Title: Psychological Characteristics of Developing Excellence in talented female field hockey players

Running head: PSYCHOLOGICAL CHARACTERISTICS OF DEVELOPING EXCELLENCE IN FIELD HOCKEY

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Abstract

Psychological Characteristics of Developing Excellence (PCDEs) are a range of psychological factors that play a key role in the realisation of potential. We examined PCDE profiles across a female national talent development field hockey programme in North America. Two-hundred-and-sixty-seven players completed the *Psychological Characteristics of Developing Excellence Questionnaire version 2* (PCDEQ-2) prior to the competitive season. One-hundred-and-fourteen players were classified as juniors (under-18) and 153 as seniors (over-18). Eighty-five players were classified as non-selected (not-selected to their age-group national team), and 182 as selected (selected to their age-group national team). A MANOVA showed multivariate differences based on age, selection status, and their interaction, within this already homogenous sample, suggesting that sub-groups within this sample vary dependent on their overall PCDE profiles. ANOVA showed differences in imagery and active preparation, perfectionist tendencies, and clinical indicators between juniors and seniors. Furthermore, differences in imagery and active preparation, and perfectionist tendencies, were observed between selected and non-selected players. Subsequently, four individual cases were identified for further analysis based on their multivariate distance to the average PCDE profile. For example, we discussed one case, Lyssa, who was a selected junior player with a very different PCDE profile to the overall sample. Thus, the use of the PCDEQ-2 at both group- and individual-levels seems an important tool to support athlete development. Particularly, individual profiling allows individual-level assessment and intervention facilitating bespoke support for players with particular strengths and weaknesses against the challenges they are likely to encounter in their pursuit of excellence.

The ultimate aim of any talent pathway in sport is to develop athletes with the ability to perform at the highest level (e.g., Ericsson et al., 1993; Philips et al., 2010; Tucker & Collins, 2012). This requires coaches, athletes and other stakeholders to conceptualise performance outcomes in developmental terms, with an 'achievement later' emphasis. Prioritising long-term development, rather than short-term success, requires a mind-set, approach, environment, and overall structure that prioritises the outcomes and processes that support athletes on this journey. Of course, this balance between development and winning will sensibly change as athletes progress along the pathway and the pressures of performance and outcomes come into play. However, for those working with a development focus, identifying, prioritising, and developing the outcome deliverables (Collins et al., 2019) that support the navigation of the talent development pathway is important.

In psychological terms, a range of constructs have been shown to be determinants of development and performance in sport. For example, grit (Duckworth et al., 2007), the growth mindset (Dweck, 2017), resilience (Seligman, 2011; Fletcher & Sarkar, 2016), and self-control (Toering & Jordet, 2015) are supported by a growing evidence base as supportive of development across sport. Collins and colleagues (Collins et al., 2019) question the comprehensiveness of these constructs and the extent to which they provide athletes with a toolbox of skills to cope with the challenges they are likely to face as they progress. To this end, it is important to consider the mechanisms and processes that underpin the young athlete's ability to make the most of developmental opportunities they are afforded. These processes must be both comprehensive (i.e., cater for the full range of challenges and contexts that athletes are likely to encounter) and proactively developable as the athlete proceeds along an inherently non-linear and dynamic pathway (Simonton, 2001). For example, psychological constructs such as resilience (Seligman, 2011; Sarkar & Fletcher, 2016) or grit (Duckworth, Peterson, Matthews, & Kelly, 2007) may be best applied through

an understanding of how they operate and the processes that underpin the outcome behaviours.

Psychological Characteristics of Developing Excellence

The role psychological factors play in the realisation of potential and as a key feature of talent development is well-supported. MacNamara and colleagues (2010a, 2010b), building on the seminal work of Orlick and Partington (1988), term these *Psychological Characteristics of Developing Excellence* (PCDEs). PCDEs encompass both mental skills such as imagery or goal setting and also the attitudes, emotions, and desires such as commitment and motivation that athletes require as they progress in their sport. Reflecting the non-linear and increasingly challenge-filled pathway that athletes encounter, especially as they progress to the latter end of the talent pathway, the possession and systematic development of PCDEs seems a logical step, allowing young athletes to interact effectively with the developmental opportunities they are afforded (Côté & Hay, 2002; Simonton, 1999; van Yperen, 2009).

Of course, it is also important to consider the psychological factors that are maladaptive to talent development (Hogan & Hogan, 2001). Poor mental health and clinical issues have been shown to have a detrimental effect on the efficacy of talent development (Hill et al., 2016). Reflecting the complexity of the skillset required, Hill et al. (2015) identified a range of psycho-behavioural characteristics that could be categorised as positive (i.e., adaptive), dual effect, or negative (i.e., maladaptive), in relation to their impact upon talent development. To assess and then support the development and deployment of these adaptive, dual effect and maladaptive psycho-behavioural characteristics, a multidimensional questionnaire for adolescent athletes was designed. Building on the work of MacNamara and Collins (2011), Hill and colleagues conducted a series of qualitative interviews to identify the key psychological characteristics and behaviours that differentiated between those that went

on to achieve elite-level success and those that didn't (2015; 2016). These findings underpinned the item generation and justification of the Psychological Characteristics of Developing Excellence Questionnaire–Version 2 (PCDEQ-2) (Hill et al., 2019) which assesses the possession and application of seven PCDEs, namely adverse response to failure, imagery and active preparation, self-directed control and management, perfectionistic tendencies, seeking and using social support, active coping, and clinical indicators.

Clearly, talent development is a multifaceted and complex challenge and an athlete's progression is unlikely to be limited to the presence, or absence, of any one variable. However, the influence of such skills has already received support, particularly in the area of self-regulation (Duckworth et al., 2010; Toering et al., 2009; Toering et al., 2011). As such, a skills development approach, where PCDEs are systematically taught, tested and tweaked as an inherent feature of the coaching environment has been shown to equip young athletes with a toolbox of skills, and opportunities to practice and gain confidence in their application to counter a variety of challenges (Collins & MacNamara, 2016). This approach has attracted growing support in the literature (e.g., Hill et al., 2015; Laureys et al., 2021; Newton & Holmes, 2017; Saward et al., 2020) and in applied practice (e.g., England Basketball Talent Pathway; Ireland Golf Programme; New Zealand Snowboarding etc. see https://www.greymattersuk.com/about). In turn, the possession and deployment of PCDEs may contribute to the attitudes, confidence, grit and persistence that support development.

There are a number of features of the PCDEQ-2 and its use in talent development environments that are important to highlight. Firstly, as evidenced in the factor structure of the questionnaire (Hill et al., 2019), some PCDEs load onto multiple factors. From a theoretical and empirical standpoint, this interrelatedness is expected since the factors represent distinct but related constructs (MacNamara & Collins, 2011). This has important implications for the applied use of the PCDEQ-2 in talent development settings, notably its

use as a tool to help coaches and athletes assess relative strengths and weaknesses and then the ability to select from a range of PCDEs to find a bespoke solution to specific challenges (Laureys et al., 2021). For example, young athletes may engage in imagery and goal setting (both linked to Imagery and Active Preparation (Factor 2)) when trying to learn a difficult, novel skill. Logically, the use of goal setting positively supports other PCDEQ-2 factors such as Self-Directed Control and Management (Factor 3) and Active Coping (Factor 6). The PCDEQ-2 is designed as a formative assessment tool to support the provision offered to young athletes. As such, the questionnaire can be used, in combination with coach observation and qualitative interviews, to offer athletes a bespoke solution to specific challenges faced in their environment. Simply, the PCDEQ-2 offers a tool for athletes and coaches to assess strengths and weaknesses as the basis for an action plan and intervention to address the identified areas. For example, although some research has shown little general population improvement in PCDE scores as athletes progress on the pathway, at an individual level, and reflecting the non-linear developmental trajectories that typify athlete progression, variations at the individual level are evident (Laureys et al., 2021). However, to date there has been limited insight offered into how the PCDEQ-2 may be used within a particular national talent development programme, despite calls for case-based, context-specific approaches to understanding effective talent development environments in sport (Henriksen et al., 2010). Indeed, understanding how PCDEs are developed and deployed at the group- and individual-level may further develop our understanding of how a talent development system may help shape and support young athletes.

Although there is an extensive literature about talent development in sport (e.g., Coutinho et al., 2016), and a growing body of literature about PCDEs (Laureys et al., 2021; MacNamara et al., 2010a, 2010b; Hill et al., 2015; Newton & Holmes, 2017; Saward et al., 2020), the lack of data pertaining to females in this context is concerning. This is especially a

concern when research is purported to provide practitioners and policy makers with a robust understanding to support their decision making. In this regard, Curran et al. (2019) identified an underrepresentation of female data across talent development research in general and, specifically, in research focused on psychological constructs. In terms of the latter, in their review of 20 years of talent development research, Curran et al. (2019) identified a single study examining psychological constructs focused solely on female athletes compared to 13 on male participants and called for caution in interpreting and making inferences about female athletes from male dominated research. Research pertaining to male athletes cannot be assumed to relate to female athletes and the implications of applying such research findings to female sport may be significant, creating talent pathways likely to be unreflective of female athlete needs. Against a growing call for pragmatic focused research (Collins et al., 2019), there is a need for research that support practitioners to make informed decisions about their practice and environment and provides a clear understanding of the experiences of female athletes. Therefore, the aim of this study was to examine PCDE profiles across a female, national talent development field hockey programme in North America.

Methods

Participants

We recruited 267 female field hockey players aged 19.2 ± 3.0 y (Mean ± SD) from a national talent development programme in North America to participate in the study. The talent development programme aimed to identify and develop players who would ultimately go on to represent the women's national team in international competition. The International Hockey Federation (FIH) ranked the women's national team in the top 15 in the world at the time the study was completed (https://www.fih.hockey/outdoor-hockey-rankings). Players were identified having participated in regional-level talent development training followed by a national-level development and selection tournament. There were 114 players aged under

18 who were classified as juniors and 153 players aged over 18 who were classified as seniors. From the 267 players involved in the talent development programme, 182 players were subsequently selected to be members of their respective age group national team squads, whereas 85 players were not selected. Among junior players 90 were selected and 24 were not selected, while among senior players, 92 were selected and 61 were not selected. Ethical approval for the study was obtained from the Ethical Advisory Committee at [*Institution*]. Written assent was obtained from players and written consent was obtained from parents or guardians, where appropriate.

Procedure

Players completed the Psychological Characteristics of Developing Excellence Questionnaire version 2 (PCDEQ-2) prior to the start of the first training camp of the year. The questionnaire was completed online and took approximately 20-30 minutes to complete, and players were signposted to appropriate support should they have any questions or concerns. Players were reminded to complete the questionnaire on their own, to be honest when answering questions, and that their responses would have no bearing on their future selection. Selections to national team squads were completed following the conclusion of the first training camp by the coaching staff of the respective age group teams.

Instrument

The PCDEQ-2 assesses a range of adaptive, dual effect, and maladaptive psycho-behavioural characteristics in a talent development in sport context (Hill et al., 2019). Seven factors are assessed by the PCDEQ-2 namely 1) adverse response to failure (Factor 1; 21 items; e.g., 'even minor setbacks disturb my focus'), 2) imagery and active preparation (Factor 2; 15 items; e.g., 'I include imagery in my preparation'), 3) self-directed control and management (Factor 3; 14 items; e.g., 'my life is well organised'), 4) perfectionistic tendencies (Factor 4; 10 items; e.g., 'I only feel happy when I win') , 5) seeking and using

social support (Factor 5; 9 items; e.g., 'I am keen to ask other people for help') , 6) active coping (Factor 6; 10 items; e.g., 'I work through set backs'), and 7) clinical indicators (Factor 7; 9 items; e.g., 'I feel tired and have little energy more often than my peers'). Each item was scored on a 6-point Likert scale ranging from 1 ('very unlike me') to 6 ('very like me'). The validity and reliability of the PCDEQ-2 has been recently demonstrated in 512 elite youth (aged 13-19 years) team-sports athletes (soccer, rugby union and rugby league) from the United Kingdom (UK) (Hill et al., 2019). In terms of the internal consistency of the PCDEQ-2, Cronbach alpha coefficients for the seven factors ranged from 0.72 to 0.91. The PCDEQ-2 also effectively discriminated between athletes rated by their coach as 'very good developers' versus athletes rated by their coach as 'very poor developers', with a discriminant function analysis correctly classifying group membership for 73% of participants (Hill et al., 2019).

Data analysis

Reliability assessments, parametric assumption assessments, and main analyses were conducted using IBM SPSS (v.26). The internal consistency of the PCDEQ-2 was examined using Cronbach's alpha. The Cronbach alpha for the whole questionnaire was 0.85. In terms of each subscale, Cronbach's alphas for Factors 1, 2, 3, 4, 5, 6, and 7 were 0.94, 0.88, 0.85, 0.75, 0.79, 0.81, and 0.80, respectively. Prior to the main analyses, parametric assumptions were checked, and a power analysis was conducted. Histograms were inspected to assess whether residuals were normally distributed, revealing no deviances from normality. The assumption of homogeneity of variance was assessed using Levene's test and the assumption of homogeneity of covariance matrices was assessed using Box's test. Box's test of equality of covariance matrices was significant ($p=.004$), and according to Field (2017) only p-values lower than .001 are causes for concern. This was supported by the observation that for each of the univariate ANOVAs, Levene's test of equality of variances was non-significant ($p>.05$). Data were screened for multivariate outliers using the Mahalanobis distance test,

with no outliers identified (at $p<.001$). As suggested by Field (2017), with unequal group sizes (as seen in the present data), when the assumptions of homogeneity of covariance matrices and multivariate normality are not violated, Pillai's trace should be used when conducting a Multivariate Analysis of Variance (MANOVA). An a priori power calculation in G*Power revealed that for a two-way MANOVA with seven dependent variables, using a 2-tailed test with an alpha level of .05 and power of 0.80, a minimum sample size of 153 was required to detect a partial eta squared of 0.06.

A MANOVA was used to test the differences between groups across several dependent variables simultaneously (Field, 2017). We conducted a two-way MANOVA to examine multivariate differences between age groups (junior vs. senior), selection statuses (selected vs. non-selected), and the interaction between age groups and selection statuses, with respect to players' scores on the seven PCDEQ-2 factors. We also conducted seven two-way univariate ANOVAs, to examine differences between age groups (junior vs. senior), selection statuses (selected vs. non-selected), and the interaction between age groups and selection statuses, with respect to players' scores on each of the seven PCDEQ-2 factors, in turn. Statistical significance was accepted at the 95% confidence level ($p<.05$). Mean (SD) were used to describe the average and variability of data. Partial eta squared statistics were used to indicate effect sizes and were interpreted as *small* (0.01-0.05), *medium* (0.06-0.13), and *large* (≥0.14) (Sink & Mvududu, 2010).

While the MANOVA can indicate multivariate differences at the group-level, it is also important to consider how multivariate combinations of PCDEs may support individual athlete development. Indeed, due to the formative, individualised nature of the PCDEQ-2, we subsequently examined individual athlete profiles. While we used Mahalanobis distance test to detect multivariate outliers, Mahalanobis distances essentially measure the distances of cases from the means of the predictor variables (Field, 2017). Therefore, we calculated

Mahalanobis distances for each participant based on scores from the seven subscales of the PCDEQ-2 in order to examine particular cases of interest. We selected two cases with Mahalanobis distances from the 99th centile, to identify individuals (pseudonyms were used to protect participant identity) with highly different PCDEQ-2 multivariate profiles compared to the whole sample. We also selected two cases with Mahalanobis distances from the 1st centile, to identify individuals with PCDEQ-2 multivariate profiles very similar to the whole sample. We subsequently examined these four profiles and that of the whole sample.

Results

Figure 1 displays the mean (SD) PCDEQ-2 scores of the whole sample. Using Pillai's trace, the MANOVA revealed that there was a significant main effect of age group on the seven PCDEQ-2 factors (V = 0.06, F(7, 257) = 2.20, p =.035, η^2_p=.06, *medium effect*). The MANOVA statistic quantifies the extent to which groups can be differentiated by a linear *combination* of the outcome variables (Field, 2017). While underlying relationships between the multiple PCDEs are not accounted for, visual inspection of Figures 2-4 provides information regarding group profiles. Figure 2 shows that on average, compared to junior players, senior players had higher scores on adverse response to failure, perfectionistic tendencies, and clinical indicators, and lower scores on imagery and active preparation, self-directed control and management, seeking and using social support, and active coping. Also, there was a significant effect of selection status on the seven PCDEQ-2 factors (V = 0.06, F(7, 257) = 2.20, p =.035, η^2_p=.06, *medium effect*). Figure 3 shows that on average, compared to non-selected players, selected players had higher scores on adverse response to failure, self-directed control and management, perfectionistic tendencies, seeking and using social support, and clinical indicators, and lower scores on active coping.

Furthermore, there was a significant interaction effect of age group and selection status on the seven PCDEQ-2 factors (V = 0.06, F(7, 257) = 2.17, p =.038, η^2_p=.06, *medium*

effect). Figure 4 shows that on average, compared to the other groupings, selected senior players had higher scores on adverse response to failure and perfectionistic tendencies, and lower scores on imagery and active preparation, and active coping. Compared to the other groupings, non-selected juniors had lower scores on adverse response to failure, self-directed control and management, perfectionistic tendencies, and clinical indicators.

INSERT FIGURE 1 HERE

INSERT FIGURE 2 HERE

The two-way ANOVA for Factor 2 of the PCDEQ-2 (imagery and active preparation) revealed a significant main effect for age group (F (1,263) = 4.88, p = .028, η^2_p=.02, *small effect*) (Mean ± SD Junior = 4.58 ± 0.71 vs. Senior = 4.26 ± 0.75) (Figure 2) with no significant main effect for selection status (F(1,263) = 0.03, p = .871, η^2_p < .001) (Figure 3) but there was a significant interaction effect (F(1,263) = 4.79, p = .029, η^2_p = .02, *small effect*) (i.e., junior non-selected = 4.39 ± 0.81 vs. selected 4.63 ± 0.68 and senior non-selected = 4.39 ± 0.75 vs. selected 4.18 ± 0.74 (Figure 4)). The two-way ANOVA for Factor 4 (perfectionistic tendencies), revealed significant main effects for age group (F (1,263) = 4.10, p = .044, η^2_p = .02, *small effect*) (Mean ± SD Junior = 2.75 ± 0.77 vs. Senior = 2.89 ± 0.67) (Figure 2) and for selection status (F (1,263) = 3.97, p = .047, η^2_p = .02, *small effect*) (Mean ± SD Non-selected = 2.73 ± 0.65 vs. Selected = 2.87 ± 0.74) (Figure 3), but no significant interaction effect (F(1,263) = 0.65, p = .42, η^2_p = .002) (Figure 4). The two-way ANOVA for Factor 7 (clinical indicators), revealed a significant main effect for age group (F (1,263) = 6.08, p = .014, η^2_p = .02, *small effect*) (Mean ± SD Junior = 1.95 ± 0.75 vs. Senior = 2.11 ± 0.68) (Figure 2), but there was no significant main effect for selection status (F (1,263) = 2.05, p = .154, η^2_p = .008) (Figure 3), and no significant interaction effect (F(2,263) = 2.35, p = .13, η^2_p = .009) (Figure 4). There were no other significant main effects or interactions revealed by the two-way ANOVAs for the remaining factors of the PCDEQ-2.

297 ***INSERT FIGURE 3 HERE***

298 ***INSERT FIGURE 4 HERE***

299 The MANOVA showed the extent to which junior, senior, and selected and non-
300 selected groups can be differentiated by the linear combination of the PCDEQ-2 factor scores
301 (Field, 2017). To understand how these combinations work in practice, we subsequently took
302 an individual profiling approach. For the individual-level analysis, figures 5-8 display the
303 four cases selected. The two cases with Mahalanobis distances from the 99th centile were
304 Joanne (Figure 5) and Lyssa (Figure 6). The two cases with Mahalanobis distances from the
305 1st centile were Adela (Figure 7) and Marissa (Figure 8).

306 ***INSERT FIGURE 5 HERE***

307 ***INSERT FIGURE 6 HERE***

308 Examination of Figures 7 and 8 indicate that Adela and Marissa had similar multivariate
309 profiles to the whole sample. Despite such similar profiles, these individuals had different
310 levels of success within the talent development programme. That is, Adela, aged 15 years,
311 was not selected, whereas Marissa, aged 16 years, was selected to be a member of her age
312 group national team squad.

313 Joanne and Lyssa (Figures 5 & 6) also had differing levels of success, but at different
314 stages of the talent development programme, whereby Joanne (aged 21 years) was not
315 selected, and Lyssa (aged 17 years) was selected to their respective age group national team
316 squads. Unlike Adela and Marissa, these two players had very different multivariate PCDE
317 profiles to that of the whole group. For instance, while Joanne (Figure 5) had similar active
318 coping ratings to the whole sample (sample Mean = 5.06 vs. Joanne = 5.10), she had much
319 lower ratings on imagery and active preparation (sample Mean = 4.40 vs. Joanne = 2.33) and
320 self-directed control and management (sample Mean = 4.97 vs. Joanne = 2.36). In similar

vein, while Lyssa (Figure 6) had similar imagery and active preparation ratings to the whole sample (sample Mean = 4.40 vs. Lyssa = 4.60), she had much higher ratings on adverse response to failure (sample Mean = 2.85 vs. Lyssa =5.10) and clinical indicators (sample Mean = 2.05 vs. Lyssa = 4.78). These individual case analyses again highlight the need for an individualised approach when using the PCDEQ-2 within a talent development programme.

INSERT FIGURE 7 HERE

INSERT FIGURE 8 HERE

Discussion

The aim of this study was to examine PCDE profiles across a female, national talent development field hockey programme in North America. The results represent the first benchmarks for PCDEQ-2 among female international field hockey players in a North American talent development programme. Importantly, and reflecting recognised gaps in the literature, the findings of this study provide data about a female talent development population (Curran et al., 2019), and consider PCDEs at the group- and individual-level.

The MANOVA showed multivariate differences based on age, selection status, and their interaction, within this already homogenous sample, suggesting that sub-groups within this female, national talent development field hockey programme in North America may vary dependent on their overall PCDE profiles. This is in line with previous work demonstrating multivariate differences in high- and low-potential groups on the PCDEQ-2 in male soccer, rugby union and rugby league athletes aged 13-19 years from the United Kingdom (UK) (Hill et al., 2019). The MANOVA results support the notion that PCDEs are interrelated and should be considered in combination (Laureys et al., 2021; MacNamara & Collins, 2011). Nevertheless, the univariate ANOVA results may offer insight into particular areas of focus when developing a PCDE curriculum within a team sport talent development environment.

Indeed, univariate differences in some PCDEQ-2 factors such as imagery and active preparation, perfectionist tendencies and clinical indicators were apparent between junior and senior participants in the present study. In addition, differences in two of those factors, imagery and active preparation and perfectionist tendencies, were observed between the selected and non-selected athletes.

Interestingly, while it may be expected that where differences were observed the senior group would score higher than the juniors, for the imagery and active preparation factor the younger group recorded the higher scores. This is consistent with previous work in male academy soccer players aged 11-16 years in the UK where imagery use during practice and competition (as assessed using the PCDEQ; MacNamara & Collins, 2011), was shown to decrease with age (Saward et al., 2020). Taken together, this may speak to the relative importance of different psychological skills and behaviours at different times along an athlete's development journey. For example, it may be that junior players lean heavily on certain psychological skills (e.g., imagery and active preparation) to help them prepare for and successfully navigate the novel and “first time” challenges of the national level development environment. As players spend more time in that environment these same skills may become less important. Of course, and pointing to some of the limitations of using the PCDEQ-2 in isolation, exploring these differences qualitatively is also important. At junior level, the selected players outscored the non-selected players for imagery and active preparation which may suggest that PCDEs may support progression through the talent system as prerequisites for learning and development (Abbott & Collins, 2004). This points to the importance of psychosocial skills players bring to the challenge, rather than the nature of the challenge alone (Collins et al., 2016a). It should also be noted that the imagery and active preparation mean scores were relatively high, with all subgroups scoring 4.17 ± 0.74 (Mean ± SD) or above, comparable with a large sample of male athletes aged 13 to 19 years

from UK-based academy programmes in soccer and rugby (Hill et al., 2019). This makes a strong case for the proactive development of PCDEs at the early stages of the talent development pathway to help more young players to continue to develop, navigate challenges and ultimately, effectively state their case for inclusion as the pathway narrows and selections are made. Of course, at senior level those selected didn't outscore the non-selected group which highlights that PCDEs are just part of a much bigger picture, a formative guide to practice and not a selection tool (Hill et al., 2019).

Alternatively, the results could be interpreted as shining a light on an area that may require more emphasis in this female national field hockey talent pathway due to the "use it or lose it" nature of some of these skills. It could be speculated that the younger athletes entered the pathway with a skill set that without the active prompting of coaches and support staff they lean on less as they progress. Of course, the results must be considered in the context that the athletes are in – senior performance in a female field hockey national talent development programme in North America is a qualitatively different environment to junior performance, with increased demands, pressures and expectations that require a different and more refined application of PCDEs. Therefore, it is worth considering not just the differences between age groups and selection statuses but rather the individual profiles as these are situated against each athlete's particular context.

The present group of talented female field hockey players exhibited significant differences in the perfectionist tendencies factor for both age group (seniors scored higher than juniors) and selection status (selected scored higher than non-selected). Previous research has highlighted the goldilocks nature of this factor where ideally there is not too much, not too little, there is just the right amount (Hill & Curran, 2016; Hill, 2018). The potential dangers of high levels of perfectionism, particularly when individuals have concerns over making mistakes, fear negative social evaluation, feel discrepancy between expectations

and performance, and react negatively to imperfection (i.e., perfectionistic concerns) are well documented (Hill & Curran, 2016). Thus, perfectionism is likely to be highly individual- and context-specific, which is reflected in the different individual athlete profiles we have reported.

It is also worthy of note that within this talent development pathway, seniors scored higher than juniors on the clinical indicators factor, particularly at time where mental health issues are prevalent both in young people in the general population (Wiens et al., 2020) and within sporting talent development environments (Hill et al., 2016). While the average reported values by these talented female field hockey players in North America are comparable to that seen in talented male athletes from the UK (see Hill et al., 2019), the increasing clinical indicators scores as players approach elite senior performance may be useful in highlighting possible areas for focus within the current talent development programme.

Implications for Practice

The PCDEQ-2 is a useful questionnaire to assess and monitor the development and deployment of PCDEs. However, although examining PCDEs at a group level may give interesting insights into the general development of a group, and perhaps act as a monitoring tool for a development curriculum (Collins et al., 2016b; Collins & MacNamara, 2022), it is also important to recognise the individual nature of PCDEs and how quite different combinations of PCDEs may facilitate progression for individuals. With this in mind, the individual athlete profiles presented in this paper, offer guidance as to the usefulness of the PCDEQ-2 as a formative assessment tool enabling practitioners to individualise support for athletes within a team sport setting, in line with similar approaches adopted in individual sports (Jones, 1993). For example, in terms of a multivariate profile, Joanne (Figure 5) has a very different profile relative to the overall sample, demonstrating high scores on adverse

response to failure, perfectionistic tendencies, and clinical indicators and low scores on imagery and active preparation, self-directed control and management, and seeking and using social support. As such, the use of the PCDEQ-2 at both group and individual levels would seem an important function. In particular, individual profiling, as shown for Joanne and the other selected cases, would allow individual-level assessment and intervention facilitating bespoke support for players with their own relative strengths and weaknesses. In doing so we can move towards a scenario where individuals are equipped with a full toolbox of psychosocial skills that help them negotiate the challenges they are likely to encounter on their particular trajectory. It is also important to note that the approach taken in the present study whereby individual cases were examined in relation to their distance to the average multivariate profile, accounts for the multidisciplinary and interactive nature of PCDEs (and talent in general) whereby an individual can score low on a particular PCDE but can compensate for this with strengths on other factors (Dohme et al., 2019). For example, Lyssa (Figure 6) had a very different multivariate profile relative to the overall sample. While she demonstrated high scores on some of the maladaptive and dual effect PCDEs, such as adverse response to failure, clinical indicators, and perfectionistic tendencies she had an above average score on imagery and active preparation. Indeed, although there were not significant differences in some factors across groups (e.g., age, selection status), individual differences were apparent within groups. It is also noteworthy that the individual cases identified from the 99^{th} and 1^{st} centiles differed in terms of selection status, i.e. Adela's PCDEQ-2 profile (Figure 7) was very similar to the average, but she was not selected, whereas Lyssa's PCDEQ-2 profile was very different to the average, and she was selected, strengthening the notion that the PCDEQ-2 is not intended to be a selection tool (Hill et al., 2019). As such, the development of PCDEs within a talent development environment appears to require a nuanced approach to account for differences at an individual level.

The importance of knowing the athlete is a well-understood construct in coaching (Jowett, 2017) and an essential factor in assessing and monitoring their needs as they engage in a talent pathway. The PCDEQ-2, particularly when used at an individual level and as formative tool to guide development rather than selection decisions, seems to be well placed to support this function (Hill et al., 2019). However, there are some important points to consider here. Firstly, although critical to development, PCDEs impact and are impacted by a range of other factors – technical, tactical, social, environmental, coaching and lifestyle factors. Therefore, assessing PCDEs in isolation without a holistic understanding of the athlete and their context would seem to offer a limited insight and, in turn, limit the impact of the findings. Instead, we would urge practitioners to use the PCDEQ-2 as one leg of the assessment stool and integrate a range of different knowledge sources in order to best support the athlete (Abraham et al., 2006; Collins & MacNamara, 2017). For example, in addition to formal tools such as the PCDEQ-2 coaches, and other stakeholders, regularly employ informal conversations, observations, debriefings to consider athlete behaviour before intervening.

Limitations and Future Research

Current talent development in sport literature, particularly in relation to psychological factors, is dominated by information concerning male athletes (Curran et al., 2019). Conversely, the present study is the first to provide PCDEQ-2 data on developing talented female athletes. Further research is required to build on this novel work to ensure that the experiences of female athletes are better understood, which, in turn, would support the development of talent development pathways for female athletes. This is particularly important given that there are sex-based differences in the prevalence of certain psychopathological problems in adolescent athletes that underpin one of the PCDEQ-2 factors (Schaal et al., 2011). Interestingly, maturational differences between males and

females may also play a role and therefore necessitating the validation of the questionnaire for a female population (Malina et al., 2015). In addition, the present study sampled athletes from the "thin end of the wedge" who had already been filtered through multiple steps along the talent development pathway before arriving at the selection camp. It is reasonable to suggest that a less homogeneous sample may provide greater insights into the PCDEs that differentiate between those who make it and those who do not.

The present study is also novel in that it considered the role of PCDEs within a female talent development programme at both the team- and individual-level. It was highlighted that a nuanced approach to monitoring and developing PCDEs within a talent development programme was necessary. Future research is warranted to further explore these nuances from both the athletes' (e.g., an in-depth understanding of female athletes' experiences of developing and deploying PCDEs in the context of a team-sport talent development pathway) and the coach's (e.g., a rich understanding of using PCDEs to support decision making on the talent development pathway) perspective. Such research should be longitudinal in nature to further understand how PCDEs are developed across a talent development programme.

Conclusion

This study examined PCDE profiles across a female, national talent development field hockey programme in North America. At the group-level, there were differences in overall PCDEQ-2 profiles between players from different age groups and selection statuses. Also, at the group-level, there were differences in individual PCDEQ-2 factors between players from different age groups and selection statuses for imagery and active preparation, perfectionistic tendencies, and clinical indicators. The group-level PCDEQ-2 scores provide the first benchmarks for female athletes in talent development programmes, and also the first benchmarks within a North American context. Furthermore, the age- and selection-group differences identified in this study demonstrate the utility for using the PCDEQ-2 to evaluate

and develop aspects of the curriculum within a talent development system. The present study also demonstrated the utility of the PCDEQ-2 at the individual-level. Indeed, a subset of individual athletes were selected based upon their unique PCDEQ-2 profile and compared to the 'average'. This highlighted that an athlete may have a PCDEQ-2 profile that differs considerably from the group benchmarks presented, (and can still be successful) and so an individualised approach to the development of PCDEs is warranted, rather than relying only on group-level information to support athletes. Particularly, individual profiling allows individual-level assessment and intervention facilitating bespoke support for players with particular strengths and weaknesses against the challenges they are likely to encounter in their pursuit of excellence.

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Declaration of interest statement

No potential conflicts of interest.

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Data availability statement

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

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Figure Captions

Figure 1. Average (Mean ± SD) scores on the PCDEQ-2 Factors in female field hockey players (n=267) from an international talent development programme

Figure 2. Average (Mean ± SD) scores on the PCDEQ-2 Factors in junior (n=114) and senior (n=153) female field hockey players from an international talent development programme

Figure 3. Average (Mean ± SD) scores on the PCDEQ-2 Factors in selected (n=182) and non-selected (n=85) female field hockey players from an international talent development programme

Figure 4. Average (Mean ± SD) scores on the PCDEQ-2 Factors in selected junior (n=90), non-selected junior (n=24), selected senior (n=92), and non-selected senior (n=61) female field hockey players from an international talent development programme

Figure 5. Joanne's PCDEQ-2 profile compared to the average (Mean ± SD) PCDEQ-2 profile of the whole sample

Figure 6. Lyssa's PCDEQ-2 profile compared to the average (Mean ± SD) PCDEQ-2 profile of the whole sample

Figure 7. Adela's PCDEQ-2 profile compared to the average (Mean ± SD) PCDEQ-2 profile of the whole sample

Figure 8. Marissa's PCDEQ-2 profile compared to the average (Mean ± SD) PCDEQ-2 profile of the whole sample