 2, much of the research in TD has focused on single club environments (e.g., professional academies or clubs) (Aalberg & Saether, 2016; Flatgard et al., 2020; Henriksen et al., 2010; 2010a; 2011). However, especially in team sports such as rugby, soccer and hockey, high potential young athletes are likely to be training and competing in multiple environments simultaneously (i.e., school, club, and national age grade). In this respect, the NGB as the system controller of the TD pathway should be responsible for the development of their sport from grassroots through to high performance

levels with input into the structure and processes of the TD systems at all levels of the pathway. Indeed, understanding and supporting the TD pathway appropriately is the means by which NGBs progress high potential young athletes from junior level through to elite senior levels; a requirement for the sustainability of elite senior representative teams.

The studies presented in this thesis recognised the need to look beyond a single TD setting and were particularly important as within team sport TDEs the TD process is particularly complex given they can encompass various contexts (e.g., school, club, regional/provincial, national) with different aims, objectives and modes of practice apparent in each of these settings. As emphasised throughout this thesis, TD is multidimensional and non-linear in nature and, from a NGB perspective, involves the entry, exit and re-entry of athletes along their development journey (Abbott et al., 2005; Sweeney et al., 2021). This process is facilitated by coherence between the different settings (e.g., club, school, national) and stakeholders' understanding of both the whole process and their role within the TD pathway. Of course, there is already a robust understanding of the key features of effective TDEs (e.g., Martindale et al., 2005; 2007; Henriksen et al., 2010; 2010a; 2011). However, as already highlighted, the majority of this research is conducted in male sports. Given there are differences in terms of depth of talent, performance markers and potential design of the TD pathway and systems in male and female sport, it was important to consider the TDE and pathway in female team sport.

As such, and reflecting on my role as an applied practitioner in development and performance female sport, the main aims of this thesis as identified in Chapter 1, were:

1) To examine gaps within TD research, specifically the lack of research relating to female athletes

2) To explore the complex TDE of a national female team sport and the coherence, or lack of across the school, club, provincial and national contexts from an athlete and coaching perspective
3) To investigate the psychological characteristics for developing excellence (PCDEs) in a national female team sport TDE across playing groups (U16, U18, U21 senior level), and compare the results between groups and to the 'ideal score'
4) To estimate between- and within-athlete variability data to form threshold values for the interpretation of changes in physical game locomotor activity over time in a female team sport using a junior national level team to represent the national context, and the same players representing data in a club level context

Given my pragmatic research approach, and desire to provide practical solutions to an applied research question, this thesis required mixed methods in meeting the thesis aims (Feilzer, 2010). Using a mixed method approach allowed me to provide practically meaningful data to assist in making evidence informed decisions and suggestions for practice in national female team sport TDEs. Accordingly, the results of this approach are discussed in this chapter with suggested applications for practice.

9.2 Implications for literature

9.2.1 Recognising the gender data gap in TD research

Given the large volume of research in TD reflects mostly male experiences, in line with the first aim of this thesis, Chapter 3 sought to examine the quantity of available TD research that included female data. As an applied practitioner it was important to determine if the research findings could be applied to female team sport TDEs. The literature search in Chapter 3 highlighted the dearth of research relating to female athletes in TD.

We can interpret the available TD research as informative and apply understanding across other sports, contexts etc. However, we must critically assess this data against the growth of interest in female sport (Chapter 1). We cannot assume male and female experiences are mirrored. In fact, often contextual factors such as funding, access to facilities and staff are limited in female sports (Emmonds et al., 2019; Simpson et al., 2022). Recognising the context within female sport settings often differs from male sport settings is important. Chapter 3 outlined the disparity in research using female only compared to male only populations in TD generally (10.5% versus 73%) and more specifically in other areas of TD. For example, Chapter 3 outlined studies relating to maturation or relative age effects are more prominent in male populations (8% versus 57% of included studies). However recent studies including both male and female soccer teams have highlighted a difference exists between genders suggesting relative age effects are present in youth male soccer and less prevalent in female soccer settings (Andrew et al., 2022; Götze & Hoppe, 2021). These studies recognise this may be related to the reduced popularity and a resultant lower talent pool in female team sports. The lower participation levels in female sports renders less competition for elite level team or TD pathway places (Andrew et al., 2022; Götze & Hoppe, 2021; Simpson et al., 2022). Therefore it can be deduced that female team sport settings do not mirror male team sport environments. Critically, the shallow talent pool, different structures and less competition for places at the elite level suggests a different approach to selection, and subsequent TD processes in the TDE might occur in female team sport.

Costello et al's (2022) case study in an elite or professional male rugby union TDE illustrates a regional or provincial elite sport setting with multiple contexts (club, school, regional academy, national training squad). In this example the talent academy at the provincial level is aligned to the provincial senior team programme, training approach and

operates at the same training base. The academy manager facilitates the coherence vertically on the TD pathway. Additionally players that compete at school or club and that simultaneously train with the national training squad also fall under the academy managers remit, facilitating horizontal coherence in the process. The talent pool is large and the TD process requires a pathway cognisant of the multiple playing contexts yet aligned to the rugby unions goals and performance markers (Costello et al., 2022). In this context a coherent approach was illustrated throughout the study, the provincial academy programme provided the setting to assist a minority of players from a large population pool be afforded opportunities to reach higher playing levels.

In the Irish sporting context, female or amateur team sport also reflect TDEs with multiple contexts that players co-inhabit. The TDE specified throughout this thesis (see Figure 1.4, p. 14) reflects the Ireland female hockey TDE where school and club competitions operate throughout the year. Athletes simultaneously compete in school and/or club whilst also train and play with their respective national age grade team. At times during the year these athletes will also train and play with regional or provincial teams, however it is for a shorter specific window than the male TDE depicted in Costello et al's study (2022). The Irish Hockey TDE is similar to the Irish female rugby TDE; both national TDEs reflect multiple contexts the athletes must balance simultaneously where national age grade teams represent the TD pathway. However, academy structures (regional or provincial) that operate to bridge athletes between the lower competition level (school and club) and the higher competition level (national age grade) are not a prominent feature of these TDEs, they exist for a short period of the year, often operating in a silo (see Chapter 5) and contrast the male elite team sport TDE reflected in the literature (Costello et al., 2022).

In a national female team sport TDE, the NGB is the apparent system controller, with a similar remit to the male professional sport setting regarding the design and implementation of the TD pathway. However, it appears different to the male professional context because in the female or amateur sport context there are varied levels of influence in the top down structured pathway. The shallow talent pool leads to a greater percentage of players converting to the TD pathway, and sometimes at a faster rate (Simpson et al., 2022), therefore the NGB may have less influence on the performance markers required to progress athletes to the higher playing level. Resultantly greater influence on TD is at the school or club level rather than the NGB necessitating coherence and alignment in the system. This reflects a different context than in popular professional male team sports.

The key features that influence an effective TDE should be similar (i.e., long term development, individualised development, wide ranging coherent approach, holistic and systematic development; Martindale et al., 2005, 2007). However, Chapter 3 highlighted the literature relating to female specific TDEs are lacking in the literature (14% female versus 38% male). Exploring female specific team sport TDEs helps to bridge the research gap. Even if the results reflect similar experiences to male TDEs, without studies using female athletes specifically we are failing to adopt evidence informed practice to maximise the potential of this cohort. Chapters 4 and 5 therefore sought to help fill this research gap.

Recognising in female team sport TDEs that the setting or context is likely different, yet the key features for effective TDEs should be reflected (Martindale et al., 2005; 2007) it is also important to understand the TD pathway processes that operate in the TDE i.e., physical and psycho-behavioural development. The TD pathway curriculum or processes must reflect evidence informed practice. However, psycho-behavioural and physical differences between males and females limit the ability to interpret and apply findings from male dominated

research to female sports (Emmonds et al., 2019). Literature in Chapter 2 highlight that males and females differ psycho-behaviourally (Crocker & Graham, 1995; Phillipe & Seiler, 2005) and Chapter 3 found only one study exploring psychological constructs in TD to reflect a female only population compared to 13 studies using a male only population. It is important therefore that research in this area also reflects female athletes. Chapter 6 aimed to add to the literature in this area. Chapter 2 also outlined differences in physical performance between males and females, suggesting common physical performance markers used in GPS tracking underestimates the distances covered at high speeds in female athletes (Bradley et al., 2014; Clarke et al., 2017). Further there is a scarcity of research depicting game variability data using GPS in female athletes. Therefore Chapters 7 and 8 explored GPS data to better determine the GPS variability for specific game physical locomotor metrics to fill this research gap.

The TD pathway curriculum in female team sport settings must reflect evidence informed practice from female specific populations. Consequently, my pragmatic philosophy did not align with using current available data to make inferences about female experiences in TD. It is understood that biopsychosocial competencies are important for best supporting athletes to progress through TD pathways and reach their potential (Collins & MacNamara, 2017; Holt & Dunn, 2004; Martindale et al., 2005). This multidisciplinary approach to TD requires research that considers the physical, psycho-behavioural and environmental variables, making references to any influence of one variable on the other. Given the growing interest in female sport along with NGBs currently focused on creating pathway programmes for young aspiring female athletes (soccer: The FA, 2017; FAI, 2021; field hockey: Field Hockey Canada, 2022), Chapter 3 was a pertinent examination of the lack of research pertaining to female TD experiences. The remainder of this Chapter aims to discuss the research from this

thesis relating to the TDE using the TDEQ-5 and the TD processes i.e., physical (through using GPS data) and psycho-behavioural (through using PCDEQ2 data) in an amateur female team sport setting outlined earlier and in Chapter 1 and reflecting a typical female team sport TDE.

9.2.2 Bridging the gender data gap in TD research; female team sport TDE

The second aim of this thesis was to investigate the level of coherence in a complex female team sport TDE. In this regard, complexity was examined by sampling a NGB national TDE in female hockey; this TDE has many moving parts with athletes concurrently involved at club, school, regional, and national level and is further complicated by the inclusion of a range of ages and experience levels. As such, Chapter 4 set out to explore a female team sport TDE, using the TDEQ-5 (Li et al., 2015; Wang et al., 2011) to determine the presence and rating of the recommended features for effective TDEs (Martindale et al., 2010). The study provided an initial insight into the facilitators (long term focus, good support network) and derailers (lack of coherence and communication between stakeholders) evident in the TDE. The derailers that were present mirror Simpson and colleagues findings in a female football TD pathway (2022) and contrast recommendations from the literature which suggest a coherent approach to TD is imperative (Bjørndal & Ronglan, 2018; Webb et al., 2016). Aligned and coherent pathways provide a somewhat 'goldilocks' experience for athletes (Webb et al., 2016, p. 1801). However, too much push and pull can result in experiences that are too contradictory for athletes, where coincidental rather than systematic performance progression occurs. In the TDE outlined in Chapter 4, though the NGB acts as the system controller, the multiple contexts were found to be working off their own agendas.

For TDEs to be effective the literature recommends NGBs should outline the programme goals of each pathway stage (POP; Collins et al., 2019), where coaches across contexts align to the outcomes and processes deemed appropriate in facilitating these goals

(Bjørndal & Ronglan, 2018). Of course, this is a more difficult task in a complex team sport TDE, where athletes co-exist in multiple contexts simultaneously. The multiple stakeholders and limited resources in female team sports heighten this challenge especially when coaches often work off their own agenda (Collins et al., 2019; Webb et al., 2016). In a complex team sport TDE there is a constant tug of war between the contexts athletes co-inhabit. When coaches across different contexts ignore the other and do not align to the bigger TD picture, athletes experience contradictory messages and learnings. Resultantly athletes may become adaptable and independent in some areas more than others (e.g., technical, physical, psycho-behavioural) and is often due to coincidence rather than systematic holistic development (Webb et al., 2016).

The findings highlight the need for the NGB to coordinate an appropriate TD curriculum (Taylor & Collins, 2022) thereby working with the influential contexts (club and school) to negotiate TD decisions and practices that are beneficial to the developing player and context. In this female team sport TDE the provincial window is short, the talent pool is low and resultantly the club and school context have a big influence on player development. The NGB is encouraged to support the club and school contexts to understand the TD practices suited to assisting appropriate player development in their context. For example, though the school setting might focus on short term success, the NGB can educate coaches to use this setting to develop a determination and drive to win. Importantly the NGB must support communication between the school and national age grade coaches concerning the inclusion of other more specific skills (physical, technical) that are appropriate for that development stage and in line with the NGB pathway outcomes. The club context could be influenced to focus on pushing young high potential athletes to experience playing with older more experienced players, experiencing failure, setbacks in performance etc. where the club

coach can be encouraged by the pathway coach (supported by the NGB) to help the player experience difficult demands in training.

While the TDEQ-5 was able to provide important information about the TDE from the players perspective, it was also important to gain a richer understanding of the coherence in a complex team sport TDE from multiple stakeholder perspectives. Therefore, in Chapter 5 a follow up qualitative approach using semi structured focus groups was adopted to deepen our understanding of the systems and processes in place throughout this complex TDE. Using a mixed methods approach across Chapters 4 and 5 reflects my pragmatic approach to this thesis, using research to support practical inquiry. The follow up qualitative enquiry in Chapter 5 provided rich insights from the perspective of young athletes and pathway practitioners about their experiences on the TD pathway with a particular focus on how the lack of TDE coherence (vertically and horizontally) influenced the developmental trajectory.

Consistent with the findings from Chapter 4 the multiple contexts were operating in silos, with little communication between coaches or guidance provided from the NGB regarding the performance outcomes and processes recommended in the TDE. As one example, and despite considerable evidence attesting to the importance of psychological (Collins & MacNamara, 2012; MacNamara et al., 2010a, 2010b) and physical (Burgess et al., 2012; Clarke et al., 2017; Jones et al., 2018) factors as key determinants of development, there appeared to be a lack of emphasis on both of these elements. In some cases, it was noted that the lack of coherence across the system meant that athletes were being prepared for current performance in each environment without due consideration of managing their longer term development. Athletes reflected a need to alter their performance depending on the playing context and coach, contradicting the recommended systematic, aligned, holistic

development approach in the literature (Bjørndal & Ronglan, 2018; Martindale et al., 2005; 2007, Webb et al., 2016).

It is possible that a lack of strategic direction and downward pressure from the NGB resulted in a lack of responsibility and ownership being taken over the development of these key skills and behaviours by coaches within the TDE. Despite the NGBs apparent role as the system controller, it in fact had less influence on TD in the lower playing contexts (clubs and schools). Instead the club and school coaches had an often uncompromised influence on player performance and development. Recognising the influence of the lower playing levels and their impact on player development prior to reaching the national age grade teams, the NGB must co-ordinate better alignment across contexts where coherence to the performance processes (physical and psychological) appropriate to the stage of development is necessary to ensure the TD pathway curriculum is conducive to long term, holistic quality development.

9.2.3 Bridging the gender data gap in TD research; psycho-behavioural skills

The role of psychological skills and behaviours has been long recognised as essential features of both performance and development. Indeed, the work of McNamara and colleagues (MacNamara et al., 2010a, 2010b) point to the crucial importance of what they term PCDEs in the TD process. Building on the findings from Chapters 4 and 5, the aim of Chapter 6 was to examine the PCDE profile of international pathway hockey players. There are limited studies investigating psycho-behavioural skills, specifically PCDEs, in a female athlete population. Therefore Chapter 6 aimed to fill this research gap in line with the third thesis aim. Trends in the results showed evidence of some PCDEs present throughout different stages of the TD pathway programme. However, results indicated little emphasis was placed on the planned or systematic inclusion of PCDEs in the TDE. The research is clear in suggesting PCDEs are important psychological skills and behaviours for developing athletes

(Collins & MacNamara, 2022; MacNamara et al., 2010a, 2010b), to equip them with the necessary psychological skills to navigate the difficult, challenge-filled route to the senior elite level (Collins & MacNamara, 2017).

Chapter 6 identified differences in the PCDEQ2 (Hill et al., 2018) scores at the group level, highlighting the level and combination of PCDEs present across each playing group and how these differ between groups but more importantly the apparent lack of systematic development of these psycho-behavioural skills in the TD pathway (Collins & MacNamara, 2017; Taylor, MacNamara & Taylor, 2022). These results differed when compared to another female hockey development population (Edwards et al., 2022) using the PCDEQ2. Of course, considering these TDE settings are different there may be different psycho-behavioural skills apparent in the populations. However, from a pragmatic perspective it is differences at the individual level that are the most important to consider.

The TD pathway process requires attention on individual development. Athletes will enter a pathway programme from varying backgrounds, life experiences, playing histories, therefore psycho-behavioural development requires a focus at the individual level (Taylor & Collins, 2020). Critically, the study in Chapter 6 focused on group differences, illustrating the PCDEs present at a group level in this population. The study highlighted information this TDE can use to tailor appropriate support and PCDE education to the young athletes, parents and other coaches/stakeholders at each pathway stage (Collins & MacNamara, 2017; MacNamara, et al., 2010a, 2010b). Though this study did not look at individual PCDE profiles, it adds to the current paucity of research relating to psycho-behavioural skills in female team sports, and provides insight into the PCDEs evident and requiring attention in this young development athlete population. Such information could encourage other pathway

practitioners to investigate the same using the PCDEQ2 in their specific contexts, highlighting the skills and behaviours requiring support at a group level.

Athletes may use different combinations of PCDEs to facilitate individual progression. Consequently practitioners should be encouraged to use the PCDEQ2 as a formative assessment tool to highlight and pay attention to individual athlete profiling more than group level analysis. This would enable practitioners to better individualise support for high potential young athletes within a team sport setting. Examples of this are available in the work carried out by Edwards et al. (2022).

9.2.4 Bridging the gender data gap in TD research; physical development

The final transition in the TD pathway, the step up to the senior elite representative level is the most difficult as discussed in Chapter 2. In addition to being associated with heightened perceived pressure and emotional disturbances (Taylor & Collins, 2021b), athletes experience increases in physical training and playing intensities, often measured using GPS data (Brewer et al., 2010; Burgess et al., 2012). There is often an over emphasis in the literature on unidimensional studies focused on a single area, e.g., physical or psychological variables without creating links to other variables of performance or TD requirements (Johnston et al., 2018). Reflecting on this, Chapters 7 and 8 sought to investigate the fourth aim of this thesis, considering physical development and progression. There is widely available research relating to physical game locomotor demands, though much of this literature relates to senior elite level teams (Macutkiewicz & Sunderland, 2011; McGuinness, Malone, Petrakos et al., 2019; McGuinness, Malone, Hughes et al., 2019). Further, much of the available research relates to mean game locomotor activity data and omits the requisite insight into how the data can inform performance tracking, progression or support coherence in a complex TD system. Consequently, we need to ascertain if we can we practically interpret

the data to assist decision making regarding performance markers and TD system effectiveness? As such, Chapters 7 and 8 examined game locomotor data at the national and club level respectively, and specifically the relative game-to-game and within-game variability measures.

The studies outlined in Chapters 7 and 8 contribute to the literature as they provide new unique studies of between- and within-game variability findings pertaining to young female team sport athletes that can be used as performance markers in TD programmes. Much of the research in this area relates to elite male team sports (Carling et al., 2016; Dalton-Barron et al., 2021; Gregson et al., 2010; Oliva-Lozano et al., 2021; Sunderland & Edwards, 2017), with little research available in female (Trewin et al., 2018) and domestic club level athletes (Espenschade, 1936). By focusing on these aspects, Chapters 7 and 8 fill this research gap and provide interesting insights into the use of between-game variability measures to provide threshold data for the interpretation of game locomotor activity data over time. From an applied perspective, the framework used can act as a performance marker to assist coaches and pathway practitioners to make evidenced informed decisions regarding a young athlete's physical progression over time and preparedness to transition horizontally towards the pathway (domestic to international) or vertically along the pathway (junior to senior international).

9.3 Implications for practice

The available TD literature clearly does not reflect female specific TDEs or TD processes. Therefore female team sport NGBs and pathway practitioners can interpret the information presented here and apply practical learnings in their own specific TDE or TD context. The literature is clear in outlining the need for a systematic, holistic, coherent

approach to TD across the entire TDE both horizontally (across contexts; school, club, national) and vertically (along the national TD pathway) assisting young high potential athletes to experience numerous and varied coaching styles, philosophies and development experiences (Bjørndal & Ronglan, 2018; Gledhill et al., 2017; Webb et al., 2016). A coherent approach in the TDE encouraged by the NGB and aligned across all contexts would support the athlete's development experiences where the multiple contexts, coaches and playing experiences they meet are not too varied, too different and are complimentary rather than contradictory (Webb et al., 2016).

9.3.1 Singing off the same hymn sheet

Chapters 4 and 5 highlighted a clear disconnect between the TDE workings and research best practice suggestions. Simply, stakeholders in the TDE did not appear to be singing off the same hymn sheet. The evident lack of horizontal (between contexts; school, club, regional, national) and vertical (along the pathway; U16 to U21) coherence in the TDE contrasts with the recommendations from the research (Bjørndal & Ronglan, 2018; Taylor MacNamara & Taylor, 2022; Webb et al., 2016). Rather, a team sport NGB should aim to create and encourage a SMM approach (Gershgoren et al., 2013; Mathieu et al., 2000). Using the POP principle (Collins et al., 2019) in a SMM approach reflects a TDE and pathway programme that is guided by the NGB and where stakeholders are aligned to commonly held principles generally and more specifically (Taylor & Collins, 2022; Taylor MacNamara & Taylor, 2022). The lack of a coherent approach throughout the TDE and limited guidance from the NGB regarding player development or stakeholder alignment outlined in Chapters 4 and 5 resulted in a pathway programme and TDE that reflected coaches and practitioners working in silos. The siloed approach was exacerbated by mismatches in participant understanding of the performance goals, outcome measures and processes that should reflect the NGB

pathway stages (Collins et al., 2019). Crucially there was also a lack of direction provided by the NGB, with little opportunity for bi-directional communication, cohesion or collaboration of efforts towards player development (Taylor, MacNamara & Taylor, 2022).

9.3.2 Performance-Outcome-Process in the TDE

The TDE requires a top-down systematic approach, where there is an understanding of the POP of each pathway stage (Collins et al., 2019) and how this is coordinated (Bjørndal & Ronglan, 2018; Webb et al., 2016). It is important that the NGB is aware of the various contexts in the TDE (school, club, regional, national). Of course, this does not mean there is a top-down mandate but it does require a coherent and cooperative means of supporting high potential athletes along with a recognition that (sometimes) there will be a need to comprise short-term results in one context (e.g., club) for the long term development of a young athlete. Using a SMM approach (Mathieu et al., 2000; Taylor & Collins, 2022), the NGB should outline the performance goals and specific outcomes conducive to TD in their specific TDE (see section 2.1.6). Crucially if a SMM approach were adopted the sharing of information and communication (horizontally and vertically) should provide an opportunity for bi-directional open communication, supporting a top-down and bottom-up approach in the TDE (Taylor, MacNamara & Taylor, 2022). This approach therefore acknowledges flexible adaptation for coaches and practitioners to apply their own coaching styles, philosophies and processes in working towards the TDE goals and outcomes.

The effectiveness of the SMM approach requires the NGB to encourage coherence and an understanding of the bandwidth of processes to meet the performance goals and outcomes. For example, the NGB must iterate when it is appropriate to focus on performance or development or when a player can be pushed to another playing level or context based on individual promise and readiness (Flatgard, 2020; Mills et al., 2014; Taylor & Collins, 2021b).

Given young high potential athletes in team sport TDEs are co-inhabiting various contexts simultaneously, as evidenced through Chapters 4 and 5, it should never be a silo. These 'worlds' (cf, Collins et al., 2012) are often looked at as independent domains with performance happening in, for example, a senior environment and development happening on the TD pathway. In fact, recently there has even been a delineation in coaching with the rise of the 'development' or 'talent' coaches and 'performance' coaches with what is often seen as discrete agendas, skills and processes. It may even be that this delineation is seen as the remit of different environments (e.g., club, school, national). In reality however it is more likely that these worlds co-exist with young athletes sometimes having a 'performance' focus and sometimes a 'development' focus. Simply, there are times when a development emphasis may be more appropriate and times when a performance emphasis will dominate but there must be fluidity and a bandwidth within the system where coaches at all stages understand the POP of their stage and context (Collins et al., 2019), adjusting their coaching, purpose and environment accordingly.

Coordinating and influencing decision making in the broader TDE is, of course, difficult (for example, encouraging process versus outcome or playing the short versus the long game). Although the NGB has responsibility for the organisation, development and structures of a sport, in reality it often has relatively little power or control in its constituent environments (e.g., clubs and schools) as depicted in Chapters 4 and 5. The NGB therefore needs to encourage alignment to the POP of the pathway stage and when it is most appropriate to lean on either end of the performance versus development bandwidth (Collins et al., 2022; Taylor, MacNamara & Taylor, 2022) through consideration of how it supports coaching and competition structures in its sport

9.3.3 Psycho-behavioural skills (PCDEs)

This thesis has identified the integral role of PCDEs in elite athlete development (Collins & MacNamara, 2022; MacNamara et al., 2010a, 2010b). Young high potential athletes will experience an inevitable array of challenges and difficult experiences (de-selection, poor performance, injury, losses) as they progress along the national TD pathway (Larsen et al., 2014; Laureys et al., 2021; Taylor & Collins, 2021b). PCDEs are important skills to assist young athletes to navigate the peaks and troughs they are likely to experience. In line with the SMM approach the NGB should encourage co-ordinated stakeholder education of PCDEs, ensuring there is an understanding across contexts and stakeholders (players, coaches, parents etc.) of the important psycho-behavioural skills that can assist young high potential athletes to deal with the emotional disturbance they are likely to experience on the national TD pathway (MacNamara et al., 2010a, 2010b; Taylor, Ashford & Collins, 2022). Failing to assist young athletes to learn and develop these requisite skills could be detrimental to the TD process, where producing adaptable, problem solving athletes is key (Collins & MacNamara, 2017; Webb et al., 2016).

As outlined in Chapter 6, the teach-test-tweak-repeat approach is one practical way for developing these skills (Collins & MacNamara, 2017). Practitioners can use the PCDEQ2 that was examined in Chapter 6 to investigate the PCDEs reflected strongest and those requiring further attention at a group level (Hill et al., 2018). This could influence an evidence informed change in coaching style or training plan for a period of time. For example, if the group majority presented with a tendency towards an adverse response to failure the coaching group may seek to upskill the players in this area. Using the teach-test-tweak-repeat approach coaches would educate athletes on the skills required to deal with failure, be able

to bounce back, cope with pressure and learn from mistakes (Collins & MacNamara, 2017; Collins & MacNamara, 2022).

Outlining the upcoming processes and training the athletes will endure and testing their ability to deal with failure and cope with pressure ensures the athletes are aware of the skills they must try to lean on during this process. Reflecting the SMM approach and necessary coherence in the TDE, the sharing of such information to coaches in other contexts and parents educates the athletes' support network of the upcoming challenges and likely emotional disturbances, the reasons for this and how they could be supported (Collins et al., 2017; Taylor & Collins, 2012b). The planned training sessions would aim to create such experiences, e.g., playing more difficult opposition, drills that may incorporate unfair advantages etc. Coupling the training or process with reflection, feedback and learning de-briefs to check for development, learning and application (Taylor & Collins, 2021b) allows coaches to check in on performance progression in this area. Coaches can then tweak and repeat the process for continued growth depending on the outcome (Collins et al., 2017; Taylor & Collins, 2012b).

Critically however, individuals will vary on the PCDEs they use in combination and the PCDEs that require attention and support (Edwards et al., 2022; Jones, 1993). Coaches must recognise the need to analyse PCDEQ2 results at an individual level in addition to or even instead of the group level. The PCDEQ2 should not be used as a selection tool, but rather a means to better support individual development (Hill et al., 2018). Given the step up towards higher playing levels is commonly met with psychological pressure and emotional disturbance it is crucial development coaches pay heed to athletes' psycho-behavioural skills, understanding when it is appropriate to push young athletes towards higher playing levels (Larsen et al., 2014; Taylor & Collins, 2021b). Strategically, however, coaches can use the

varied playing contexts within the TDE to assist with individual player development. If the coaching group feels a young high potential athlete has the requisite social skills, ability to cope with pressure and failure etc. supported by their individual results in the PCDEQ2, then they might progress the athlete towards experiencing more difficult training or competition environments (vertically or horizontally on the pathway). On the other hand, if a high potential athlete is unable to handle the high pressure environment, setbacks etc. that may occur at the high performance playing level, then co-ordinating that the athlete train more often at the lower playing level contexts may be a better fit. However, for this to happen communication between stakeholders regarding the PCDE upskilling required is necessary to assist this athlete to develop the appropriate skills to better cope with the high performance environment should they transition back towards the pathway (Taylor, Ashford & Collins, 2022). Applying the PCDEQ2 learnings in such a manner can assist with the individual, holistic development of young high potential athletes, informing practitioners of the psycho-behavioural skills that may need attention and support.

Critically, considering the multidimensional nature of TD (Collins & MacNamara, 2022), where psycho-behavioural, environmental *and* physical variables contribute, Chapters 7 and 8 explored a practical means to analyse physical game locomotor metrics to make inferences about an individual athlete's physical readiness to transition towards the next playing level.

9.3.4 Physical development

The use of GPS is common in team sports (Buchheitt et al., 2014). More often than not it is used to quantify game load and to determine the mean game locomotor activity demands to help prepare athletes for the expected competition intensities (Brewer et al., 2010; Vescovi, 2016; Vescovi, 2014). Though much of the research relates to senior elite level teams,

there is research available pertaining to younger level athletes (Burgess et al., 2012, Vescovi, 2016; Vescovi, 2014). Studies using elite junior level populations are useful for TD settings where sport scientists and coaches can interpret research to inform the game or competition intensities they are preparing athletes for. Critically, the goal of the pathway programme generally is long term development with progression to the senior elite level key in determining pathway effectiveness. In practical terms, preparing players for the mean relative competition intensities may not be enough to ensure they can withstand the physical progression to higher playing levels. Appreciating the transition to higher playing levels is accompanied by psychological pressure and emotional disturbance (Gledhill et al., 2017; Larsen et al., 2014; Taylor & Collins, 2021b) it is important practitioners can also make evidence informed decisions on an athlete's physical ability to handle the transition to higher intensities.

Chapters 7 and 8 contribute a practical means for interpreting GPS game locomotor activity data over time to more practically determine an improvement in physical performance. This knowledge will allow practitioners to make a more evidence informed decision on an athlete's ability to handle higher game locomotor intensities. The within-athlete variability data is analysed using the SWC to provide thresholds for interpreting the game-to-game variability over time. Subsequently, if an athlete increases their physical locomotor activity beyond the game-to-game variability threshold it could be interpreted that they are handling higher playing intensities (Doncaster & Unnithan, 2019). This information informs practitioners of the athlete's physical preparedness to progress vertically along the pathway or as a late entry or re-entry to the pathway horizontally from a lower playing level.

The transitioning athlete would be more prepared for an increase in physical training and competition intensity should they move to higher playing levels. This information

provides more detail than a one off performance snapshot or mean game locomotor data over time as it acknowledges that games can vary in intensity, where a bandwidth of locomotor activity is more representative of the lower and higher thresholds athletes experience. If mean game locomotor data is the only information used to inform decisions on an athlete's readiness to transition to higher playing levels, we cannot be confident that the athlete is physically ready for the upper thresholds of intensity and likely increased intensities they will experience at higher playing levels.

This analysis framework could be used to support coach-to-coach conversations both between contexts (horizontally) and along the pathway (vertically) assisting bi-directional communication and coherent efforts in physical performance progression. The information can help practitioners understand the game's locomotor demands in more detail. NGB pathway practitioners could share their learnings to assist coaches in the lower playing levels understand means by which to physically prepare high potential athletes in their specific contexts for the intensities expected on the pathway.

9.4 Contribution of this thesis to the literature and TD practice

A strength of this PhD thesis is the calibre of young athletes recruited for all studies detailed in the thesis chapters. There is discussion in the research relating to the inconsistent use of participant sampling in TD research. Specifically studies lack clarity in defining the participant sample making it challenging to interpret the findings for application in other contexts (McAuley et al., 2022). All participant athletes in this thesis were part of a national junior age grade female hockey team, while simultaneously competing at either school, club or school and club level. Further, the coaches and pathway staff recruited for the study in Chapter 5 averaged fourteen years of combined experience working with high potential

young athletes. Their insights, knowledge and willingness to share learnings were crucial to gaining rich qualitative data. Given complexity is high in a female team sport TDE and resources are limited, participant recruitment was very important.

Another key strength of this thesis is the underpinning pragmatic philosophy. A pragmatic approach allowed me to use mixed methods in answering the thesis aims. Participant recruitment, chosen research method, data analysis and interpretation were all aligned with a pragmatic philosophy. The philosophy was aligned with my desire to be an applied practitioner, striving to provide meaningful evidence informed suggestions for practice in female team sport TDEs that are impactful at a practical and theoretical level (Giacobbi et al., 2005). With this, the mixed methods applied throughout the chapter studies provided triangulation of data, allowing a deep, rich and clear picture of the practical findings of each study and minimising potential limitations of a singular data collection method.

A final strength of this thesis was that all studies contributed to the current gap in TD literature relating to female team sports. The underrepresentation of females in TD research warrants future studies to consider using female populations to triangulate the findings from male dominated studies.

9.5 Limitations of this thesis

As with all research, transparency of limitations, as well as strengths, is important. For the duration of this thesis, I have worked as part of a multidisciplinary team of practitioners, delivering applied sport science support for elite level athletes. For the purposes of this thesis, elite level is defined as competing at the national level and being supported within the relevant NGB. My role provided me with access to and relationships with high calibre athletes and the high performance environment around them. More specifically, the athletes I worked

with at the early stages of this thesis were athletes progressing through the latter stage of their development pathway, which was particularly pertinent to this specific area of study. Later during the thesis, my role shifted to working with elite level athletes at senior national level. This allowed me to appreciate the full development spectrum, the development athlete progressing through pathway stages and the cohort of athletes they aspire towards; the elite senior level athlete at the final national representative stage. As such, early planning decisions for this thesis concluded that I would recruit athletes from the TDE that I worked part of at the beginning of this PhD thesis. Subsequently, the results of the studies were limited to one specific TDE and therefore reflect the NGBs' structural and cultural norms. Though the participants represented multiple contexts (school, club, regional, national), one TDE was used therefore research findings are specific to that environment. However as a pragmatist, it is important to acknowledge the information provided throughout this thesis can be understood and learnings applied to other contexts, appreciating the benefit of evidence informed practice.

Another limitation of this thesis was the short term data collection procedure. Collecting the data for a longer period of time would have provided much greater information. Though the mixed methods used allowed for the triangulation of data and deeper insights into the research findings, collecting the data over a longer period of time could have provided more detailed longitudinal insights into the progression of athletes through the pathway stages for example.

An added limitation in the data collection was the limited resources available at the club and school level making it difficult to collect data in these contexts, specifically physical locomotor activity data representative of non-international level athletes. Further, it could be interpreted that my role with the athletes in the TDE may have contributed to some research

bias. Accordingly, the investigation in Chapter 5 specifically, depicted steps taken to minimise any bias. Using my supervisory team to act as critical friends throughout all steps of data collection in Chapter 5 and also to check and challenge my interpretation of results in every other study was viewed as essential to enhance the trustworthiness of data.

9.6 Future Research

With specific reference to the limitations mentioned previously regarding researcher bias, future research could expand on the findings in this thesis by incorporating an outsiders perspective with a presumed non-bias towards previous assumptions. This may eliminate possible negative impact or bias from a practitioner's perspective and provide an alternative lens to the findings.

Building on the overall findings in this thesis future studies could implement an intervention to assist with supporting improved coherency in a complex team sport TDE. Measuring pre and post intervention could provide some insight for NGBs and pathway coordinators on the practices that could assist or hinder alignment and coherency both horizontally and vertically in a complex team sport TDE.

The findings outlined in this thesis are a first step at filling the research gap pertaining to female athletes in TD literature. However, it cannot be a stand-alone and must be added to. Using current methods future research could aim to understand the features of effective female TDEs in addition to those which are ineffective or unsuccessful. The features present may be the same as male team sports, however, the research must reflect female specific case studies to incorporate findings from TDEs that appear successful (long term progression of players to elite senior levels) and those not as successful (less turn over to elite senior levels). Addressing a further limitation of this thesis, future longitudinal research could be

conducted to better understand the development of PCDEs over time for example, or the physical performance progression of young athletes as they transition through the pathway. Longitudinal research could incorporate formal teachings of PCDEs, or physical training interventions to better inform practitioners to make evidence informed decisions in programme planning and refinement.

9.7 Conclusion

This thesis sought to examine the TD systems and processes in place in a female team sport TDE. In doing so, the complex nature of a team sport TDE is apparent in addition to the level of coherence required horizontally and vertically within the TDE to allow effective player development that is not too varied or different, yet collaborative and adaptable to meet athlete's needs. Overall, the findings have contributed knowledge to the existing literature and provided information for practitioners working in female team sport TDEs to assist evidence informed decision making and practice suggestions. This thesis provided a multiple methods design, providing links throughout the thesis between multiple variables that contribute to TD in young high potential athletes i.e., the environment, psycho-behavioural skill development and physical performance progression. It is essential practitioners can work together to create an evidence informed best practice environment to suit all development needs of young athletes aspiring to the elite senior representative level. In addition to providing insights into the PCDEs apparent along the stages of a TD pathway this thesis outlined the use of a GPS analysis framework to assist with practical decision making regarding athlete progression and transition through TD pathway stages. In summary, this thesis provides a significant contribution to the literature by providing female specific data in the well-researched TD field that underrepresents female experiences. The programme of

research in this thesis provides a transition from theory to practice with applied implications for NGBs, coaches and pathway practitioners working with young high potential athletes.

References

Aalberg, R. R., & Saether, S. A. (2016). The Talent Development Environment in a Norwegian top-level football club. *Sport Science Review*, 25(3-4), pp. 159-182. doi: 10.1515/ssr-2016-0009

Abbot, A., & Collins, D. (2004). Eliminating the dichotomy between theory and practice in talent identification and development: considering the role of psychology. *Journal of Sports Science,* 22, pp. 395–408.

Abbott, A., & Collins, D. (2002). A Theoretical and Empirical Analysis of a 'State of the Art' Talent Identification Model. *High Ability Studies*, 13(2), pp. 157-178.

Abbott, A., Button, C., Pepping, G., & Collins, D. (2005). Unnatural selection: Talent identification and development in sport: Nonlinear Dynamics. *Psychology and Life Sciences*, 9, pp. 61–88.

ACSM. (2019). Load, Overload, and Recovery in the Athlete: Select Issues for the Team Physician—A Consensus Statement. *Current Sports Medicine Reports,* 18(4), pp. 141-148.

Andersson, H., Randers, M., Heiner-Moller, A., Krustrup, P., & Mohr, M. (2010). Elite female soccer players perform more high-intensity running when playing in international games when compared with domestic league games. *Journal of Strength and Conditioning Research*, 24, pp. 912–919.

Andrew, M., Finnegan, L., Datson, N., & Dugdale, J. H. (2022). Men are from Quartile One, Women are from? Relative Age Effects in European Soccer and the influence of Age, Success and Playing Status. *Children,* 9(11), pp. 1747.

Andronikos, G., Souglis, A., & Martidale, R. J. J. (2021). Relationship between the talent development environment and motivation, commitment, and confidence. *Journal of Physical Education and Sport,* 21(1), pp. 208-217.

Arazi, H., Faraji, H., & Mehrtash, M. (2013). Anthropometric and physiological profile of Iranian junior elite gymnasts. *Facta Universitas*, 11, pp. 35–41.

Bailey, R. (2007). Talent Development and the Luck Problem. *Sport Ethics and Philosophy,* 1(3), pp. 367-377.

Bailey, R., & Morley, D. (2006). Towards a model of talent development in physical education. *Sport Education and Society*, 11, pp. 211–230.

Baker, J., Wattie, N., & Schorer, J. (2019). A proposed conceptualization of talent in sport: The first step in a long and winding road. *Psychology of Sport & Exercise,* 43, pp.27-33.

Barreiros, A., Coté, J., & Fonseca, A. (2014). From early to adult sport success: Analysing athletes' progression in national squads. *European Journal of Sport Science*, 14(Suppl 1), pp. 178-182, doi: 10.1080/17461391.2012.671368

Batterham, A. M., & Birch, K. M. (1996). Allometry of anaerobic performance: a gender comparison. *The Canadian Journal of Applied Physiology*, 21(1), pp. 48-62.

BBC. (2022). Euro 2022: *Lionesses' success shows how far game has come.* Available at: https://www.bbc.com/news/uk-62317579. Accessed 08 October 2022.

Bennett, K. J. M., Vaeyens, R., & Fransen, J. (2019). Creating a framework for talent identification and development in emerging football nations. *Science and Medicine in Football,* 3, pp. 36–42. doi: 10.1080/24733938.2018.1489141

Bjørndal, C. T., & Ronglan, L. T. (2018). Orchestrating Talent Development: Youth Players' Developmental Experiences in Scandinavian Team Sports. *Sports Coaching Review,* 7(1), pp. 1-22.

Bjørndal, C. T., Ronglan, L. T., & Andersen, S. S. (2017). Talent development as an ecology of games: a case study of Norwegian handball. *Sport, Education and Society,* 22(7), pp. 864-877, doi: 10.1080/13573322.2015.1087398

Boccia, G., Cardinale, M., & Brustio, P. R. (2020). Performance progression of elite jumpers: Early performances do not predict later success. *Scandinavian Journal of Medicine and Science in Sport,* 31, pp. 132-139, doi: 10.1111/sms.13819

Boccia, G., Cardinale, M., & Brustio, P. R. (2020a). World-Class Sprinters' Careers: Early Success Does Not Guarantee Success at Adult Age. *International Journal of Sports Physiology and Performance,* 16(3), pp. 367-374, doi: 10.1123/ijspp.2020-0090

Bose, D., Segui-Gomez, M., & Crandall, J. R. (2011). Vulnerability of female drivers involved in motor vehicle crashes: an analysis of US population at risk. *American Journal of Public Health*, 101, pp. 2368–2373. doi: 10.2105/AJPH.2011.300275

Bradley, P. S., Dellal, A., Mohr, M., Castellano, J., & Wilkie, A. (2014). Gender Differences In Match Performance Characteristics Of Soccer Players Competing In The Uefa Champions League. *Human Movement Science, 33,* 159-71.

Bradley, P., & Vescovi, J. (2015). Velocity thresholds for women's soccer matches: Sex specificity dictates high-speed running and sprinting- Female athletes in motion (FAiM). *International Journal of Sports Physiology and Performance,* 10, pp. 112–116.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology,* 3(2), pp. 77-101, doi: 10.1191/1478088706qp063oa

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise & Health,* 11(4), pp. 589-587, doi: 10.1080/2159676X.2019.1628806

Brazo-Sayavera, J., Olivares, P. R., Andronikos, G., & Martindale, R. J. J. (2017). Spanish version of the Talent Development Environment Questionnaire for sport: Cultural adaptation and initial validation. *PLoS ONE*, 12(6), pp. 1-10. doi: 10.1371/journal.pone.0177721

Brewer, C., Dawson, B., Heasman, J., Stewart, G., & Cormack, S. (2010). Movement Pattern Comparison in elite (AFL) and sub-elite (WAFL) Australian Football Games Using GPS. *Journal of Science and Medicine in Sport*, 13, pp. 618-623.

Brustio, P. R., Boccia, G., De Pasquale, P., Lupo, C., & Ungureanu, A. N. (2021). Small Relative Age Effect Appears in Professional Female Italian Team Sports. *International Journal of Environmental Research and Public Health*, 19, pp. 385

Brustio, P. R., Cardinale, M., Lupo, C., Varalda, M., De Pasquale, P., & Boccia, G. (2021). Being a top swimmer during the early career is not a prerequisite for success: A study on sprinter strokes. *Journal of Science and Medicine in Sport*, 24(12), pp. 1272-1277, doi: 10.1016/j.jsams.2021.05.015

Bryant, A. (2009). Grounded Theory and Pragmatism: The Curious Case of Anselm Strauss. *Biography and Ethnicity*, 10(3), doi: 10.17169/fqs-10.3.1358

Buchheitt, M., Allen, A., Poon, T. K., Gregson, W., & Di Salvo, V. (2014). Integrating different tracking systems in football: multiple camera semi-automatic system, local position measurement and GPS technologies. *Journal of Sports Sciences,* 32, pp. 1844–1857.

Burgess, D. J., & Naughton, G. A. (2010). Talent Development in Adolescent Team Sports: A Review. *International Journal of Sports Physiology and Performance*, 5, pp. 103-116.

Burgess, D., Naughton, G., & Norton, K. (2012). Quantifying the Gap Between Under 18 and Senior ADFL Football: 2003 and 2009. *International Journal of Sports Physiology and Performance,* 7, pp. 53-58.

Carling, C., Bradley, P., McCall, M., & Dupont, G. (2016). Match-to-match variability in high-speed running activity in a professional soccer team. *Journal of Sport Sciences,* 34(24), pp. 2215–2223.

Carpio-Pinedo, J., De Gregorio Hurtado, S., & Sanchez De Madariaga, I. (2019). Gender mainstreaming in urban planning: the potential of geographic information systems and open data sources. *Planning Theory & Practice*, 20(2), pp. 221–240.

Clarke, A. C., Anson, J. M., & Pyne, D.B. (2017). Game movement demands and physical profiles of junior, senior and elite male and female rugby sevens players. *Journal of Sports Sciences*, 35(8), pp. 727-733.

Clarke, A. C., Presland, J., Rattray, B., & Pyne, D. B. (2014). Critical Velocity As A Measure Of Aerobic Fitness In Women's Rugby Sevens. *Journal Of Science And Medicine In Sport*, 17(1), 144-148.

Collins, D., Bailey, R., Ford, P. A., MacNamara, Á., Toms, M., & Pearce, G. (2012). Three Worlds: new directions in participant development in sport and physical activity. *Sport, Education and Society,* 17(2), pp. 225-243.

Collins, D., & MacNamara, Á. (2012). The rocky road to the top. *Sports Medicine*, 42, pp. 907–914.

Collins, D., & MacNamara, A. (2017). Making Champs and Super-Champs—Current Views, Contradictions, and Future Directions, *Frontiers in Psychology*, 8(823).

Collins, D., & MacNamara, A. (2022). *Talent Development. A Practitioner and Parents Guide* (2nd ed). New York: Routledge.Collins, D., & MacNamara, Á. (2012). The rocky road to the top. *Sports Medicine*, 42, pp. 907–914.

Collins, D., MacNamara, A., & Cruickshank, A. (2019). Research and Practice in Talent Identification and Development—Some Thoughts on the State of Play. *Journal of Applied Sport Psychology*, 31(3), pp. 340-351. doi:10.1080/10413200.2018.1475430

Collins, D., MacNamara, A., & McCarthey, N. (2016). Super Champions, Champions, and Almosts: Important Differences and Commonalities on the Rocky Road. *Frontiers in Psychology,* 6(2009).

Collins, D., MacNamara, A., & McCarthey, N. (2016b). Putting the Bumps in the Rocky Road: Optimizing the Pathway to Excellence. *Frontiers in Psychology,* 7(1482). oi: 10.3389/fpsyg.2016.01482

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed). New York: Routledge.

Costello, I., Belton, S., & MacNamara, A. (2022). Stand up and Fight: A Case Study of a Professional Rugby Club Negotiating a COVID-19 Crisis, a Talent Development Perspective. *Sports,* 10(124). doi: 10.3390/sports10080124

Costello, J. T., Bieuzen, F., & Bleakley, C. M. (2014). Where are all the female participants in sports and exercise medicine research? *European Journal of Sport Science*, 14, pp. 847–851.

Coutinho, P., Mesquita, I., & Fonseca, A. M. (2016). Talent development in sport: A critical review of pathways to expert performance. *International Journal of Sports Science and Coaching,* 11(2), pp. 279-293.

Coutinho, P., Mesquita, I., Fonseca, A. M., & Côte, J. (2015). Expertise development in volleyball: the role of early sport activities and players' age and height. *Kinesiology*, 47, pp. 215–225.

Cramer, J. T., Housh, T. J., Weir, J. E., Johnson, G. O., Ebersole, K. T., Perry, S. R., & Bull, A. J. (2002). Power Output, Mechanomyographic, And Electromyographic Responses To Maximal, Concentric, Isokinetic Muscle Actions In Men And Women. *Journal of Strength & Conditioning Research*, 16(3), pp. 399-408.

Creswell, J., & Miller, D. (2000). Determining Validity In Qualitative Inquiry. *Theory Into Practice,* 39, 124-130.

Criado-Perez, C. (2019). Invisible Women: Exposing Data Bias in a World Designed for Men. London: Chatto & Windus.

Crocker, P. R. E., & Graham, T. R. (1995). Coping by Competitive Athletes with Performance Stress: Gender Differences and Relationships with Affect. *The Sport Psychologist,* 9, pp. 325-338.

Cunniffe, E., Connor, M., Beato, M., Grainger, A., McConnell, W., McCarthey Persson, U., Delahunt, E., Boreham, C., & Blake, C. (2022). The influence of possession status on the physical output of male international hockey players. *International Journal of Sport Science & Coaching,* 17(2), pp. 412-422.

Cunningham, D. J., Shearer, D. A., Drawer, S., et al. (2016) Movement Demands of Elite Under-20s and Senior International Rugby Union Players. *PLoS ONE,* 11(11): e0164990. doi: 10.1371/journal.pone.0164990

Curran, O., MacNamara, A., & Passmore, D. (2019). What about the girls? Exploring the gender data gap in talent development. *Frontiers in Sport and Active Living*, 1(3), pp. 1-7. https://doi.org/10.3389/fspor.2019.00003

Curran, O., MacNamara, A., & Passmore, D. (2021). Singing off the same hymn sheet? Examining coherence in a talent development pathway (part 1). *Journal of Sports Sciences*, 39(15), pp. 1709-1716. doi: 10.1080/02640414.2021.1896456

Curran, O., Neville, R. D., Passmore, D., & MacNamara, A. (2022). Variability in locomotor activity in a female junior international hockey team. *Journal of Science and Medicine in Sport,* 25(7), pp. 586-592. doi: 10.1016/j.jsams.2022.02.007

Curran, O., Passmore, D., & MacNamara, A. (2022). Singing off the same hymn sheet? Examining coherence in a talent development pathway (part 2). *Journal of Sports Sciences*, 40(8), pp. 863-870. doi: 10.1080/02640414.2021.2021702

Dalton-Barron, N., Palczewska, A., McLaren, S. J., Rennie, G., Beggs, C., Roe, G., & Jones, B. (2021). A league-wide investigation into variability of rugby league match running from 322 Super League games. *Science and Medicine in Football,* 5, pp.225–233.

Davids, K., Araujo, D., Vilar, L., Renshaw, I., & Pinder, R. (2013). An ecological dynamics approach to skill acquisition: implications for development of talent in sport. *Talent Development and Excellence*, 5, pp. 21–34.

De Bosscher, V., & van Bottenburg, M. (2011). Elite for all, all for elite? An assessment of the impact of sports development on elite sport success. In Houlihan, B. & Green, M. *Routledge Handbook of Sports Development* (1st ed), pp. 579-598. New York: Routledge.

DeVellis, R. F. (2016). Scale development: Theory and applications. Newbury Park: Sage publications.

Dimundo, F., Cole, M., Blagrove, R., Till, K., McAuley, A., Hall, M., Gale, C., & Kelly, A. (2021). Talent Identification and Development in Male Rugby Union: A Systematic Review. *Journal of Expertise*, 4(1), pp. 33-55.

Domingues, M., & Gonçalves, C. E. (2013). The role of parents in talented youth sport. does context matter? *Polish Journal of Sport & Tourism*, 20, pp. 117–122.

Doncaster, G., & Unnithan, V. (2019). Between-game variation of physical soccer performance measures in highly trained youth soccer player. *Journal of Strength and Conditioning Research,* 33, pp.1912-1920.

Duffy, M. (2021). Breaking News: *'If she can't see, she can't be': the success and legacy of the 20x20 campaign.* Available at: https://www.breakingnews.ie/sport/if-she-cant-see-she-cant-be-the-success-and-legacy-of-the-20x20-campaign-1065409.html. Accessed 08 October 2022.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.

Edwards, P. L., MacNamara, A., & Saward, C. (2022). Psychological Characteristics of Developing Excellence in talented female field hockey players. *Journal of Sport Sciences* (in press).

Elferink-Gemser, M. T., Visscher,C., Lemmink, K. A. P. M., & Mulder, T. W. (2004). Relation between multidimensional performance characteristics and level of performance in talented youth field hockey players. *Journal of Sport Sciences,* 22, pp. 1053-1063.

Elferink-Gemser, M. T., Visscher,C., Lemmink, K. A. P. M., & Mulder, T. W. (2007). Multidimensional performance characteristics and standard of performance in

talented youth field hockey players: a longitudinal study. *Journal of Sport Sciences,* 25(4), pp. 481-489.

Elliott, S., Drummond, M. J. N., & Knight, C. (2018). The experiences of being a talented youth athlete: lessons for parents. *Journal of Applied Sport Psychology*, 30, pp. 437–455.

Emmonds, S., Heyward, O., & Jones, B. (2019). The Challenge of Applying and Undertaking Research in Female Sport. *Sports Medicine – Open,* 5(51). doi: 10.1186/s40798-019-0224-x

Erikstad, M. K., Høigaard, R., Johansen, B. T., Kandala, N.-B., & Haugen, T. (2018a). Childhood football play and practice in relation to self-regulation and national team selection; a study of Norwegian elite youth players. *Journal of Sports Science*, 36, pp. 2304–2310. doi: 10.1080/02640414.2018.1449563

Erikstad, M. K., Martin, L. J., Haugen, T., & Høigaard, R. (2018b). Group cohesion, needs satisfaction, and self-regulated learning: a one-year prospective study of elite youth soccer players' perceptions of their club team. *Psychology of Sport and Exercise*, 39, pp. 171–178. doi: 10.1016/j.psychsport.2018.08.013

Espenschade, A. (1936). An analysis of activity records of field hockey players. *Research Quarterly*, 7, pp. 62-74.

FAI. (2021). *Girls Emerging Talent*. Available at: https://www.fai.ie/domestic/fai-womens/girls-emerging-talent. Accessed 09 October 2022.

Field Hockey Canada. (2022). *Women's Nextgen National Programme*. Available at: https://fieldhockey.ca/program/womens-junior-development-squad/. Accessed 09 October 2022.

Feilzer, M. Y. (2010). Doing Mixed Methods Research Pragmatically: Implications for the Rediscovery of Pragmatism as a Research Paradigm. *Journal of Mixed Methods Research,* 4(1), pp. 6-16.

FIH. (2021). *FIH Rankings, Outdoor.* Available at: http://www.fih.ch/rankings/outdoor-old/ Accessed 28 December 2021.

FIH. (2019). *Our Official Documents, Rules of Hockey.* Available at: https://fih.ch/inside-fih/our-official-documents/rules-of-hockey/. Accessed 20 July 2021.

Fink, J. S. (2015). Female Athletes, Women's Sport, And The Sport Media Commercial Complex: Have We Really "Come A Long Way, Baby?". *Sport Management Review*, 18, pp. 331-342.

Flatgard, G., Larsen, C. H., & Saether, S. A. (2020). Talent Development Environment in a Professional Football Club in Norway. *Scandinavian Journal of Sport and Exercise Psychology,* 2, pp. 8-15.

Ford, P., Ward, P., Hodges, N., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement Hypothesis. *High Ability Studies*, 20, 65–75.

Fornasiero, A., Savoldelli, A., Modena, R., Boccia, G., Pellegrini, B., & Schena, F. (2018). Physiological and anthropometric characteristics of top-level youth cross-country cyclists. *Journal of Sports Science*, 36, pp. 901–906. doi: 10.1080/02640414.2017.1346271

Forsman, H., Blomqvist, M., Davids, K., Liukkonen, J., & Konttinen, N. (2016). Identifying technical, physiological, tactical and psychological characteristics that contribute to career progression in soccer. *International Journal of Sports Science & Coaching*, 11, pp. 505–513. doi: 10.1177/1747954116655051

Gabbett T. (2010). GPS analysis of elite women's field hockey training and competition. *Strength and Conditioning Research,* 24, pp.1321–1324.

Gagné, F. (1993). Constructs and models pertaining to exceptional human abilities. In Heller, K. A., Mönks, F. J., & Passow, A. M., (Eds). *International Handbook of Research and Development of Giftedness and Talent.* (1st ed), (pp. 69-87). New York: Pergamon Press.

Gagné, F. (1995). From giftedness to talent: A developmental model and its impact on the language of the field*, Roeper Review*, 103.

Gagné, F. (2000). Understanding the Complex Choreography of Talent Development Through DMGT-Based Analysis. In Heller, K. A., Mönks, F. J., Sternberg, R. J., & Subotnik, R. F. *International Handbook of Research and Development of Giftedness and Talent.* (2nd ed), (pp. 67-79). Oxford, UK: Elsevier Science.

Gagné, F. (2004). Transforming gifts into talents: the DMGT as a developmental theory. *High Ability Studies,* 15, pp. 119–147.

Gagné, F., & Schader, R. M. (2006). Chance and Talent Development. *Roeper Review,* 28(2), pp. 88-90.

Gershgoren, L., Medeiros, F., Tenenbaum, G., & Schinke, R. J. (2013). Coaching Shared Mental Models in Soccer: A Longitudinal Case Study. *Journal of Clinical Sport Psychology,* 7, pp. 293-312.

Giacobbi, P. R., Poczwardowski, A., & Hager, P. F. (2005). A pragmatic research philosophy for applied sport psychology. *The Sport Psychologist*, 19, pp.18–31.

Gledhill, A., & Harwood, C. (2015). A holistic perspective on career development in UK female soccer players: A negative case analysis. *Psychology of Sport and Exercise,* 21, pp. 65-77.

Gledhill, A., & Harwood, C. (2019). Toward an understanding of players' perceptions of talent development environments in Uk female football. *Journal of Applied Sport Psychology,* 31, pp. 105–115. doi: 10.1080/10413200.2017.1410254

Gledhill, A., Harwood, C., & Forsdyke, D. (2017). Psychological Factors Associated with Talent Development in Football: A Systematic Review. *Psychology of Sport and Exercise,* 31, pp. 93-112.

Götze, M., & Hoppe, M. W. (2021). Relative Age Effect in Elite German Soccer: Influence of Gender and Competition Level. *Frontiers in Psychology,* 11(587023).

Green, C. (2005). Building Sport Programs to Optimize Athlete Recruitment, Retention, and Transition: Toward a Normative Theory of Sport Development. *Journal of Sport Management,* 19(19), pp. 233-253.

Gregson, W., Drust, B., Atkinson, G., & Salvo, V. D. (2010). Match-to-match variability of high-speed activities in Premier League soccer. *International Journal of Sports Medicine,* 31(4), pp.237-42.

Hanstad, D. V., & Skille, E. A. (2010). Does Elite sport Develop Mass Sport? A Norwegian Case Study. *Scandinavian Sport Studies Form,* 1, pp. 51-68.

Harwood, C., & Johnston, J. (2016). Positive Youth Development and Talent Development – Is there a best of both worlds? In Holt, N. L. *Positive Youth Development through Sport* (2nd ed), (pp. 113-121). London & New York: Routledge.

Hauser, L., Harwood, C. G., Höner, O., O'Connor, D., & Wachsmuth, S. (2022). Talent development environments within sport: A scoping review examining functional and dysfunctional environmental features. *International Review of Sport and Exercise Psychology (IRSEP),* (ahead of print).

Henriksen, K., Larsen, C. H., & Christensen, M. K. (2014). Looking at success from its opposite pole: the case of a talent development golf environment in Denmark. *International Journal of Sport and Exercise Psychology*, 12, pp. 134–149.doi: 10.1080/1612197X.2013.853473

Henriksen, K., Stambulova, N., & Roessler, K. K. (2010). Holistic Approach to Athletic Talent Development Environments: A Successful Sailing Milieu. *Psychology of Sport and Exercise,* 11(3), pp. 212-222.

Henriksen, K., Stambulova, N., & Roessler, K. K. (2010a). Successful Talent Development in Track and Field: Considering the Role of Environment. *Scandinavian Journal of Medicine and Science in Sports,* 20(Suppl. 2), pp. 122-132.

Henriksen, K., Stambulova, N., & Roessler, K. K. (2011). Riding the Wave of an Expert: A Successful Talent Development Environment in Kayaking. *The Sport Psychologist*, 25(3), pp. 341-362.

Henriksen, K., Storm, L. K., Kuettel, A., Linnér, L., & Stambulova, N. (2020). A holistic ecological approach to sport and study: The case of an athlete friendly university in Denmark. *Psychology of Sport and Exercise,* 47, 101637.

Herrebrøden, H., & Bjørndal, J. (2022). Youth International Experience is a Limited Predictor of Senior Success in Football: The Relationship Between U17, U19 and U21 Experience and Senior Elite Participation Across Nations and Playing Positions. *Frontiers in Sports and Active Living,* 4. doi: 10.3389/fspor.2022.875530

Hill., A., MacNamara, A., & Collins, D. (2018). Development and Initial Validation of the Psychological Characteristics of Developing Excellence Questionnaire Version 2. *European Journal of Sport Sciences*, doi: 10.1080/17461391.2018.1535627

Hill, A., MacNamara, A., & Collins, D. (2015). Psychobehaviorally Based Features of Effective Talent Development in Rugby Union: A Coach's Perspective. *The Sport Psychologist*, 29, pp. 201-212.

Hill, A., Mallinson-Howard, S. H., & Jowett, G. E. (2018). Multidimensional perfectionism in sport: A meta-analytical review. *Sport, Exercise, and Performance Psychology*, 7(3), pp. 235. doi:10.1037/spy0000125.

Hockey Ireland. (2021). *Strategy 2021-2024, change the game.* Available at: https://hockey.ie/wp-content/uploads/2021/03/Ireland-Strategic-Plan-2021_2024-compressed-1.pdf Accessed 08 October 2022.

Hockey Ireland. (2022). *The 2022 FIH Hockey Women's World Cup Squad Announcement.* Available at: https://hockey.ie/hockey-ireland-announce-the-2022-fih-hockey-womens-world-cup-squad/. Accessed 31 July 2022.

Holt, N. L., & Black D. E. (2007). Parenting styles and specific parenting strategies in youth sport. *Journal of Sport & Exercise Psychology,* 29, pp.170.

Holt, N. L., & Dunn, J. G. H. (2004). Toward a Grounded Theory of the Psychological Competencies and Environmental Conditions Associated with Soccer Success. *Journal of Applied Sport Psychology,* 16, pp. 199-219.

Höner, O., & Feichtinger, P. (2016). Psychological talent predictors in early adolescence and their empirical relationship with current and future performance in soccer. *Psychology of Sport and Exercise*, 25, pp. 17–26. doi: 10.1016/j.psychsport.2016.03.004

Hopkins, W. G. (2000). Measures of reliability in sports medicine and science. *Sports Medicine,* 30(1) pp. 1–5.

Hopkins, W. G. (2006). A Spreadsheet for Combining Outcomes from Several Subject Groups. *Sportscience*, 10, pp. 51-53. Available at: https://sportsci.org/resource/stats/xCombineGroups.xls

Hopkins, W. G. (2010). Linear models and effect magnitudes for research, clinical and practical applications. *Sportscience,* 14, pp. 49-58.

Hopkins, W. G. (2015). Individual responses made easy. *Journal of Applied Physiology*, 118(12), pp. 1444-1446.

Hopkins, W. G., & Hewson, D. J. (2001). Variability of competitive performance of distance runners. *Medicine & Science in Sports & Exercise,* 33(9), pp. 1588–1592.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise,* 41(1), pp. 3–12.

Howard, S. M. A., Cumming, S. P., Atkinson, M., & Manila, R. M. (2016). Biological maturity-associated variance in peak power output and momentum in academy rugby union players. *European Journal of Sport Science,* 16(8), pp. 972-980.

Irish Rugby. (2022). *McDarby appointed Head of Women's Performance and Pathways.* Available at: https://www.irishrugby.ie/2022/08/04/mcdarby-appointed-head-of-womens-performance-pathways/ Accessed 08 October 2022.

Irish Sport. (2020). *20 X 20.* Available at: https://www.irishsport.ie/20-x-20/. Accessed 20 July 2021.

Ivarsson, A., Stenling, A., Fallby, J., Johnson, U., Borg, E., & Johansson, G. (2015). The predictive ability of the talent development environment on youth elite football players' well-being: A person-centered approach. *Psychology of Sport and Exercise*, 16 (part 1), pp. 15-23. doi: 10.1016/j.psychsport.2014.09.006.

Jennings, D. H., Cormack, S. J., Coutts, A. J., & Aughey, R. J. (2012). International field hockey players perform more high speed running than national-level counterparts. *Journal of Strength and Conditioning Research*, 26(4), pp. 947–52.

Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent Identification in Sport: A Systematic Review. *Sports Medicine,* 48, pp.97-109

Jones, G. (1993). The role of performance 551 profiling in cognitive behavioural interventions in sport. The Sport Psychologist, 7(2), 160-172.

Jones, B., Weaving, D., Tee, J., Darrall-Jones, J., Weakley, J., Phibbs, P., Read, D., Roe, G., Hendricks, S., & Till, K. (2018). Bigger, stronger, faster, fitter: the differences in physical qualities of school and academy rugby union players. *Journal of Sports Science,* 36, pp. 2399–2404. doi: 10.1080/02640414.2018.1458589

Kay, T. (2000). Sporting excellence: A family affair? *European Physical Education Review,* 6(2), pp.151-169.

Kearney, P. E., & Hayes, P. R. (2018). Excelling at youth level in competitive track and field athletics is not a prerequisite for later success. *Journal of Sport Sciences,* 36(21), pp. 2502-2509. doi: 10.1080/02640414.2018.1465724

Kelly, L. M., & Cordeiro, M. (2020). Three principles of pragmatism for research on organisational process. *Methodological Innovations,* 13(2).

Kempton, T., Sirotic, A. C., & Coutts, A. (2014). Between match variation in professional rugby league competition. *Journal of Science and Medicine in Sport,* 17, pp. 404–407.

Larsen, C. H., Alfermann, D., Henriksen, K., & Christensen, M. K. (2014). Preparing Footballers for the Next Step: An Intervention Program From an Ecological Perspective. *The Sport Psychologist*, 28, pp. 91-102.

Larsen, C. H., Alfermann, D., Henriksen, K., & Christensen, M. K. (2013). Successful talent development in soccer: The characteristics of the environment. *Sport, Exercise, and Performance Psychology, 2*(3), pp. 190–206. doi: 10.1037/a0031958

Larsen, C. H., Storm, L. K., Sæther, S., Pyrdol, N., & Henriksen, K. (2020). A world class academy in professional football. *Scandinavian Journal of Sport and Exercise Psychology, 2*(0).

Laureys, F., Collins, D., Deconinck, F. J. A., & Lenoir, M. (2021). Exploring the use of the Psychological Characteristics of Developing Excellence (PCDEs) in younger age groups: First steps in the validation process of the PCDE Questionnaire for Children (PCDEQ-C). *PLoS One,* 16(11).

Li, C., Martindale, R., & Sun, Y. (2019). Relationships between talent development environments and mental toughness: The role of basic psychological needs satisfaction. *Journal of Sports Sciences,* 37(18), pp. 2057-2065.

Li, C., Martindale, R., Wu, Y., & Si, G. (2018). Psychometric properties of the Talent Development Environment Questionnaire with Chinese talented athletes. *Journal of Sports Sciences*, 36(1), pp. 79-85. doi: 10.1080/02640414.2017.1282619

Li, C., Wang, J. C. K., & Pyun, D. Y. (2014). Talent Development Environmental Factors in Sport: A Review and Taxonomic Classification. *Quest,* 66(4), pp. 433-447.

Li, C., Wang, J. C. K., Pyun, D. Y., & Martindale, R. J. J. (2015). Further Development of the Talent Development Environment Questionnaire for Sport. *Journal of Sports Sciences,* 33(17), pp. 1831-1843. doi: 10.1080/02640414.2015.1014828

Linder, A., Svenson, M., Carlsson, A., Lemmen, P., Chang, F., Schmitt, K., & Kulgren, A. (2011). “Evarid - Anthropometric and biomechanical specification of a finite element dummy model of an average female for rear impact testing,” in The 22nd

International Technical Conference on the Enhanced Safety of Vehicles (ESV) (Washington, DC: Swedish National Road And Transport Research Institute), 11.

Liu, H., Gómez, M. A., Gonçalves, B., & Sampaio, J. (2016). Technical performance and match-to-match variation in elite football teams. *Journal of Sport Sciences,* 34(6), pp. 509–518.

LGFA. (2018). *LGFA Strategic Roadmap*. Available at: https://ladiesgaelic.ie/wp-content/uploads/2018/04/LGFA-Strategic-Roadmap_April-2018.pdf. Accessed 02 March 2023.

Lundqvist, C., Gregson, W., Bonanno, D., Lolli, L., & Di Salvo, V. (2022). A worldwide survey of perspectives on demands, resources, and barriers influencing the youth-to-senior transition in academy football players. *International Journal of Sports Science & Coaching,* (ahead of print), pp. 1-9. doi: 10.1177/17479541221135626

MacNamara, Á., & Collins, D. (2011). Development and Initial Validation of the Psychological Characteristics of Developing Excellence Questionnaire. *Journal of Sport Sciences,* 29(12), pp. 1273-1286.

MacNamara, Á., Button, A., & Collins, D. (2010a). The role of psychological characteristics in facilitating the pathway to elite performance. Part 1: Identifying mental skills and behaviours. *The Sport Psychologist*, 24 (1), pp. 52-73.

MacNamara, Á., Button, A., & Collins, D. (2010b). The role of psychological characteristics in facilitating the pathway to elite performance. Part 2: Examining Environmental and Stage-Related Differences in Skills and Behaviours. *The Sport Psychologist*, 24 (1), pp. 74-96.

Macutkiewicz, D., & Sunderland, C. (2011). The use of GPS to evaluate activity profiles of elite women hockey players during match-play. *Journal of Sports Sciences,* 29(9), pp. 967–973.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). Growth, Maturation, and Physical Activity (2nd ed). Human Kinetics: Champaign, IL.

Martindale, R. J. J., Collins, D., & Abraham, A. (2007). Effective Talent Development: The Elite Coach Perspective in UK Sport. *Journal of Applied Sport Psychology*, 19, pp. 187–206.

Martindale, R. J. J., Collins, D., & Daubney, J. (2005). Talent Development: A Guide for Practice and Research Within Sport. *Quest,* 57(4), pp. 353-375.

Martindale, R. J. J., Collins, D., Wang, J. C. K., McNeill, M., Lee, S. K., Sproule, J., & Westbury, T. (2010). Development of the Talent Development Environment Questionnaire for Sport. *Journal of Sports Sciences*, 28(11), pp. 1209-1221. doi: 10.1080/02640414.2010.495993

Martindale, R. J. J., Collins, D., Douglas, C., & Whike, A. (2013). Examining ecological validity of the talent development environment questionnaire. *Journal of Sport Sciences,* 31(1), pp. 41-47.

Mathieu, J. E., Goodwin, G. F., Heffner, T. S., Salas, E., & Cannon-Bowers, J. A. (2000). Shared Mental Models on Team Process and Performance. *Journal of Applied Psychology,* 85(2), pp. 273-283.

Mathorne, W., Henriksen, K., & Stambulova, N. (2020). An “Organizational Triangle” to Coordinate Talent Development: A Case Study in Danish Swimming. *Case Studies in Sport & Exercise Psychology*, 4, pp.11-20.

McAuley, A. B. T., Baker, J., & Kelly, A. L. (2022). Defining “elite” status in sport: from chaos to clarity. *German Journal of Exercise and Sport Research,* 52, pp. 193-197.

McGuinness, A., Malone, S., Petrakos, G., & Collins, K. (2019). Physical and Physiological Demands of Elite International Female Field Hockey Players During Competitive Match-Play. *Journal of Strength and Conditioning Research,* 33(11), pp. 3105-3113.

McGuinness, A., Malone, S., Hughes, B., Collins, K., & Passmore, D. (2019). Physical Activity and Physiological Profiles of Elite International Female Field Hockey Players Across the Quarters of Competitive Match Play. *Journal of Strength and Conditioning Research,* 33(9), pp.2513-2522.

McGuinness, A., McMahon, G., Malone, S., Kenna, D., Passmore, D., & Collins, K. (2020). Monitoring wellness, training load, and running performance during a major international female field hockey tournament. *Journal of Strength and Conditioning Research,* 34(8), pp. 2312–2320.

McLaren, S. J., Weston, M., Smith, A., Cramb, R., & Portas, M. D. (2016). Variability of physical performance and player match loads in professional rugby union. *Journal of Science and Medicine in Sport,* 19(6), pp. 493-497.

Mills, A., Butt, J., Maynard, I., & Harwood, C. (2014). Examining the Development Environments of Elite English Football Academies: The Players’ Perspective. *International Journal of Sports Science & Coaching*, 9(6), pp. 1457–1472. doi: 10.1260/1747-9541.9.6.1457

Mills, A., Butt, J., Maynard, I., & Harwood, C. (2012). Identifying factors perceived to influence the development of elite youth football academy players. *Journal of Sports Sciences,* 30(15), pp. 1593-1604, doi: 10.1080/02640414.2012.710753

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred Reporting Items For Systematic Reviews And Meta-Analyses: The Prisma Statement. *Annals Of Internal Medicine*, 151, 264-269. Doi:10.7326/0003-4819-151-4-200908180-00135.

Mohr, M., Krustrup, P., Andersson, H., Kirkendal, D., & Bangsbo, J. (2008). Match activities of elite women soccer players at different performance levels. *Journal of Strength and Conditioning Research,* 22, pp. 341–349.

Morley, D., Turner, G., Roberts, A. H., Lidmus, M., Melvin, I., Nicholson, M., & Donaldson, A. (2022). What do coaches want to know about identifying, developing, supporting and progressing athletes through a national pathway? *Sports Coaching Review,* (ahead of print), pp. 1-24. doi: 10.1080/21640629.2022.2142409

Morris, R., Tod, D., & Eubank, M. (2017). From Youth Team to First Team: An Investigation into the Transition Experiences of Young Professional Athletes in Soccer. *International Journal of Sport and Exercise Psychology*, 15(5), pp. 523-539.

Murcia, J. A. M., Gimeno, E. C., & Coll, D. G. (2008). Relationship Among Goal Orientations, Motivational Climate, and Flow in Adolescent Athletes: Differences by Gender. *The Spanish Journal of Psychology,* 11(1), pp. 181-191.

Nash, C., & Taylor, J. (2021). Just Let Them Play: Complex Dynamics in Youth Sport, Why It Isn't So Simple. *Frontiers in Psychology*, 12, pp. 700-750. doi: 10.3389/fpsyg.2021.700750

Nicholls, A. R., Polman, R., Levy, A. R., Taylor, J., & Cobley, S. (2007). Stressors, coping, and coping effectiveness: Gender, type of sport, and skill differences. *Journal of Sport Sciences*, 25(13), pp. 1521-1530.

Nikander, J. A. O., Ronkainen, N. J., Korhonen, N., Saarinen, M., & Ryba, T. V. (2020). From athletic talent development to dual career development? A case study in a

Finnish high performance sports environment. *International Journal of Sport and Exercise Psychology,* 20(1), pp. 245-262.

Oliva-Lozano, J. M., Muyor, J. M., Fortes, V., & McLaren, S. J. (2021). Decomposing the variability of match physical performance in professional soccer: implications for monitoring individuals. *European Journal of Sport Science,* 21(11), pp. 1–9.

Pankhurst, A., & Collins, D. (2013). Talent Identification and Development: The Need for Coherence Between Research, System, and Process. *Quest,* 65(1), pp. 83-97.

Paul, D. J., Bradley, P. S., & Nassis, G. P. (2015). Factors affecting match running performance of elite soccer players: shedding some light on the complexity. *International Journal of Sports Physiology and Performance,* 10, pp. 516-519.

Peña-González, I., Fernández-Fernández, J., Moya-Ramón, M., & Cervell, Ó. E. (2018). Relative age effect, biological maturation, and coaches' efficacy expectations in young male soccer players. *Research Quarterly for Exercise and Sport*, 89, pp. 373–379. doi: 10.1080/02701367.2018.1486003

Phibbs, P. J., Jones, B., Roe, G., Read, D., Darrall-Jones, J., Weakley, J., Rocks, A., & Till, K. (2018). The organised chaos of English adolescent rugby union: Influence of weekly match frequency on the variability of match and training loads. *European Journal of Sport Science,* 18(3), pp. 341-348.

Phillipe, R. A., & Seiler, R. (2005). Sex Differences on Use of Associative and Dissociative Cognitive Strategies Among Male and Female Athletes. *Perceptual and Motor Skills,* 101, pp. 440-444.

Phillips, E., Davids, K., Renshaw, I., & Portus, M. (2010). Expert performance in sport and the dynamics of talent development. *Sports Medicine*, 40, pp. 271–283. doi: 10.2165/11319430-000000000-00000

Pope, C., Mays, N., & Popay, J. (2007). *Synthesizing Qualitative And Quantitative Health Research: A Guide To Methods.* Maidenhead, UK: Open University Press.

Romann, M., Rössler, R., Javet, M., & Faude, O. (2018). Relative Age Effects In Swiss Talent Development - A Nationwide Analysis Of All Sports. *Journal Of Sports Sciences, 36,* 2025-2031.

Romann, M., Javet, M., & Fuchslocher, J. (2017). Coaches' eye as a valid method to assess biological maturation in youth elite soccer. *Talent Development and Excellence,* 9, pp. 3–13.

Rongen, F., Mckenna, J., Cobley, S., & Till, K. (2018). Are youth sport talent identification and development systems necessary and healthy? *Sports Medicine*, Open 4, pp. 18–18. doi: 10.1186/s40798-018-0135-2

RTE. (2022). *All-Ireland ladies final attracts record-breaking crowd.* Available at: https://www.rte.ie/sport/gaa/2019/0915/1076060-all-ireland-ladies-final-attracts-record-breaking-crowd/. Accessed 31 July 2022.

RTE. (2022b). *AFLW salaries set to almost double when season starts in August.* Available at: https://www.rte.ie/sport/other-sport/2022/0519/1299938-aflw-salaries-set-to-almost-double-next-season/ . Accesses 08 October 2022.

Ryba, T. V., Stambulova, N. B., Ronkainen, N. J., Bungaard, J., & Selanne, H. (2015). Dual Career Pathways of Transitional Athletes. *Psychology of Sport and Exercise*, 21, pp. 125-134.

Ryom, K., Ravn, M., During, R., & Henriksen, K. (2020). Talent Development in Football – A Holistic Perspective: The Case of KRC Genk. *International Sport Coaching Journal,* (ahead of print). doi: 10.1123/iscj.2019-0045

Sabiston, C. M., Sedgwick, W. A., Crocker, P. R. E., Kowalski, K. C., & Mack, D. E. (2007). Social Physique Anxiety in Adolescence, An Exploration of Influences, Coping Strategies, and Health Behaviours. *Journal of Adolescent Research,* 22(1), pp. 78-101.

Savage, J., Collins, D., & Cruickshank, A. (2017). Exploring Traumas in the Development of Talent: What Are They, What Do They Do, and What Do They Require? *Journal of Applied Sport Psychology,* 29, pp. 101-117.

Saward, C., Morris, J. G., Nevill, M. E., Minniti, A. M., & Sunderland, C. (2020). Psychological Characteristics of Developing Excellence in elite youth football players in English professional academies. *Journal of Sport Sciences*, 38(11-12), pp. 1380-1386.

Schorer, J., Baker, J., Lotz, S., & Büsch, D. (2010). Influence of early environmental constraints on achievement motivation in talented young handball players*. International Journal of Sport Psychology,* 41, pp. 42–57.

Siekańska, M., & Wojtowicz, A. (2017). Polish version of research based Model of Sport Talent Development Environment and adaptation of Talent Development Environment Questionnaire. *Studies in Sport Humanities*, 22, pp. 7-17. doi: 10.5604/01.3001.0012.6519

Simpson, D., Martindale, R. J. J., Travlos, A., Souglis, A., & Adronikos, G. (2022). An investigation of the talent development pathway in Scottish female football. *International Journal of Sport Psychology,* 53, pp. 218-241.

Simonton, D. K. (2001). Talent Development as a Multidimensional, Multiplicative, and Dynamic Process. *Current Directions in Psychological Science,* 10(2), pp. 39-43.

Smith, B., & McGannon, K. R. (2018). Developing rigor in qualitative research: problems and opportunities within sport and exercise psychology. *International Review of Sport and Exercise Psychology*, 11(1), pp. 101-121, doi: 10.1080/1750984X.2017.1317357

Smith, M. (2010). Research Methods In Sport. UK: Learning Matters.

Sotiriadou, P., Brouwers, J., & De Bosscher, V. (2016). High performance development pathways. In Sherry, E., Schulenkorf, N., & Phillips, P. *Managing Sport Development: An international approach,* (pp. 63-73). London & New York: Routledge.

Sparkes, A. C. (2015). Developing mixed methods research in sport and exercise psychology: Critical reflections on five points of controversy. *Psychology of Sport & Exercise,* 16, pp. 49-59.

Sparkes, A., & Smith, B. (2009). Judging The Quality Of Qualitative Inquiry: Criteriology And Relativism In Action. *Psychology Of Sport And Exercise, 10*, 491-497.

Sport England. (2018). *The talent plan for England, creating the world's best talent system.* Available at: https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/the-talent-plan-for-england.pdf?VersionId=FMAAxsmgrkyJ0hXlJQl2aB7s9uIpV.uN. Accessed 09 October 2022.

Sport Ireland. (2020). *High performance strategy 2021-2023.* Available at: https://www.sportireland.ie/sites/default/files/media/document/2021-06/strategy_eng.pdf. Accessed 09 October 2022.

Stambulova, N., Franck, A., & Weibull, F. (2012). Assessment of the Transition from Junior-to-Senior Sports in Swedish Athletes. *International Journal of Sport and Exercise Psychology,* 10(2), pp. 79-95.

Stambulova, N. B., Engstrom, C., Franck, A., Linner, L., & Lindahl, K. (2015). Searching for an Optimal Balance: Dual Career Experiences of Swedish Adolescent Athletes. *Psychology of Sport and Exercise*, 21, 4-14.

Stambulova, N., Pehrson, S., & Olsson, K. (2017). Phases in the junior-to-senior transition of Swedish ice hockey players: From a conceptual framework to an empirical model. *International Journal of Sports Science & Coaching,* 12(2), pp. 231-244.

Stambulova, N. B., & Wylleman, P. (2019). Psychology of athletes' dual careers: A state-of-the-art critical review of the European discourse. *Psychology of Sport and Exercise*, 42, pp. 74-88.

Subijana, C. L., Barriopedro, M., & Conde, E. (2015). Supporting Dual Career in Spain: Elite Athletes Barrier to Study. *Psychology of Sport and Exercise*, 21, pp. 57-64.

Sunderland, C. D., & Edwards, P. L. (2017). Activity profile and between-match variation in elite male field hockey. *Journal of Strength & Conditioning Research,* 31(3), pp. 758–764.

Sweeney, L., Horan, D., & MacNamara, Á. (2021). Premature Professionalisation or Early Engagement? Examining Practise in Football Player Pathways. *Frontiers in Sports and Active Living*, 3.

Sweeney, L., MacNamara, Á., & Horan, D. (2022). The Irish Football Player Pathway: Examining Stakeholder Coherence Throughout and Across the Player Development System. *Frontiers in Sports and Active Living*, 4.

Taylor, J., Ashford, M., & Collins, D. (2022). The Role of Challenge in Talent Development: Understanding Impact in Response to Emotional Disturbance. *Psych,* 4, pp. 668-694

Taylor, J., & Collins, D. J. (2019). Shoulda, Coulda, Didnae—Why Don't High Potential Players Make it? *The Sport Psychologist*, 33 (2). pp. 85-96.

Taylor, J., & Collins, D. (2020). The Highs and the Lows – Exploring the Nature of Optimally Impactful Development Experiences on the Talent Pathway. *Sports Psychologist,* 34(4), doi: 10.1123/tsp.2020-0034

Taylor, J., & Colins, D. (2021). Getting in the Way: Investigating Barriers to Optimizing Talent Development Experience. *Journal of Expertise*, 4(3), pp. 315-332.

Taylor, J., & Collins, D. (2021b). Navigating the Winds of Change on the Smooth Sea - The Interaction of feedback and emotional disruption on the talent pathway. *Journal of Applied Sport Psychology*, doi: 10.1080/10413200.2021.1894505

Taylor, J., & Collins, D. (2022). "The talent development curriculum," in Practical Sport Coaching, 2nd ed, C. Nash (London: Routledge).

Taylor, J., Collins, D., & Cruickshank, A. (2021). Too Many Cooks, Not Enough Gourmets: Examining Provision and Use of Feedback for the Developing Athlete. *The Sport Psychologist,* 36(2), doi: 10.1123/tsp.2021-0037

Taylor, J., MacNamara, A., & Taylor, R. D. (2022). Strategy in talent systems: Top-down and bottom-up approaches. *Frontiers in Sport and Active Living*, doi:10.3389/fspor.2022.988631

Tedesqui, R. A. B., & Young, B. W. (2018). Comparing the contribution of conscientiousness, self-control, and grit to key criteria of sport expertise development. *Psychology of Sport and Exercise*, 34, pp. 110–118. doi: 10.1016/j.psychsport.2017.10.002

Tekavc, J., Wylleman, P., & Erpic, S. C. (2015). Perceptions of Dual Career Development Among Elite Level Swimmers and Basketball Players. *Psychology of Sport and Exercise*, 21, pp. 27-41.

The Camogie Association. (2022). *Written Statement to Joint Committee on Media, Tourism, Arts, Culture, Sport and the Gaeltacht.* Available online at: https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_tourism_culture_arts_sport_and_media/submissions/2022/2022-06-28_submission-the-camogie-association_en.pdf. Accessed 02 March 2023.

The FA. (2017). *Talent Pathway*. Available online at: http://Www.Thefa.Com/Womens-Girls-Football/England-Talent-Pathway Accessed April 30, 2019.

The World Bank. (2017). Population, Female (% Of Total). Available online at: https://Data.Worldbank.Org/Indicator/Sp.Pop.Totl.Fe.Zs Accessed 30 April 2019.

Thomas, C. E., Abbott, G., Gastin, P. B., & Main, L. C. (2020). Construct validity and reliability of the Talent Development Environment Questionnaire in Caribbean youth track and field athletes. *PLoS ONE*, 15(1) e0227815. doi: 10.1371/journal.pone.0227815

Trewin, J., Meylan, C., Varlay, M. C., & Cronin, J. (2018). The match-to-match variation of match-running in elite female soccer. *Journal of Science & Medicine in Sport,* 21(2), pp. 196–210.

Tucker, R., & Collins, M. (2012). What makes champions? A review of the relative contribution of genes and training to sporting success. *British Journal of Sports Medicine*, 46, pp. 555–561. doi:10.1136/bjsports-2011-090548

UEFA. (2022). *Biggest Women's EURO crowds: 2022 final the best attended ever.* Available at: https://www.uefa.com/womenseuro/news/0276-15748cb0ba74-f342af5f57b8-1000--biggest-women-s-euro-crowds-2022-finals-the-best-attended-ever/. Accessed 31 July 2022.

UK Sport & English Institute of Sport. (2020). *UK Sport Coach Development Team & EIS Performance Pathways, Pathway Coaching Position Statement.* Available at: https://www.uksport.gov.uk/news/2020/12/02/coaching-pathway-position-statement Accessed 17 February 2021.

Varnes, J. R., Stellefson, M. L., Janelle, C. M., Dorman, S. M., Dodd, V., & Miller, M. D. (2013). A systematic review of studies comparing body image concerns among female college athletes and non-athletes, 1997-2012. *Body Image,* 10(4), pp. 421-432.

Vescovi, J. D. (2014). Motion characteristics of youth women soccer matches: Female athletes in motion (FAiM) study. *International Journal of Sports Medicine*, 35, pp. 110-117.

Vescovi, J. D. (2016). Locomotor, heart-rate, and metabolic power characteristics of youth women's field hockey: female athletes in motion (FAiM) Study. *Research Quarterly for Exercise and Sport,* 87(1), pp.68-87.

Vescovi, J., & Frayne, D. (2015). Motion characteristics of Division I College Field Hockey: Female Athletes in Motion (FAiM) Study. *International Journal of Sports Physiology and Performance,* 10, pp. 476-481.

Vitale, C., Fini, M., Spoletini, I., Lainscak, M., Seferovic, P., & Rosana, G. M. C. (2017). Under-representation of elderly and women in clinical trials. *International Journal of Cardiology*, 232(2), pp. 16–221. doi: 10.1016/j.ijcard.2017.01.018

Wang, C. K. J., Pyun, D., Y., Chunxiao, L., & Lee, M. S. (2016). Talent Development Environment And Achievement Goal Adoption Among Korean And Singaporean Athletes: Does Perceived Competence Matter? *International Journal Of Sports Science & Coaching,* 11, 496-504.

Wang, C. K. J., Sproule, J., McNeill, M., Martindale, R. J. J., & Lee, K. S. (2011). Impact of the Talent Development Environment on Achievement Goals and Life Aspirations in Singapore. *Journal of Applied Sport Psychology*, 23(3), pp. 263-276.

Watts, D. G. (2014). The Validity of Field Testing Methods to Discriminate Between Representative Playing Level in Elite Female Field Hockey Players. *Journal of Australian Strength and Conditioning,* 22(5), pp. 31-34.

Webb, V., Collins, D., & Cruickshank, A. (2016). Aligning The Talent Pathway: Exploring the Role and Mechanisms of Coherence in Development. *Journal of Sports Sciences,* 34(19), pp. 1799-1807.

Weber, C. L., Chia, M., & Inbar, O. (2006). Gender Differences in Anaerobic Power of the Arms and Legs – A Scaling Issue. *Medicine & Science in Sports & Exercise*, 38(1), pp. 1-9.

White, A. D., & MacFarlane, N. G. (2015). Contextual effects on activity profiles of domestic field hockey during competition and training. *Human Movement Science,* 40, pp. 422–431.

Williams, G., & MacNamara, Á. (2020). "I didn't make it but…": Deselected Athletes Experiences of the Talent Development Pathway. *Frontiers in Sport and Active Living*, doi: 10.3389/fspor.2020.00024

Williams, G., & MacNamara, Á. (2022). Challenge is in the eye of the beholder: Exploring young athlete's experience of challenges on the talent pathway. *Journal of Sport Sciences*, 40(10), pp. 1078-1087. doi: 10.1080/02640414.2022.2047503

Women's AFL. (2022). AFLW passes the million mark as crowds keep growing. Available at: https://www.womens.afl/news/79647/aflw-passes-the-million-mark-as-crowds-keep-growing#:~:text=Supporters%20of%20AFLW%20are%20not,compared%20to%20FTA%20in%202021 Accessed 08 October 2022.

Woolcock, G., & Burke, M. (2013). Measuring Spatial Variations in Sports Talent Development: the approach, methods and measures of 'Talent Tracker'. *Australian Geographer*, 44(1), pp. 23-39.

Wylleman, P., & Lavellee, D. (2004). A developmental perspective on transitions faced by athletes. In M. Weiss (Ed.), *Developmental sport psychology* (pp. 503-524). Morgantown, WV: Fitness Information Technology.

Zarrett, N., & Eccles, J. (2006). The Passage to Adulthood: Challenges of Late Adolescence. *New Directions for Youth Development*, (111), pp. 13-28.

Appendices

Appendix	Appendix Title
A1	Plain Language Statement – Chapter 4 and 6
A2	Informed Consent and Informed Assent Form – Chapter 4 and 6
A3	Talent Development Environment Questionnaire (5 factor) (TDEQ-5) – Chapter 4
A4	Psychological Characteristics for Developing Excellence Questionnaire Version 2 (PCDEQ2) – Chapter 6
A5	Plain Language Statement – Chapter 5
A6	Informed Consent and Informed Assent Form – Chapter 5
A7	Semi Structured Focus Group Interview Guide - Athletes
A8	Semi Structured Focus Group Interview Guide - Coaches
A9	Plain Language Statement – Chapter 7 and 8
A10	Informed Consent and Informed Assent Form – Chapter 7 and 8

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Plain Language Statement for Participants (Players)

'The Talent Development of International Female Irish Hockey Players'

Introduction to the Research Study

The research title for this study is '*The Talent Development of International Irish Hockey Players'.* The principal investigator of this study is Dr David Passmore, Lecturer in the School of Human Health and Human Performance in Dublin City University (DCU). The other primary investigator is Miss Orlaith Curran, PhD student DCU. The purpose of this study is to investigate the talent development environment and also understand the psychological skills of female hockey players in the TD pathway in Hockey Ireland. The study is being carried out to help with improving the current Hockey Ireland Female Talent Development Pathway. Hockey Ireland can update any participants on the development of this pathway.

Details of what involvement in the Research Study will require

Involvement in this study will require you to complete two questionnaires.

The first questionnaire is the Talent Development Environment Questionnaire (TDEQ-5; Li et al., 2015) which will involve questions about the athlete's experiences of the talent development environment within which they participate. The second questionnaire is the Psychological Characteristics of Development Excellence Questionnaire version 2 (Hill et al., 2018).

You will be sent a link via email for the questionnaires and you will be asked to complete the questionnaire online.

If you decide that you would like to take part in this research study, you will need to confirm your consent.

If you are under 18 years of age your parent or guardian will also need to give their consent and fill in their name as a way of confirming that consent.

The questionnaire can be completed anonymously so your answers will be confidential. All participant information will be stored privately on a password protected hard drive and destroyed after five years.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

The questionnaire will be filled in anonymously so that any answers you give will be confidential. Any participant under the age of 18 is asked that your parent fills out the questionnaire on your behalf. Confidentiality of information provided is subject to legal limitations. The Identity and information shared by each of the participants will be protected in the research by giving each participant a pseudo name e.g A1 (athlete 1). Data will often be collated and presented using the participants playing position and age group. All participant information will be stored privatley on a password protected hard drive and destroyed after five years.

Statement that involvement in the Research Study is voluntary

Involvement in this study is completely voluntary and participants can withdraw from the study up until results of the study are published. Taking part in this study involves no health risks and is completely voluntary. If you do agree to take part in this study you can say you do not want to be part of the study anymore at any point without any negative consequences for treatment or future support.

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

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Informed Consent Form (Players): Ages 18 years and up
Informed Assent Form (Players): Ages 14-17 years

Dear Participant,

Potential Participants 18 years and older: This is a consent form. It provides a summary of the information of this research study. If you decide that you would like to take part in this research study, you would sign this form to confirm your consent.

Potential Teen Participants: This form also serves as an assent form. That means that if you choose to take part in this research study, you would need to confirm your choice to consent. Your parent or guardian would also need to give their consent and fill in their name as a way of confirming that consent. Please not that all names will be kept confidential and excluded for purpose of the research.

Purpose of this study:

The Hockey Ireland High Performance Committee has agreed to the U16, U18 and U21 Squad players be involved in a project which is part of a PhD and final year project for a Sport Science and Health degree program in Dublin City University. The study's title is '*The Talent Development of International Irish Hockey Players'.* We are aiming to understand the talent development environment and also the psychological skills used by U16, U18, and U21 players. The information gathered in this project will help to update the current talent development pathway for hockey players in Ireland so that Hockey Ireland can provide an holistic development environment and underage programme where players are developed appropriately both physically and mentally at each stage along the playing pathway.

The investigators involved in the study are:
Investigators:
Dr David Passmore, Lecturer in Coaching Science, School of Health and Human Performance, Dublin City University
Dr Aine MacNamara, Lecturer, Institute of Coaching and Performance, University of Central Lancashire, Preston, United Kingdom
Orlaith Curran, PhD student in School of Health and Human Performance, Dublin City University

Why have I been chosen?

You have been chosen to be invited to participate as a youth hockey player in Ireland, playing at either club, school or international level. Your invovement is voluntary.

What will happen if I agree to take part?

Your anonymity will be protected throughout. The data stored and presented will use Pseudonyms (ie. Athlete 1) and playing position and playing group only. If you would like to receive data from the analysis that will follow the collection, this will be available within six months.

Confidentiality:

Rest assured that all information gathered in this study will remain completely anonymous and confidential. At no point will you be asked for your name in this study. Responses will be identified using a code number that you will be assigned. All collected data will be held on a password protected hard drive and kept in a secure locked cupboard. Data will be stored for five years from the end of the project and then destroyed. The researchers will not know individual responses of recipients.

Benefits:

The information you provide will help us understand more about the talent development needs of youth hockey players in Ireland and will be available to you after completion of the Hockey Ireland Talent Development Pathway. You will be benefit from this as it will be tailored to provide a holistic environment and pathway for progressive player development.

Confirmation that involvement in the Research Study is voluntary

I understand participation in this study is voluntary and it is at my discretion as to whether I participate in the research. I understand that I can withdraw from this study up until results are published.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

Dublin City University will protect all my personal information. However, confidentiality of information provided is subject to legal limitations. My identity will be protected with the use of a pseudo name for each participant. Data will be saved in a password protected secure file.

If you require further information or have questions please contact orlaith.curran2@gmail.com

I understand if I have any concerns about the way the research is being conducted I can contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000

Confirmation of particular requirements as highlighted in the Plain Language Statement

Participant's (Parent/Guardian for under 18 years)

I have read and understand the attached information (or had it read to me).

I have had an opportunity to ask questions and discuss this study, receiving satisfactory answers to all my questions

I know that my participation is voluntary and that I can withdraw from the project at any stage without giving any reason.

Consent:

I have a copy of this consent form. Therefore, I consent to take part in this research project

Participants Signature: _____ **Date:** _____

Name in Block Capitals: _____

Participants Parent/Guardian Signature: _____

Name in Block Capitals: _____

5 FACTOR TALENT DEVELOPMENT ENVIRONMENT QUESTIONNAIRE

(TDEQ-5)

Li et al., 2015 Version

Name:_____ **Team:** _____

Instructions

Over the next few pages there are series of statements (25) which refer to you and your development in sport. Please indicate the extent to which you agree or disagree with each statement based on your current experiences. For example:

		Strongly Agree	Agree	Agree a little bit	Disagree a little bit	Disagree	Strongly Disagree	
1. Spectators regularly come to watch our games…….	1	☐	☐	☐	■	☐	☐	1
2. My coach often talks to me about how I can improve…….	2	☐	■	☐	☐	☐	☐	2

There are no right or wrong answers. All answers will be kept confidential and nobody except for the researcher will see your personal responses. Any information disclosed will only be presented as a group average. This is to ensure you are comfortable about giving honest responses.

The questionnaire will take about 5 minutes to complete. Please do not dwell on questions. If you are not sure, go with your gut instinct. However, please try to answer questions as accurately as you can as this could help improve the standard of your development experiences.

Appendix A3. Talent Development Environment Questionnaire (5 factor) (TDEQ-5) – Chapter 4

After you have finished please check through your responses to make sure you have an answer for each question

		Strongly Agree	Agree	Agree a little bit	Disagree a little bit	Disagree	Strongly Disagree	
.. I can pop in to see my coach or other support staff whenever I need to (e.g. hysiotherapist, psychologist, strength trainer, nutritionist, lifestyle advisor etc).....	1	☐	☐	☐	☐	☐	☐	1
. I am rarely encouraged to plan for how I would deal with things that might go wrong....	2	☐	☐	☐	☐	☐	☐	2
. The advice my parents give me fits well with the advice I get from my coaches.....	3	☐	☐	☐	☐	☐	☐	3
. My coach and I talk about what current and/or past world class performers did to be uccessful.....	4	☐	☐	☐	☐	☐	☐	4
. My coach doesn't appear to be that interested in my life outside of sport.....	5	☐	☐	☐	☐	☐	☐	5
. My coach and I regularly talk about things I need to do to progress to the top level in my port (e.g. training ethos, competition performances, physically, mentally, technically, actically).....	6	☐	☐	☐	☐	☐	☐	6
. Those who help me in my sport seem to be on the same wavelength as each other when it omes to what is best for me (e.g. coaches, physiotherapists, sport psychologists, strength rainers, nutritionists, lifestyle advisors etc).....	7	☐	☐	☐	☐	☐	☐	7
. My coach and I often try to identify what my next big test will be before it happens.....	8	☐	☐	☐	☐	☐	☐	8
. Currently, I have access to a variety of different types of professionals to help my sports levelopment (e.g. physiotherapist, sport psychologist, strength trainer, nutritionist, lifestyle advisor tc).....	9	☐	☐	☐	☐	☐	☐	9
0. The guidelines in my sport regarding what I need to do to progress are not very clear....	10	☐	☐	☐	☐	☐	☐	10
1. I don't get much help to develop my mental toughness in sport effectively.....	11	☐	☐	☐	☐	☐	☐	11
	12	☐	☐	☐	☐	☐	☐	12

Appendix A3. Talent Development Environment Questionnaire (5 factor) (TDEQ-5) – Chapter 4

		Strongly Agree	Agree	Agree a little bit	Disagree a little bit	Disagree	Strongly Disagree	
.2. My coach rarely takes the time to talk to other coaches who work with me……..								
.3. My coach rarely talks to me about my well-being……..	13	☐	☐	☐	☐	☐	☐	13
.4. I regularly set goals with my coach that are specific to my individual development…….	14	☐	☐	☐	☐	☐	☐	14
.5. I am involved in most decisions about my sport development……..	15	☐	☐	☐	☐	☐	☐	15
.6. My coaches make time to talk to my parents about me and what I am trying to achieve..	16	☐	☐	☐	☐	☐	☐	16
.7. I am not taught that much about how to balance training, competing and recovery……..	17	☐	☐	☐	☐	☐	☐	17
.8. My coaches talk regularly to the other people who support me in my sport about what I am rying to achieve (e.g. physiotherapist, sport psychologist, nutritionist, strength & conditioning oach, life style advisor etc)……..	18	☐	☐	☐	☐	☐	☐	18
.9. My training is specifically designed to help me develop effectively in the long term……	19	☐	☐	☐	☐	☐	☐	19
0. I spend most of my time developing skills and attributes that my coach tells me I will need if am to compete successfully at the top/professional level……..	20	☐	☐	☐	☐	☐	☐	20
1. My coach explains how my training and competition programme work together to help me levelop……..	21	☐	☐	☐	☐	☐	☐	21
2. My coach allows me to learn through making my own mistakes……..	22	☐	☐	☐	☐	☐	☐	22
3. I would be given good opportunities even if I experienced a dip in performance…….	23	☐	☐	☐	☐	☐	☐	23
4. My progress and personal performance is reviewed regularly on an individual basis……	24	☐	☐	☐	☐	☐	☐	24
5. My coach emphasises that what I do in training and competition is far more important than winning……..	25	☐	☐	☐	☐	☐	☐	25

Psychological Characteristics of Developing Excellence Questionnaire (Version 2)

Name:_____

Team: _____

1. I often seek advice from different people

Very unlike me Very like me

O O O O O O

---

2. The people around me expect me to be perfect at everything I do

Very unlike me Very like me

O O O O O O

---

3. When things are going wrong for me, my future seems uncertain

Very unlike me Very like me

O O O O O O

---

4. I often act without thinking through all the alternatives

Very unlike me Very like me

O O O O O O

---

5. Although they may not say it, other people get upset when I make mistakes

Very unlike me Very like me

O O O O O O

---

6. When we need to work hard I am first in the queue

Very unlike me Very like me

O O O O O O

---

7. I often lie awake at night thinking things over and over

Very unlike me Very like me

O O O O O O

---

8. I value and use the opinion of others about my performance

Very unlike me Very like me

O O O O O O

---

9. I include imagery in my preparation

Very unlike me Very like me

O O O O O O

---

10. If I encounter a problem I make a plan to get around it

Very unlike me Very like me

O O O O O O

11. I know who to go to to get things done

Very unlike me Very like me

O O O O O O

12. I like to take control when dealing with problems

Very unlike me Very like me

O O O O O O

13. After eating, I sometimes feel guilty about its effect on my body shape

Very unlike me Very like me

O O O O O O

14. I can deal with whatever comes my way

Very unlike me Very like me

O O O O O O

15. I use imagery to improve my physical performance

Very unlike me Very like me

O O O O O O

16. I am able to adapt and change when things aren't going right for me

Very unlike me Very like me

O O O O O O

17. The day-to-day setbacks can often get me down

Very unlike me Very like me

O O O O O O

18. I am keen to ask other people for help

Very unlike me Very like me

O O O O O O

19. I often lack energy

Very unlike me Very like me

O O O O O O

20. My preparation for competition has to be exactly the same each time

Very unlike me Very like me

O O O O O O

21. My sleep is often disturbed by worrisome thoughts

Very unlike me Very like me

○ ○ ○ ○ ○ ○

22. Even minor setbacks disturb my focus

Very unlike me Very like me

○ ○ ○ ○ ○ ○

23. I have a carefully thought out plan of my pathway to the top

Very unlike me Very like me

○ ○ ○ ○ ○ ○

24. I imagine coping with setbacks

Very unlike me Very like me

○ ○ ○ ○ ○ ○

25. I regularly imagine what a good performance feels like

Very unlike me Very like me

○ ○ ○ ○ ○ ○

26. If I don't know something, I will find out who to ask

Very unlike me Very like me

○ ○ ○ ○ ○ ○

27. When I am failing at something, I hate the fact that I am not in control of the outcome

Very unlike me Very like me

○ ○ ○ ○ ○ ○

28. I often worry that bad things will happen

Very unlike me Very like me

○ ○ ○ ○ ○ ○

29. My life is well organised

Very unlike me Very like me

○ ○ ○ ○ ○ ○

30. I give myself treats even when I don't achieve my goals

Very unlike me Very like me

○ ○ ○ ○ ○ ○

31. People would say that I am very self-disciplined

Very unlike me Very like me

O O O O O O

32. I regularly set clear targets for myself

Very unlike me Very like me

O O O O O O

33. I like to try things out in my head first

Very unlike me Very like me

O O O O O O

34. When I fail, people are less interested in me

Very unlike me Very like me

O O O O O O

35. I sometimes forget items of equipment

Very unlike me Very like me

O O O O O O

36. I think asking other people for help is a sign of weakness

Very unlike me Very like me

O O O O O O

37. I often keep thinking about the mistakes I have made and let this interfere with my performance

Very unlike me Very like me

O O O O O O

38. I worry about putting weight on

Very unlike me Very like me

O O O O O O

39. I would usually blame other people or circumstances for failure

Very unlike me Very like me

O O O O O O

40. I find it difficult to overcome my feelings of anxiety when I perform

Very unlike me Very like me

O O O O O O

41. If I don't give my sport all of my attention, all of the time, my performances will suffer

Very unlike me Very like me

O O O O O O

42. When things go wrong, I find it difficult to see a way forwards

Very unlike me Very like me

O O O O O O

43. I only feel happy when I win

Very unlike me Very like me

O O O O O O

44. I use mental rehearsing to focus myself on what I have to do

Very unlike me Very like me

O O O O O O

45. I often find it hard to talk to other people about things that are bothering me

Very unlike me Very like me

O O O O O O

46. When things are not going well, I get worried about what other people will think

Very unlike me Very like me

O O O O O O

47. I am lazy

Very unlike me Very like me

O O O O O O

48. The day-to-day setbacks can often get me down

Very unlike me Very like me

O O O O O O

49. If something unexpected happens I find it really hard to adapt

Very unlike me Very like me

O O O O O O

50. I find it hard to push myself to overcome difficulties

Very unlike me Very like me

O O O O O O

51. I am good at resisting temptation

Very unlike me Very like me

O O O O O O

52. When faced with a problem there is no one I can ask to help

Very unlike me Very like me

O O O O O O

53. If I make a mistake I dwell on it and can't see the big picture

Very unlike me Very like me

O O O O O O

54. I socialise with my teammates much less than I used to

Very unlike me Very like me

O O O O O O

55. I often do things I know I shouldn't do

Very unlike me Very like me

O O O O O O

56. I can't be bothered with people who don't always strive to better themselves

Very unlike me Very like me

O O O O O O

57. Failures do not distract me from my pathway to success

Very unlike me Very like me

O O O O O O

58. I can clearly see my pathway to the top

Very unlike me Very like me

O O O O O O

59. I take time to clarify what is required

Very unlike me Very like me

O O O O O O

60. I often forget appointments or timings

Very unlike me Very like me

O O O O O O

61. When I am not succeeding, I feel like people lose interest in me

Very unlike me Very like me

O O O O O O

62. I tend not to worry about things

Very unlike me Very like me

O O O O O O

63. My teammates would describe me as a consistent person

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

64. I tend to run through things over and over again

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

65. Before attempting a skill, I imagine myself performing it

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

66. My mood depends entirely on my sporting success

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

67. I work through set backs

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

68. I wish I had more discipline

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

69. I incorporate mental rehearsal in my practice

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

70. Compared to my teammates I often fail to complete a heavy training session

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

71. When things seem hopeless, I still keep going

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

72. I struggle to get myself motivated

Very unlike me | Very like me

○ ○ ○ ○ ○ ○

73. When I am failing, I worry most about what others think about me

Very unlike me Very like me

O O O O O O

74. I have lost interest in socialising with my training group

Very unlike me Very like me

O O O O O O

75. I prepare carefully for training sessions

Very unlike me Very like me

O O O O O O

76. I often feelnervous

Very unlike me Very like me

O O O O O O

77. I get annoyed very easily

Very unlike me Very like me

O O O O O O

78. I feel tired and have little energy more often than my peers

Very unlike me Very like me

O O O O O O

79. Before I arrive at a performance venue, I mentally rehearse my performance there

Very unlike me Very like me

O O O O O O

80. I sometimes feel down without really knowing why

Very unlike me Very like me

O O O O O O

81. When I have to do something that worries me, I imagine how I will overcome my anxieties and perform successfully

Very unlike me Very like me

O O O O O O

82. When I am failing, significant others are often disappointed in me

Very unlike me Very like me

O O O O O O

83. I dislike asking people for help and advice

Very unlike me | Very like me

O O O O O O

84. When I make a mistake I find it difficult to get my focus back on task

Very unlike me | Very like me

O O O O O O

85. I get distracted thinking about how other performers are doing

Very unlike me | Very like me

O O O O O O

86. I do certain things that are bad for me if they are fun

Very unlike me | Very like me

O O O O O O

87. When I am failing, I am afraid I might not have what it takes

Very unlike me | Very like me

O O O O O O

88. I have a hard time breaking bad habits

Very unlike me | Very like me

O O O O O O

DUBLIN CITY UNIVERSITY

Plain Language Statement for Participants (Parents/Coaches)

'The Talent Development of International Female Irish Hockey Players'

Introduction to the Research Study

The research title for this study is '*The Talent Development of International Female Irish Hockey Players'***.** The principal investigator of this study is Dr David Passmore, Lecturer in the School of Human Health and Human Performance in Dublin City University (DCU). The other primary investigator is Miss Orlaith Curran, PhD student in DCU. The purpose of this study is to investigate the talent development environment and talent development pathway of female hockey players in Ireland. The study is being carried out to help with improving the current Hockey Ireland Female Talent Development Pathway. Hockey Ireland can update any participants on the development of this pathway.

Details of what involvement in the Research Study will require

Involvement in this study will require you to take part in a semi structured focus group interview. This interview will include questions about the Talent Development Environment of the team you are playing with or involved with coaching. You will be asked to provide information surrounding your experiences of the training environment of this team. This interview will be audio recorded and should take no longer than 60 minutes to complete.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

Your involvement in the interview will be kept anonymous. The Identity and information shared by each of the participants will be protected in the research by giving each participant a pseudo name e.g C1 or P1 (coach or parent 1). All participant information and audio recordings will be stored privatley on a password protected hard drive and destroyed after five years.

Statement that involvement in the Research Study is voluntary

Involvement in this study is completely voluntary and participants can withdraw from the study at any time. Taking part in this study involves no health risks and is completely voluntary. If you do agree to take part in this study you can say you do not want to be part of the study anymore at any point without any negative consequences for treatment or future support.

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

DUBLIN CITY UNIVERSITY

Informed Consent Form: Ages 18 years and up
Informed Assent Form: Ages 14-17 years

Dear Participant,

Purpose of this study:

The Hockey Ireland High Performance Committee has agreed to the U16, U18, U21 and Senior Squad squads be involved in a project which is part of a PhD and final year project for a Sport Science and Health degree program in Dublin City University. The study's title is '*The Talent Development of International Female Irish Hockey Players'***.** We are aiming to understand the talent development environment of female hockey teams in Ireland from a player's perspective as well as the perspective of coaches and pathway staff members. The information gathered in this project will help to update the current talent development pathway for female hockey players in Ireland so that Hockey Ireland can provide a holistic development environment and underage programme where players are developed appropriately both physically and mentally at each stage along the playing pathway.

The investigators involved in the study are:
Dr David Passmore, Lecturer in Coaching Science, School of Health and Human Performance, Dublin City University
Orlaith Curran, PhD student in School of Health and Human Performance, Dublin City University
Eimear Corri - BSc Sport Science and Health students in DCU

Why have I been chosen?

You have been chosen to be invited to participate as a parent or coach of female hockey players in Ireland, playing at either club, school, or international level. Your invovement is voluntary.

What will happen if I agree to take part?

Your anonymity will be protected throughout. The data stored and presented will use Pseudonyms (ie. Athlete 1) and playing position and playing group only. If you would like to receive data from the analysis that will follow the collection, this will be available within six months.

Confidentiality:

Rest assured that all information gathered in this study will remain completely anonymous and confidential. Responses will be identified using a code number that you will be assigned. All collected data will be held on a password protected hard drive and kept in a secure locked cupboard. Data will be stored for five years from the end of the project and then destroyed.

Benefits:

The information you provide will help us understand more about the talent development needs of female hockey players in Ireland and will be available to you after completion of the Hockey Ireland Talent Development Pathway. You will be benefit from this as it will be tailored to provide a holistic environment and pathway for progressive player development.

Confirmation of requirements as highlighted in the Plain Language Statement

Participant's (Parent/Guardian for under 18 years) – please complete the following (Circle Yes or No for each question)

I have read the Plain Language Statement (or had it read to me)	*Yes / No*
I understand the information provided	*Yes / No*
I have had an opportunity to ask questions and discuss this study	*Yes / No*
I have received satisfactory answers to all my questions	*Yes / No*
I know that my participation is voluntary and that I can withdraw from the project at any stage without giving any reason.	*Yes / No*
I am aware that my interview will be audiotaped	*Yes/No*

Confirmation that involvement in the Research Study is voluntary

I understand participation in this study is voluntary and it is at my discretion as to whether I participate in the research. I may withdraw from this study at any stage of the research.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

Dublin City University will protect all my personal information. However, confidentiality of information provided is subject to legal limitations. My identity will be protected with the use of a pseudo name for each participant. Data will be saved in a password protected secure file.

I understand if I have any concerns about the way the research is being conducted I can contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000

Appendix A7. Semi Structured Focus Group Interview Guide (Athletes) – Chapter 5

QUESTION	PROBE	PROMPT	REASON
1. Tell me about your experiences in hockey? (Background and pathway experiences) Tell me about your hockey at the moment? What do you want to achieve from it?	• Do you have long term performance goals? Are these set at school/club/international level? • Does your coach have conversations with you/your team about what success looks like? Tell me about these. • Does your coach have conversations with you/your team about what good performance looks like? Tell me about these. • Does anyone feel the focus of their school/club hockey is concerned with winning every league? And what gives you that impression? • Tell me how this compares to your U16/18/21 International team? Is it similar where the focus is about winning summer competitions? • Is your training designed with a focus to help you to win or to help to progress and develop effectively in the long term? What about at school/club/international? • Do any of your coaches have conversations with you/your teams about a focus on training/competition other than just winning? Tell me what they might emphasise instead? • Can any of you tell me about a time where you were helped to develop skills, outside of hockey skills, that will help you to be better prepared and be successful at senior level? • Do you still get playing opportunities even if you feel you have a dip in your performance?	• Long term goals • What success looks like • What good performance looks like • Focus on winning (school, international) versus long term development • Effort in competition/training • Skills for future success • Dip in performance	• Long term vision • Long term development goals • Effort & development over win at all costs • Skill development for future is priority • Allow for natural dips in performance • Overall coherence between school/club/international
2. What is it like to balance everything at the moment? Can you give me some examples? What would help you?	• What do you feel your priorities are? • Do you find it difficult to balance everything? Who helps you with this? • Tell me about a time where you found it hard to keep on top of all of your commitments. • Does your coach know much about your life outside of sport? Your club, school, other sporting commitments? • Are you prepped with developing mental skills to help you to deal with such a busy schedule? Tell me about a time where	• Life outside sport • Training/life balance competence • Mental toughness • Wellbeing • Education in training/life balance • National Coach – school links	• Holistic quality preparation • Mental toughness prep for top level • Educated in life/training balance for future

	you used X skill to help with balancing your many commitments. • Do you get educated in how to appropriately balance training with school/college, recovery, other sports, family, friends etc.? Who helps here? • Is there communication between your various coaches so they understand your commitment to high performance training?		
3. Tell me about the support network that surrounds you in your sport e.g., coaches, physio etc. OR We talked about how X helps you with your training and life balance, can you tell me more about that or who else might support you in your commitments?	• What support staff surrounds you in your national team and also in your school/club team? • Can you tell me about a time where support staff have been approachable and available to you when you needed? • Do the support staff appear to be on the same wavelength as each other in regard to knowing what's best for you? In your national team? And in your school/club team? • What additional support staff or professionals do you feel you would benefit from having but currently do not have access to? • Do the coaches from your various teams understand what support surrounds you within your other teams? • Do your national and/or school/club coaches make time to talk to your parents about you and your goals?	• Types of support staff • Approachable and available support • Staff work well and on same page • Need for additional professional support? • Coach to coach communication • Coach to parent communication	• Support Network • Approachable and available to athletes • Support staff in agreement with needs • Lack of support in any area • Sharing info with parents
4. You have lots of coaches, what is your role in this? Tell me about what you do to keep everyone informed? How easy is that? Give me examples of when it worked	• Does your coach talk to you about area's you need to work on to improve and progress? • Tell me about a time where you might have been encouraged to make mistakes so that you could learn from them? • Does anyone have examples of when your coach helped you understand what you need to be able to progress in your sport? • You have lots of coaches, does anyone feel their coaches from different teams talk to each other about their performance? • How are you involved in the decision-making process about your development?	• Coach athlete communication around areas for development • Encouraged to learn through mistakes • Understanding of what is needed to progress in sport • Coach to coach communication about individual players development	• Coach athlete communication • Mistakes help learning • Understanding of development needs • Coach to coach communication • Review and reflection practice to help develop athletes' weaker areas

well/didn't work well.	• Does your coach review your individual progress and development regularly with you?	• Performance reviews for individual feedback and development	
5. How well do you have your plan in hockey mapped out to take you to the top? What do you think will be the biggest challenge for you? What do you think is the biggest opportunity for you?	• Tell me about how you set your goals? • Who gives you help with this? • How specific to your needs are the goals you set with your national coach? • Tell me how the goals you set with your school/club coach might differ to those you set with your national coach? • Does anyone feel their coaches from school/club and national team are aware of the goals you set with the other coaches? • Tell me how your training programmes are set to aid with your specific development in mind? • How do you plan and prepare for times when things might go wrong, and you cannot reach your goal? • Are your parents aligned with your goals, does their advice fit with what your coaches advise?	• Individual goal setting • Goal setting with coach input • National and school level input • Training programme aimed at your individual improvement. • Prepped to plan for failure • Parents advice aligned with the sport/goals	• Alignment of expectations • Training tailored to support development • Parents aware of expectations

Appendix A8. Semi Structured Focus Group Interview Guide (Coaches) – Chapter 5

QUESTION	PROBE	PROMPT	REASON
1. Tell me about your coaching role at the moment. What do you want to achieve from it? Tell me about your experiences in coaching hockey? (School, club, pathway experiences)	• What are your goals with this team? • How do these goals differ to ones you might have set with other teams you work/worked with? (school/club/national) • Do you have conversations with your team about what success looks like? Tell me about these. • Do you have conversations with your team about what good performance looks like? Tell me about these. • Is your training designed with a focus to help your team to win or to help them to progress and develop effectively in the long term? • Do you have conversations with your team about a focus on training/competition other than just winning? Tell me what you might emphasise instead? • Can any of you tell me about a time where you helped the athletes to develop skills, outside of hockey skills, that will help them to be better prepared and be successful at senior level? • Do you still give playing opportunities even if you feel the athlete has had a dip in their performance?	• Long term goals • What success looks like • What good performance looks like • Focus on winning (school, international) versus long term development • Goal setting (individually, with coach) • Effort in competition/training • Skills for future success • Dip in performance	• Long term vision • Long term development goals • Effort & development over win at all costs • Skill development for future is priority • Allow for natural dips in performance • Overall coherence between school/club/international
2. What do you feel is most important to help your group of athletes to balance everything? Tell me about a time where you helped them with learning to balance their commitments? What has been the most difficult challenge in this	• What do you feel the athletes' priorities are/should be? • Do you think they find it difficult to balance everything? Who helps most with educating them how best to balance training with school/college, recovery, other sports, family, friends etc.? Who else might help here? • Do any of you know much about your athletes lives outside of sport? Their club, school, other sporting commitments? • Do you as coaches in some way help to prep the athletes with developing mental skills to help them to deal with such a busy schedule? • Is there communication between you and other coaches the athletes are in close connection with so those coaches can understand what your goals are for these athletes?	• Life outside sport • Training/life balance competence • Mental toughness • Wellbeing • Education in training/life balance • National Coach – school links	• Holistic quality preparation • Mental toughness prep for top level • Educated in life/training balance for future

regard? How do you help them to understand balancing everything?			
3. Tell me about the support network that you have built around your group of athletes. Tell me about the support network that surrounds your coaching staff? Who can you talk to for advice/reflections etc.?	• Amongst this group of coaches, what various support staff roles surround this team of athletes? Does this differ to any other teams you work with (club/school/national)? • How do you make sure that as a coaching group, as the support staff, that you are all on the same wavelength as each other in regard to knowing what's best for the athletes? • What additional support staff or professionals do you feel the athletes would benefit from having, but currently do not have access to? • Do you as coaches understand what support surrounds the athletes within their other teams? • Do you as coaches make time to talk to the athletes' parents about the athletes and their needs/goals?	• Types of support staff • Staff work well and on same page • Need for additional professional support? • Coach to coach communication • Coach to parent communication	• Support Network • Approachable and available to athletes • Support staff in agreement with needs • Lack of support in any area • Sharing info with parents
4. We talked about how the athletes have lots of coaches, where does your role as one of these coaches lie in their overall development?	• Do you talk to your individual athletes about area's they need to work on to improve and progress? • Do you as coaches review athletes individual progress and development regularly with them? • Tell me about a time where you might have encouraged an athlete to make mistakes so that they could learn from them? • Tell me about what you do to keep informed on what they're doing with other coaches or how you might keep their other coaches informed on what you are doing to better their development? • How easy is that? • Give me examples of when it worked well/didn't work well.	• Coach athlete communication around areas for development • Encouraged to learn through mistakes • Understanding of what is needed to progress in sport • Coach to coach communication about individual players development • Performance reviews for individual feedback and development	• Coach athlete communication • Mistakes help learning • Understanding of development needs • Coach to coach communication • Review and reflection practice to help develop athletes' weaker areas

Appendix A8. Semi Structured Focus Group Interview Guide (Coaches) – Chapter 5

5. How do you fit in to the athlete's overall development pathway in assisting them to reach the top? What do you think will be the biggest challenge for you as a coach to help them succeed?	• Tell me about how you set your coaching goals? • How specific to the particular group of athlete's needs are the goals you set with your coaching group? • Do you set individual goals with each athlete? • Do you share these goals with other coaches involved with coaching these same athletes? • Are you aware of the goals that are set by the other coaches working with these athletes in other teams? • Do you help the athletes to plan and prepare for times when things might go wrong, and you/they cannot reach the set goal? • Do you inform and update the athletes' parents so they are aligned with your coaching goals for this team, so their advice might fit with what you as a coach advise?	• Individual goal setting • Goal setting with coach input • National and school level input • Training programme aimed at your individual improvement. • Prepped to plan for failure • Parents advice aligned with the sport/goals	• Alignment of expectations • Training tailored to support development • Parents aware of expectations

Plain Language Statement for Participants

'Activity profiling and variability of a junior women's international field hockey team'

Introduction to the Research Study

The research title for this study is to '*Activity profiling and variability of a junior women's international field hockey team'.* The principal investigator of this study is Dr David Passmore, Lecturer in the School of Human Health and Human Performance in Dublin City University (DCU). The other primary investigator is Miss Orlaith Curran, PhD student and 4th year BSc Sport Science and Health students in DCU – Aaron Senior, Jonathan Whan, Juliette Foprtune, Eimear Corri and Kate McGowan. The purpose of this study is to identify the activity and time motion analysis profiles using the VXSport GPS system in junior (U21) hockey

Details of what involvement in the Research Study will require

Involvement in this study will require participants to wear a GPS unit provided by Hockey Ireland during all physical activity within school, club, and international hockey. GPS data will be unloaded during the duration of the project by Orlaith Curran and the other researchers as normally happens within your international training program.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

The GPS information shared with us will be kept in confidence. However, confidentiality of information provided is subject to legal limitations. The Identity and information shared by each of the participants will be protected in the research by giving each participant a pseudo name e.g A1 (athlete 1). Data will often be collated and presented using the participants playing position.

Statement that involvement in the Research Study is voluntary

Involvement in this study is completely voluntary and participants can withdraw from the study at any time. Taking part in this study involves no health risks and is completely voluntary. If you do agree to take part in this study you can say you do not want to be part of the study anymore at any point without any negative consequences for treatment or future support.

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

DUBLIN CITY UNIVERSITY

Informed Consent Form: Ages 18 years and up
Informed Assent Form: Ages 16-18 years

Dear Participant,

Purpose of this study:

The Hockey Ireland High Performance Committee has agreed to the U21 Squad athletes be involved in a project which is part of a PhD and final year projects for a Sport Science and Health degree program in Dublin City University. The study's title is '*Activity profiling and variability of a junior women's international field hockey team'.* We are aiming to identify the current activity profiles of U21 international athletes and compare with other data (training, club, international) and comparison between different positions, match quarters and fitness testing data. This will highlight what the future needs of U21 training programs are and how these can be assisted in other environments (ie. Club training) to develop athletes with senior international data.

The investigators involved in the study are:
Dr David Passmore, Lecturer in Coaching Science, School of Health and Human Performance, Dublin City University
Orlaith Curran, PhD student in School of Health and Human Performance, Dublin City University
Aaron Senior, Jonathan Whan, Juliette Foprtune, Eimear Corri and Kate McGowan - BSc Sport Science and Health students in DCU

Why have I been chosen?

You have been chosen to be invited to participate as an Ireland U21 Women's National Team playing member. Your invovement is voluntary.

What will happen if I agree to take part?

Your anonymity will be protected throughout. The data stored and presented will use Pseudonyms (ie. Athlete 1) and playing position only. If you would like to receive data from the analysis that will follow the collection, this will be available within five months.

Confidentiality:

Rest assured that all information gathered in this study will remain completely anonymous and confidential. Responses will be identified using a code number that you will be assigned. All collected data will be held on a password protected hard drive and kept in a secure locked cupboard. Data will be stored for five years from the end of the project and then destroyed.

Benefits:

The information you provide will help us understand more about the development needs of international women's international hockey players and will be available to you on a week to week basis and post match as it is uploaded. You will be able to use this data to monitor your own physical data and running performance in training and matches.

Confirmation of particular requirements as highlighted in the Plain Language Statement

Participant's Parent/Guardian – please complete the following (Circle Yes or No for each question)

I have read the Plain Language Statement (or had it read to me)	*Yes / No*
I understand the information provided	*Yes / No*
I have had an opportunity to ask questions and discuss this study	*Yes / No*
I have received satisfactory answers to all my questions	*Yes / No*
I am aware that my interview will be audiotaped	*Yes / No*
I know that my participation is voluntary and that I can withdraw from the project at any stage without giving any reason.	*Yes / No*

Confirmation that involvement in the Research Study is voluntary

I understand participation in this study is voluntary and it is at my discretion as to whether I participate in the research. I may withdraw from this study at any stage of the research.

Advice as to arrangements to be made to protect confidentiality of data, including that confidentiality of information provided is subject to legal limitations

Dublin City University will protect all my personal information. However, confidentiality of information provided is subject to legal limitations. My identity will be protected with the use of a pseudo name for each participant. Data and audio recordings will be saved in a password protected secure file. Audio recordings will be stored for 12 months in a password protected hard drive for 12 months after the study.

I understand if I have any concerns about the way the research is being conducted I can contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000

Participants Signature: _____ **Date:** _____

Name in Block Capitals: _____