Journal of Sports Sciences

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rjsp20

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To cite this article: Matthew Andrew, Paul R. Ford, Sam E. Alder, Francesca M. Champ, Thomas E. Brownlee, Naomi Datson & Joe Causer (25 Jun 2024): Talent development in female soccer: Developmental activities of professional players in England, Journal of Sports Sciences, DOI: 10.1080/02640414.2024.2356434

To link to this article: https://doi.org/10.1080/02640414.2024.2356434

Published online: 25 Jun 2024.

JOURNAL OF SPORTS SCIENCES
https://doi.org/10.1080/02640414.2024.2356434

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SPORT AND EXERCISE PSYCHOLOGY

Talent development in female soccer: Developmental activities of professional players in England

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ABSTRACT

The activities soccer players engage in during their formative years are thought to significantly contribute to the acquisition of expert performance. Whilst this area has seen great interest in male players, there has been little research in females. The study examined developmental activities engaged in by professional female soccer players in England. 56 female soccer players that had either progressed to professional status in adulthood (professional), or did not (ex-academy), completed the Participant History Questionnaire. Professional players started engaging in soccer at an earlier age than their ex-academy counterparts, resulting in greater engagement in practice and play during childhood. During adolescence, professional players engaged in higher amounts of practice than ex-academy players. Engagement in competition and practice was rated as high in physical and cognitive effort by all, yet ex-academy players reported higher levels of physical effort during early adolescence, and cognitive effort during late adolescence. Findings provide an illustration of the talent pathways of professional female soccer players in England and may inform future talent development systems. Large interindividual variation in soccer-specific and other-sport activity data highlight the importance of further understanding the environments of individual soccer nations and their potential impact on the talent identification and development processes.

ARTICLE HISTORY
Received 16 June 2023
Accepted 9 May 2024

KEYWORDS
Expert performance; coaching; football; skill acquisition; talent pathways

Introduction

The process of identifying talented youth female soccer players and developing them into experts (professionals) in adulthood is influenced many factors (Williams et al., 2020), such as physical skills (Datson et al., 2020), technical/motor (Höner et al., 2019) and psychological skills (Ruiz-Esteban et al., 2020), sociology (Gledhill & Harwood, 2014) and chance events (e.g., relative age effect; Finnegan, et al., 2024). The amount and types of different soccer-specific and other-sport activities (coach-led practice; peer-led play; competition) that players engage in during their developmental pathway are thought to significantly contribute to the acquisition of expert performance (Ericsson, 2020; Ford & Williams, 2023; Güllich, Faß, et al., 2020). Research on the developmental activities of players has seen great interest in male (e.g., Andrew, Baptiste, et al., 2022b; Ford & Williams, 2012; Ford et al., 2009, 2012; Haugaasen & Jordet, 2012; Hendry et al., 2014; Hornig et al., 2016; Roca et al., 2012), yet modest attention to female soccer players (Curran et al., 2019; Ford, Hodges, et al., 2020a; Güllich, 2019; Hendry et al., 2019; Peters et al., 2022). In this study, we examined the developmental activities engaged in by professional female soccer players, competing in the highest tier in England, the Women's Super League (WSL).

Recently, several researchers have examined the developmental activities of female soccer players from other soccer nations. For example, both national level and varsity team soccer players in Canada reported more hours of soccer-specific activities compared to other sports, which did not differentiate the groups. However, those that represented their country engaged in higher amounts of soccer-specific peer-led play during their childhood compared to varsity-level players (Hendry et al., 2019). International players in Germany engaged in less coach-led soccer practice compared to their national-level counterparts, but they engaged in greater amounts of peer-led soccer play and coach-led practice in other sports (Güllich, 2019). One of the most comprehensive studies in the area assessed 86 female soccer national team players from Australia, Canada, England, Sweden, and the United States. Players engaged in soccer from an early age, accumulating more hours in soccer-specific activities than other sports. Practice increased throughout development until adulthood where it plateaued at 15–16 h/per week, with hours accumulated in peer-led play not different to practice in childhood but decreasing from early adolescence onwards (Ford, Hodges, et al., 2020a). These studies establish that the pathways of professional female soccer players may be characterised on average by early engagement in the sport, high

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amounts of sport-specific play with some diversification into other-sport activity during childhood and specialising from adolescence into adulthood, and with a progressive increase in amounts of sport-specific practice across development (for a review, see Ford & Williams, 2023). The dichotomous patterns of the early specialisation (i.e., early start; early high amounts of sport-specific practice; low other sport involvement; Ericsson, 2013) and early diversification (i.e., low amounts of sport-specific practice; early high amounts of other-sport play; Côté et al., 2007) pathways do not fully explain the complexities of developmental activities of expert athletes (Ford & Williams, 2017; Ford & Williams, 2023; Güllich, Faß, et al., 2020), and is further supported by two of these studies overtly indicating large interindividual variability in the total hours accumulated in soccer-specific and other-sport activity data (Ford, Hodges, et al., 2020a; Hendry et al., 2019).

The differences in the relative amounts of play and practice across soccer nations and players within them, as well as interindividual variations (Ford, Hodges, et al., 2020a; Güllich, 2019; Hendry et al., 2019), could also be directly attributed to the talent development systems within single soccer nations (Ford & Williams, 2017). Soccer nations can differ based upon a mixture of characteristics including formal developmental systems, participation rates, strength of competition, coaching, and financial resources (Bennett et al., 2019; Ford, Bordonau, et al., 2020b). For example, due to a lack of qualified coaches, soccer-specific facilities, and organisational structure, youth male players in a small island nation engaged in higher amounts of individual, rather than coach-led practice (Andrew, Baptiste, et al., 2022b). While contrasts between countries (Ford et al., 2012; Ford, Hodges, et al., 2020a) can provide useful insights and common patterns, examinations of single nations may reveal the direct impact of the talent development system on the amounts and types of activities for players within the system.

Whilst these studies have provided detailed retrospective accounts of the amounts and types of soccer-specific and other sports activities of female soccer players (Güllich, 2019; Ford, Hodges, et al., 2020a), they do not give a clear indication of the learner's perceptions of these activities (Coughlan et al., 2014, Ford et al., 2015; Hendry et al., 2019). The deliberate practice (DP) theory (Ericsson et al., 1993) define practice as being rated as high in effort (challenge), high in relevance (to improve current performance), and relatively low in enjoyment (however some activities such as coach-led practice which may not share all the characteristics of DP contradict this enjoyment aspect; Ford & Coughlan, 2019; Güllich, Cronauer, et al., 2020), with learners motivated to engage to improve performance. Early studies examining the DP theory recorded ratings of these characteristics (Hodges & Starkes, 1996; Starkes et al., 1996). For example, in soccer, elite youth male players rated soccer-specific practice (e.g., technical skills) as higher than average for physical and cognitive effort, as well as enjoyment, whereas non-soccer-specific practice (e.g., running) were rated as high in physical effort but average for enjoyment (Helsen et al., 1998; Ward et al., 2007). A further assessment of physical effort, cognitive effort, enjoyment (Ericsson et al., 1993; Güllich, Faß, et al., 2020), and motivation (Ericsson et al., 1993; Hendry et al., 2014; Thomas & Güllich, 2019) attributed to each activity across the pathway would provide an indication of how developmental activities (e.g., soccer-specific play/practice) impacts future expertise in adulthood (Ford & Coughlan, 2019).

Two applied and theoretical frameworks have been forwarded highlighting the importance of athlete perceptions of developmental activities (Williams & Hodges, 2023). The EXPERTS framework proposed that for practice to be considered "deliberate" and high in "quality", it must use established techniques; improve existing skills; push the learner beyond their current skill level; enhance mental representations; use individualised feedback; gain learners' full attention; and focus on specific goals for development (Eccles et al., 2022). Furthermore, the Challenge Point Framework suggests that task difficulty of practice must be just beyond the skill level of the learner (i.e., functional task difficulty), whereas if it is too low then no learning may occur or too high and the learner may become overwhelmed and not learn (Guadagnoli & Lee, 2004; Hodges & Lohse, 2022). Indeed, engagement in moderate-high challenging practice and play distinguished national and varsity level female soccer players in Canada (Hendry et al., 2019), further justifying the need to examine both the quantity and perceptions of developmental activities.

The aim of the present study was to examine the developmental activities engaged in by female soccer players in English youth training academies and compare between players who progressed to professional status in adulthood, and players who did not. Moreover, we aimed to understand the players perceptions of these activities by examining players ratings of enjoyment, motivation, and physical and cognitive effort for each activity across their development, and whether they further discriminated attainment of expert performance. Given the opposing literature surrounding sporting milestones (e.g., start age), the type and amount of sport-specific and other sport activities, as well as the limited literature examining players perceptions of developmental activities (Güllich, Faß, et al., 2020, 2020b; Hendry et al., 2019), we have forgone formulating respective *a priori* directed hypotheses.

Methods

Participants

Fifty-six female soccer players with a mean chronological age of 23.9 ± 3.2 years volunteered to participate and were assigned to a group based on skill level (professional; ex-academy). Participants were recruited and selected through convenience sampling from the research team's network of contacts based on previous links with the soccer clubs. Club representatives (e.g., sport scientists) who worked directly with the first/senior team in 10 of the 12 clubs competing in the WSL (highest tier) were initially contacted. They originally agreed to take part (two later declined due to important fixtures/congestion) and one did not respond. The club representatives acted as gatekeepers and assisted in data collection (e.g., contacting the players). During data collection, no member of the research team held a position at any of the clubs, nor had they worked directly with the participants. Data was collected during the 2020–21 WSL season. The *professional* group comprised of 28 female soccer players (39% response rate) with a mean age of

25.0 ± 4.1 years contracted to 7 different WSL clubs at the time of data collection. During their childhood, they played soccer for various female-only elite youth training academies as well as engaging in practice/competition as part of a mixed gender (50%) and/or a male/boys (i.e., only female/girl, 64%) team. They signed a professional contract at their respective club at 17.4 ± 1.5 years, with either a full-time (n = 19), dual-career (i.e., student-athlete, n = 4), or voluntary (i.e., unpaid, n = 5) contract. They made their debut in senior professional soccer at 17.0 ± 1.7 years. From the 28 players, 25 (89%) represented their country at international youth level, making their debut at 14.7 ± 1.1 years, with 10 players (36%) representing their country at international senior level, making their debut at 19.4 ± 2.5 years. The *ex-academy* group comprised of 28 female soccer players with a mean age of 23.7 ± 2.9 years who had also played soccer for various female-only elite youth training academies, as well as mixed gender (21%) and/or male/boys (11%) teams. From the 28 players, 2 (7%) represented their country at international youth level, making their debut at 15.7 ± 0.7 years. These players were not offered a contract at any time by their respective professional clubs and were subsequently "released" at 17.4 ± 0.9 years. Players were considered not to possess the skills required to progress to professional status in adulthood. During the 2020–21 season, they played for various teams in the National League (Tiers 3 and 4), University soccer (British Universities and Colleges) or ceased participation all together (n = 1). All participants provided written informed consent. The study was designed in accordance with the Declaration of Helsinki and approved by the host University local ethics committee.

Questionnaire

The Participation History Questionnaire (PHQ) was used to elicit information relating to activities that players engaged in during their development. The PHQ has been used in previous studies examining developmental activities of female soccer players (Ford, Hodges, et al., 2020a; Hendry et al., 2019). The reliability and validity of retrospective sport-specific hours/per week in the PHQ were shown in Ford et al. (2010), with a large interclass correlation coefficient (ICC) of 0.87 for a 3-month test re-test and 0.76 for parent/player validity. Questionnaires that have used similar and/or identical questions as the PHQ have shown a large ICC of 0.86 for a 3-month test re-test and 0.71 for parent/player validity of the yearly total practice hours (Haugaasen et al., 2014), as well as a high test, re-test recall correlations for practice hours (r = 0.91–0.95; Ward et al., 2007). In female adult soccer players, Hendry et al. (2019) reported high similarities of estimates of weekly hours in practice with ICCs of 0.85, and Cronbach's alpha and percent agreement (PA) of 90.75%. Furthermore, moderate to high levels of agreement in challenge/effort at an individual level have been shown, with ICCs ranging from 0.55 to 0.76 for individual actives (Hendry et al., 2019). This type of retrospective questionnaire method is held as one of the best available collecting activities data from athletes (Hopwood, 2015).

The questionnaire contained three sections. The first section was designed to elicit information on soccer-specific milestones. These milestones included the age at which the participants first took part in soccer (i.e., start age), start ages in supervised soccer practice (i.e., coach-led practice), organised competition, and being recruited for a youth training academy of a professional club. The second section was designed to elicit information on their engagement in soccer-specific activities. Overall, three soccer-specific activities: competition (i.e., organised competition between two teams supervised by adults/coaches); coach-led practice (i.e., organised group practice supervised by coaches); peer-led play (i.e., games with rules supervised by yourself/peers). The activities were chosen based on previous research (Andrew, Baptiste, et al., 2022b) and to match the recommendations proposed by Côté et al. (2005). For each activity, participants were required to report the hours/per week and months/per year participating, as well as weeks when they were injured per year. Information was recorded in two-year intervals (e.g., 5–6 years) from 17 to 18 years (when players typically sign their first professional contract) back to the age at which participants began playing soccer. The categorisation date of youth age groups within England is 1st September in the selection year. Prior to the start of each year, to aid recall and prevent inflammation of estimates associated with the earliest age date, participants provided information in reverse order. As the hours in soccer activity were recorded in two-year intervals between the age of 18 years and start age, linear interpolation methods were used to determine estimate values in missing years (i.e., average of the year proceeding and succeeding). In addition to the amount of each soccer activity, participants were also required to provide their rating of enjoyment, physical effort, cognitive effort, and motivation to improve performance associated with each activity during that time-point. Enjoyment was described as "*how enjoyable did you find the activity*" and related to the participants happiness/pleasure during engagement. Physical effort was described as "*how physically demanding did you find the activity*" and related to the relationship between their effort during the activity and physical ability. Cognitive effort was described as "*how mentally demanding did you find the activity*" and related to the relationship between their concentration during the activity and cognitive ability. Motivation was described as "*how motivating did you find the activity*" and related to their motivation to complete the activity and improve performance (Güllich, Faß, et al., 2020). Participants provided ratings of their enjoyment, physical and cognitive effort, and motivation for each activity using a 5-point Likert scale (1 = not enjoyable at all; 2 = some enjoyment; 3 = neutral; 4 = enjoyable; 5 = very enjoyable).

The third section was designed to elicit information on engagement in other sport activities. It contained a list of sports (plus space to add sports) from which participants were required to indicate those in which they had participated in regularly for at least a total minimum period of 3-months. Participants were also required to report hours/per week for practice, play, and competition for a typical week, and months/per year participating.

Procedure

The research team initially contacted representatives from each team via email correspondence regarding the purpose of the

questionnaire before players were approached. Players completed the PHQ in small groups with supervision (via video conference) of the lead researcher who was experienced with the PHQ and provided verbal instructions on how to complete the PHQ, definitions of soccer-specific milestones, soccer-specific, other-sport activities, and ratings of activities, as well clarification if needed. Participants were instructed how to complete the first section of the PHQ before commencing the next section as a group when they were instructed how to do so. This procedure occurred for all three sections. On average participants completed the PHQ ~60 min.

Data analysis

For milestone data, we calculated the mean years of age achieved for each group. Independent sample *t*-tests were used to examine milestone data separately for each variable. Using G*Power software (HHU, Düsseldorf, Germany), post-hoc sensitively analysis indicated that with 28 participants per group and an alpha level of $p = 0.05$, 80% power is achieved for effect sizes $d \geq 0.76$. This was due to it only being possible to recruit female soccer players that were currently competing in the WSL and whose formative years were spent in the talent pathways of clubs in England. For developmental soccer-specific activities data, we calculated the hours accumulated for practice, play, and competition during childhood (6–12 years), early (13–15 years) and late (16–18 years) adolescence for each group. For ratings data, we calculated mean enjoyment, motivation, cognitive, and physical effort ratings by aggregating the mean score for each activity separately during childhood, early and late adolescence for each group.

Three separate 2 group (professional; ex-academy) × 3 activity (practice; play; competition) ANOVAs were used to examine soccer-specific activity and ratings data separately across childhood, early, and late adolescence. A G*Power post-hoc sensitively analysis indicated that, for a 2 group × 3 measurement ANOVA with a total sample size of 56 participants, an alpha level of $p = 0.05$, 80% power is achieved for effect sizes $\eta_p^2 \geq 0.028$. As the group main effect of an ANOVA calculates the mean across the developmental activities (i.e., hours spent in practice, play, and competition as one data set), to examine between group differences in total hours accumulated in the sport, we calculated the sum of hours engaged in all soccer-specific activity for each player, and additionally performed separate between-group *t*-tests. For the ratings data, we utilised the group main effect of the ANOVA to establish between-group differences. Effect sizes were calculated using partial eta squared (η_p^2) and Cohens *d*. Significant main and/or interactions effects involving more than two means were analysed using Bonferroni post-hoc procedure. Alpha level was set at $p < 0.05$. For ratings data, supplementary individual Pearson's correlation tests were used to verify correlations between player ratings of enjoyment and motivation, as well as physical and cognitive effort for each activity during childhood, early and late adolescence for each group. Moreover, to examine ratings across childhood, early and late adolescence, we performed subsequent 2 group (professional; ex-academy) × 3 age (childhood; early adolescence; late adolescence) ANOVAs. For other-sport data, descriptive statistics were calculated for number of other sports, type of other sport, start/end ages, and hours accumulated in each activity during childhood, early, and late adolescence. For interindividual variances descriptive statistics were calculated for all notable variances outlined by Ford, Hodges, et al. (2020a) during childhood and early adolescence for each group.

Results

Milestones

Table 1 contains the average age at which players in each group reached soccer-specific milestones. The independent *t*-test indicated that professional players started engaging in soccer [$t(54) = -2.04$, $p = 0.04$, $d = 0.54$] and practice led by an adult/coach at a significantly [$t(54) = -2.94$, $p = 0.01$, $d = 0.79$] earlier age compared to ex-academy players. Although professional players entered the youth training academy of a professional club at an earlier age compared to ex-academy players, this was short of significance [$p = 0.51$, $d = 0.46$]. The independent *t*-test indicated no significant between group differences in the age that all players first engaged in organised competition [$p = 0.27$, $d = 0.28$].

Soccer-specific activities

For childhood, the *t*-test revealed that the professional players accumulated significantly more hours in total soccer activities (1557 ± 1143 h) compared to ex-academy players (713 ± 510 h) [$t(48) = 3.32$, $p < 0.01$, $d = 0.94$]. The ANOVA revealed that hours significantly differed between activities [$F(2, 66) = 8.09$, $p < 0.01$, $\eta_p^2 = 0.19$] with players accumulating significantly more [$ps < 0.01$] hours of practice (494 ± 433 h) and play (612 ± 778 h) compared to competition (200 ± 137 h). This was superseded by a group × activity interaction [$F(2, 66) = 4.71$, $p < 0.01$, $\eta_p^2 = 0.13$]. As outlined in Figure 1(a), professional players (light-grey bars) engaged in significantly more [$p < 0.05$] hours of practice (736 ± 465 h) and play (959 ± 980 h) compared to ex-academy players (practice 266 ± 274 h; play = 284 ± 272 h, dark-grey bars). During childhood, 22 (42%) players engaged in female soccer only, 5 (10%) engaged in mixed-gender soccer only, 8 (15%) engaged in male soccer only (i.e., only female/girl) teams only, 7 (13%) engaged in a combination of female/mixed-gender, 5 (10%) engaged in a combination of female/

Table 1. Mean milestone data and total accumulated hours of soccer-specific activity for professional and ex-academy players.

	Start Age in Soccer	Start Age in Practice	Start Age in Competition	Start Age in Academy	Total Hours in Soccer Childhood	Total Hours in Soccer Early Adolescence	Total Hours in Soccer Late Adolescence
Professional	5.9 ± 1.7	6.9 ± 2.0	8.6 ± 3.2	12.4 ± 2.8	1,557 ± 1143	923 ± 489	1,058 ± 512
Ex-Academy	7.0 ± 2.3	8.8 ± 2.7	9.5 ± 2.6	13.7 ± 1.9	713 ± 510	689 ± 353	907 ± 426

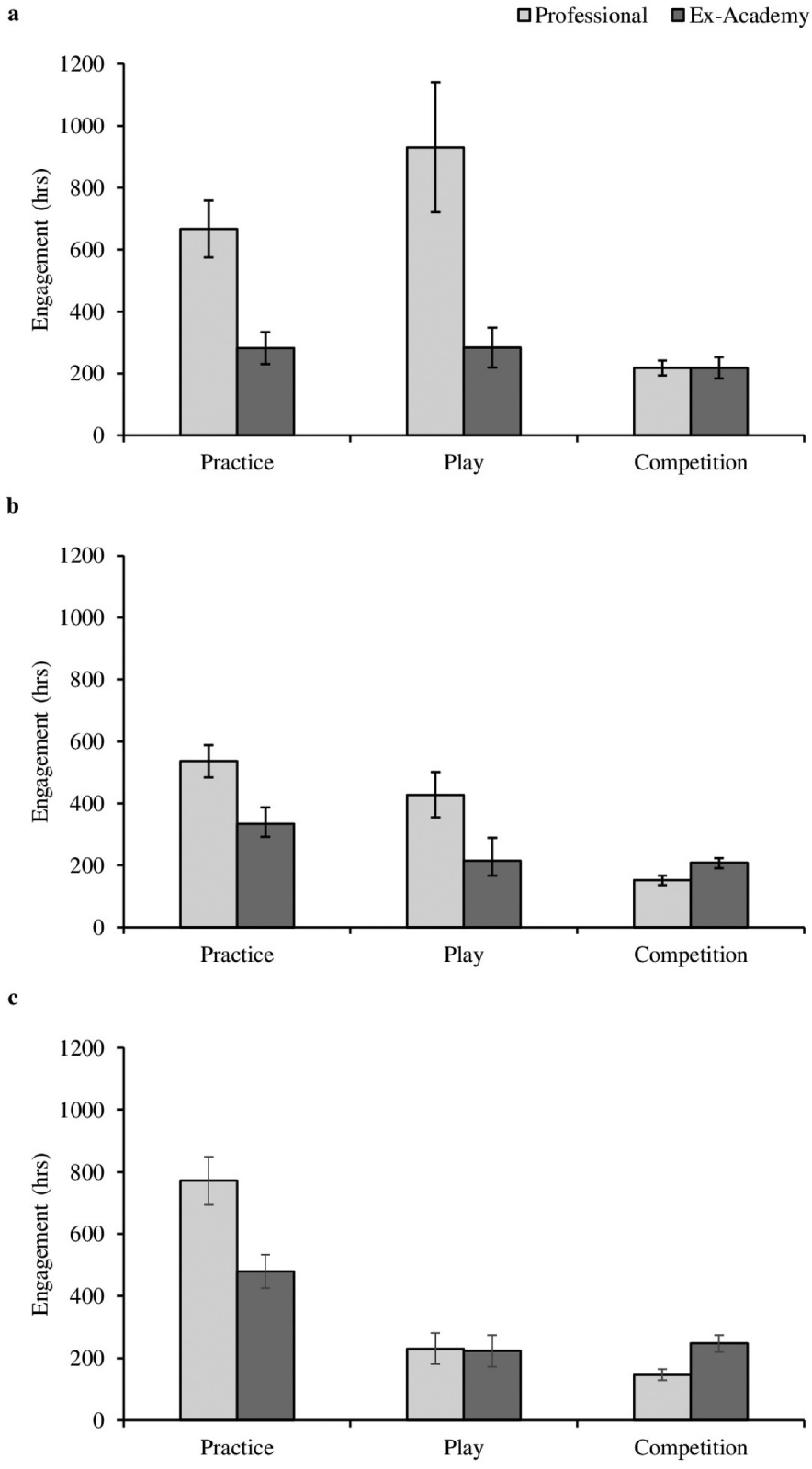

Figure 1. Hours accumulated (error bars represent standard error of the mean) during (a) childhood (6–12 years), (b) early adolescence (13–15 years), and (c) late adolescence (16–18 years) in competition, practice, and play for the Professional (light-grey bars) and Ex-Academy (dark-grey bars) players.

male, 3 (6%) engaged in a combination of mixed-gender/male, and 2 players (4%) engaged in a combination of female/male/mixed-gender.

For early adolescence, the *t*-test revealed that professional (923 ± 489 h) and ex-academy players (689 ± 353 h) did not differ in hours in total soccer activities [$p = 0.06$, $d = 0.55$]. The ANOVA revealed that hours significantly differed between activities [$F(2, 60) = 18.58$, $p < 0.01$, $\eta_p^2 = 0.38$] with players accumulating significantly more [$ps < 0.01$] hours in practice (421 ± 281 h) and play (331 ± 299 h) compared to competition (168 ±

74 h). This was superseded by a group × activity interaction [$F(2, 60) = 6.82$, $p < 0.01$, $\eta_p^2 = 0.19$]. As outlined in Figure 1(b), professional players (light-grey bars) engaged in significantly more [$p < 0.05$] hours of practice (559 ± 279 h) compared to ex-academy players (296 ± 222 h, dark-grey bars). During early adolescence, 44 (85%) players engaged in female soccer only, 1 (2%) engaged in mixed-gender only, 1 (2%) engaged in male teams only, 3 (6%) engaged in a combination of female/mixed-gender, 5 (10%) engaged in a combination of female/male, and 1 (2%) engaged in a combination of mixed-gender/male.

For late adolescence, the *t*-test revealed that professional (1058 ± 512 h) and ex-academy (907 ± 426 h) players did not differ in hours accumulated in soccer activity [$p = 0.24$, $d = 0.32$]. The ANOVA revealed that hours significantly differed between activities [$F(2, 74) = 38.97$, $p < 0.01$, $\eta_p^2 = 0.51$] with players accumulating significantly more [$ps < 0.01$] hours in practice (615 ± 388 h) and play (265 ± 272 h) compared to competition (202 ± 131 h). This was superseded by a group × activity interaction [$F(2, 74) = 8.25$, $p < 0.01$, $\eta_p^2 = 0.18$]. As outlined in Figure 1(c), professional players (light-grey bars) engaged in significantly more [$p < 0.05$] hours of practice (795 ± 419 h) compared to ex-academy players (456 ± 283 h, dark-grey bars). During late adolescence, 54 (96%) players engaged in female soccer only, whereas 2 (4%) players engaged in mixed gender soccer only.

Ratings of soccer-specific activities

In childhood, for enjoyment and motivation, the ANOVA did not reveal effects or interactions. For physical effort, ratings significantly differed between activities [$F(2, 76) = 3.98$, $p < 0.01$, $\eta_p^2 = 0.25$]. Practice and competition were rated significantly more physically effortful [$ps < 0.01$] compared to play. For cognitive effort, ratings significantly differed between activities [$F(2, 76) = 12.11$, $p < 0.01$, $\eta_p^2 = 0.24$], practice and competition rated significantly more cognitively effortful [$ps < 0.01$] compared to play (Table 2).

In early adolescence, for enjoyment and motivation the ANOVA did not reveal any effects or interactions. Rating of physical effort significantly differed across groups [$F(1, 33) = 4.44$, $p = 0.04$, $\eta_p^2 = 0.12$], ex-academy players rated activities as significantly more physically effortful [$p < 0.01$] compared to professional players. Furthermore, ratings significantly differed between activities [$F(2, 66) = 33.00$, $p < 0.01$, $\eta_p^2 = 0.50$], practice and competition rated as significantly more physically effortful [$ps < 0.01$] compared to play. These were superseded by a group × activity interaction [$F(2, 66) = 5.51$, $p = 0.01$, $\eta_p^2 = 0.14$]. As outlined in Table 2, ex-academy players rated practice and competition as significantly more physically effortful [$p < 0.05$] compared to professional players. For cognitive effort, ratings significantly differed between activities [$F(2, 66) = 27.22$, $p < 0.01$, $\eta_p^2 = 0.45$], practice and competition rated as significantly more cognitively effortful [$ps < 0.01$] compared to play.

In late adolescence, for enjoyment and motivation the ANOVA did not reveal a group or interaction effect. Rating of motivation significantly differed between activities [$F(2, 82) = 7.32$, $p < 0.01$, $\eta_p^2 = 0.15$]. Competition was rated significantly more motivating [$ps < 0.01$] compared to play and practice. For physical effort, the ANOVA did not reveal a group or interaction effect, yet ratings significantly differed between activities [$F(2, 80) = 35.88$, $p < 0.01$, $\eta_p^2 = 0.47$]. Competition was rated significantly more physically effortful [$ps = 0.01$] compared to play and practice. Furthermore, practice was rated significantly more physically effortful [$p < 0.01$] compared to play. For cognitive effort, the ANOVA did not reveal a group or interaction effect, yet ratings significantly differed between activities [$F(2, 80) = 17.63$, $p < 0.01$, $\eta^2 = 0.45$]. Competition was rated significantly more cognitively effortful [$ps < 0.01$] compared to play and practice. Furthermore, Competition was rated significantly more cognitively effortful [$p < 0.01$] compared to practice (Table 2).

Additional analysis revealed that ex-academy players significantly increased their ratings of physical and cognitive effort across age categories when compared to professional players for both practice and competition [$ps < 0.02$], but not play. Furthermore, there were significant positive correlations for ratings of enjoyment and motivation [$p's < 0.01$], and physical and cognitive effort [$p's < 0.01$] for both groups across all activities and age categories.

Other sports activities

Table 3 contains the total number of other sports engaged in, the average age in which players in each group started and ceased engagement in other sports, as well as hours in each activity across development. Altogether, 32 (57%) players engaged in other sports during childhood, with those players engaging in 1.6 other sports, starting at 10.3 years, and accumulating an average of 863 h of activity. During early adolescence, 37 (66%) players engaged in other sports, with 9 engaging for the first time, and 4 ceasing participation in childhood. Those players engaged in 1.6 other sports and

Table 2. Mean ratings of soccer-specific activities across childhood (6–12 years), early (13–15 years) and late adolescence (16–18 years) for professional and ex-academy players.

		Childhood			Early Adolescence			Late Adolescence		
		Practice	*Play*	*Comp*	*Practice*	*Play*	*Comp*	*Practice*	*Play*	*Comp*
Enjoyment	*Professional*	4.0 ± 0.9	4.4 ± 0.9	4.3 ± 0.8	4.1 ± 0.8	4.5 ± 0.7	4.1 ± 1.1	4.1 ± 0.6	4.1 ± 1.0	3.9 ± 0.7
	Ex-Academy	4.1 ± 1.3	4.1 ± 1.2	4.2 ± 1.3	3.9 ± 1.2	4.0 ± 1.0	4.3 ± 1.1	4.0 ± 1.1	3.9 ± 0.7	3.8 ± 1.0
Physical Effort	*Professional*	2.4 ± 1.0	2.2 ± 1.1	2.5 ± 1.0	3.0 ± 0.8	2.3 ± 1.1	3.0 ± 0.9	3.3 ± 0.9	2.4 ± 1.0	3.5 ± 0.8
	Ex-Academy	2.8 ± 1.3	2.3 ± 1.2	3.1 ± 1.2	3.7 ± 0.9	2.4 ± 1.2	4.0 ± 0.9	3.5 ± 1.1	2.5 ± 1.2	4.2 ± 0.9
Cognitive Effort	*Professional*	2.9 ± 0.9	2.5 ± 1.0	2.9 ± 0.9	3.5 ± 0.7	2.7 ± 1.1	3.6 ± 0.7	3.7 ± 0.7	2.8 ± 1.2	3.8 ± 0.7
	Ex-Academy	3.0 ± 1.2	2.6 ± 1.4	3.1 ± 1.1	4.0 ± 1.0	2.9 ± 1.0	4.2 ± 0.8	3.8 ± 0.9	2.9 ± 1.0	4.4 ± 0.6
Motivation	*Professional*	3.6 ± 0.9	3.8 ± 1.1	3.7 ± 1.0	3.8 ± 0.7	3.5 ± 1.1	4.0 ± 0.8	3.8 ± 0.8	3.5 ± 1.2	4.0 ± 0.9
	Ex-Academy	3.9 ± 1.4	3.5 ± 1.3	4.1 ± 1.3	4.0 ± 0.9	3.8 ± 0.9	4.1 ± 1.1	3.7 ± 1.1	3.7 ± 0.8	4.4 ± 0.9

Table 3. Mean number of other sports engaged in, start age, and total accumulated hours in other sport activities across engagement for professional and ex-academy players.

		Professional	Ex-Academy
	Start Age	9.6 ± 2.9	10.9 ± 2.7
	End Age	13.9 ± 2.4	15.4 ± 1.9
Childhood	*No. of Sports*	1.6 ± 1.0	1.6 ± 0.7
	No. of Players	15	17
	Total Hours in Practice	602 ± 513	422 ± 492
	Total Hours in Play	399 ± 266	156 ± 203
	Total Hours in Competition	244 ± 158	226 ± 224
Early Adolescence	*No. Other Sports*	1.4 ± 0.7	1.7 ± 0.7
	No. of Players	18	18
	Total Hours in Practice	273 ± 340	297 ± 272
	Total Hours in Play	149 ± 129	137 ± 129
	Total Hours in Competition	108 ± 62	168 ± 182
Late Adolescence	*No. Other Sports*	1.2 ± 0.4	1.6 ± 0.6
	No. of Players	9	14
	Total Hours in Practice	89 ± 103	236 ± 243
	Total Hours in Play	64 ± 42	64 ± 54
	Total Hours in Competition	58 ± 36	112 ± 87

accumulated an average of 476 h of activity. During early adolescence, 14 players ceased participation in other sports. For the 12 (22%) that continued participating, they engaged in 1.5 other sports, accumulating an average of 254 h of activity. Table 4 shows the type of sports players participated in. Altogether players engaged in 18 different additional sports, with athletics, swimming, cricket, and hockey being the most reported. In total, 41 (73%) players engaged in other sports during childhood and adolescence.

Interindividual variations

Previous examinations of developmental activities in professional female soccer players have reported large interindividual variability in the hours accumulated in soccer-specific and other-sport activities, particularly in childhood (Ford, Hodges, et al., 2020a; Hendry et al., 2019). This was suggested to be due to the relatively small number of registered female players worldwide (<5 million; FIFA, 2014). In England, the number of registered female players in England between 5–15 years of age (~860,000) is three times lower compared to their male counterparts (~2.46 million; The FA, 2015). Therefore, we conducted the same analysis of interindividual variability as Ford, Hodges, et al. (2020a). This indicated there was notable interindividual variations from the average data for hours accumulated across development, with only 2 players (1 per group) within the 350 h (1 h/wk across 7 50-wk years) of both means for total hours accumulated in soccer-specific and other-sport activities in childhood, and 2 different players (1 per group) within the 150 h (1 h/wk across 3 50-wk years) of both means in early adolescence. Table 5 illustrates the frequency of players within each group that had notable variance for one or more dependent variable in the total hours accumulated in soccer-specific and other-sport activity data, and the types of variation. There were 20 professional (71%) and 21 ex-academy (75%) players who had at least one notable interindividual variation in childhood, and 18 professional (64%) and 16 ex-academy (57%) players in early adolescence.

Table 4. The type of other-sport engaged in and the number of players that engaged.

Type of Sport	Number of Players
Athletics	20
Swimming	7
Cricket	6
Hockey	6
Netball	5
Badminton	4
Table Tennis	4
Cross-Country	4
Karate/Judo	3
Rugby	3
Tennis	3
Basketball	2
Gymnastics	2
Volleyball	2
Boxing	1
Handball	1
Horse Riding	1
Taekwondo	1

Discussion

In the present study, we examined the developmental activities engaged in by female, adult soccer players in England who were either professional playing in the WSL or who had previously played at the youth training academy of professional clubs but did not become professional in adulthood. Our aim was to identify the activities engaged in by current professional players relative to existing talent developmental pathways and previously limited data for female soccer players (Peters et al., 2022; Williams et al., 2020). Our findings indicated that the start age in soccer for professional players in England was in early childhood, alike to female players from other soccer nations (Güllich, 2019; Hendry et al., 2019; Ford, Hodges, et al., 2020a), yet slightly later than reported for male players (Ford & Williams, 2012; Roca et al., 2012). Both professional and ex-academy players entered a youth training academy in early adolescence
(13 years) slightly earlier than reported in other soccer nations (14 years; Ford, Hodges, et al., 2020a; Hendry et al., 2019), but later than male players (10 years; Ford & Williams, 2012).

Professional players started playing soccer and engaging in formal soccer activities (practice) at an earlier age than ex-

Table 5. Frequency (%) of players that had notable variance from one or more dependent variable in the total hours accumulated in soccer-specific and other-sport activity data, and the types of variation in childhood and early adolescence.

	Childhood		Early Adolescence	
Variation	Professional	Ex-Academy	Professional	Ex-Academy
(1) More total hours engagement in other-sports than soccer-specific activities	6 (21)	6 (21)	5 (18)	7 (25)
(2) Equal total hours engagement in other-sports than soccer-specific activities	5 (18)	6 (21)	4 (14)	8 (29)
(3) Very low total hours engagement in other-sport activities (<1/wk)	5 (18)	6 (21)	3 (11)	3 (11)
(4) More hours in soccer-specific play than practice	10 (36)	9 (32)	4 (14)	5 (18)
(5) No hours in soccer-specific play	8 (29)	10 (36)	13 (46)	10 (36)
(6) More hours in soccer-specific competition than practice	3 (11)	3 (11)	1 (4)	1 (4)
(7) Less that 1 h/wk in total accumulated soccer soccer-specific activities	3 (11)	4 (14)	0 (0)	0 (0)
Total players with at least one variation	20 (71)	21 (75)	18 (64)	16 (57)

academy players, so expectedly their childhood soccer-specific activities differed between-groups. Professional players engaged in three times (647 h) as many hours in soccer-specific play, and twice (384 h) as many hours in soccer-specific practice between 6 and 12 years of age in comparison to ex-academy players (Figure 1(a)). The higher number of hours in play engaged in by professional players (931 h) was comparable to top performing international soccer players (911 h; Ford, Hodges, et al., 2020a) at a similar age, but greater than international soccer players from Canada (417 h; Hendry et al., 2019). Although the accumulated hours in soccer practice by 18 years of age for the professional players (1,973 h) was greater than ex-academy players (1,095 h), they were considerably lower than those reported from international players in Canada (6,099 h; Hendry et al., 2019) and other nations (3,642 h; Ford, Hodges, et al., 2020a). The differences in practice hours within the present sample are likely underpinned by differences in the talent development systems in England compared to other female soccer nations, particularly in demographics, formal selection ages, professional opportunities, and socio-cultural influences (Bennett et al., 2019; Kelly et al., 2024). Furthermore, the absolute level of professional players within the current study were "national" class (Güllich et al., 2022), compared to "international" or "world-class" in previous studies (Ford, Hodges, et al., 2020a; Güllich, 2019; Hendry et al., 2019). Examinations of world-class vs. national class athletes have revealed differences predictor effects such as amounts of sport-specific practice, start ages, milestones, and amounts of other-sports coach-led practice (Barth et al., 2022; Güllich et al., 2022).

Across their adolescent years, professional players continued to engage in more hours of both play and practice compared to ex-academy players (Figure 1). Professional players accumulated 536 h of soccer-specific practice (2.2 h/wk across 3 50-wk years) in early adolescence which increased to 771 h (5.1 h/wk across 3 50-wk years) in late adolescence. While these findings did not reach significance, it should be noted that a medium effect size was found which indicates that we may have been underpowered to detect this difference. Hours accumulated in practice were generally lower compared with international players from Germany (early = 3.6 h/wk; late = 7.0 h/wk across 40-wk years; Güllich, 2019) and Canada (12.5 h/wk; Hendry et al., 2019) and players other soccer nations (early = 6.7 h/wk; late = 7.0 h/wk; Ford et al., 2020a). The comparatively smaller practice hours engaged in by professional players from England in the current study may be linked to the talent development system and the emerging nature of youth female soccer in England (Ford & Williams, 2017; Curran et al., 2019). In England, the FA have recently reformed their female talent development system, such as the introduction of a youth academy programme, national pathway, with the aim to develop more talented youth players that progress to club and national senior teams. With this and the age of players included within this study (m = 24 years), it would be advantageous to examine the activities engaged by players who are currently engaging in these talent pathways.

In addition to examining whether the type and quantity of soccer-specific activities engaged in during development differentiates levels of expertise in female soccer players (Güllich, 2019; Ford et al., 2020a), we further quantified players perceptions of the activities (Hendry et al., 2019; Hodges & Starkes, 1996; Starkes et al., 1996). During childhood, consistent with previous studies (Güllich, Faß, et al., 2020; Helsen et al., 1998; Hendry et al., 2019; Ward et al., 2007) both professional and ex-academy players reported that engagement in practice and competition activities were perceived as high in both physical and cognitive effort compared to play (Table 2). Both groups of players also reported that engagement in coach-led practice was "enjoyable" and did not differ to play for this variable and is consistent with the notion that athletes typically perceive effortful practice as enjoyable (Helsen et al., 1998; Hodges & Starkes, 1996; Young & Salmela, 2010). Moreover, players may have engaged practice with high proportions of soccer-related activities such as games and tactics that have previously been rated by youth male soccer players as high for enjoyment, compared to less-related elements of practice (e.g., running) that have been rated as average for enjoyment (Helsen et al., 1998; Ward et al., 2007). Retrospective assessments of international female players in Germany indicated that 40–50% of coach-led practice were "play like" activities and was a strong discriminator between world-class vs. national-class players (Güllich, 2019). Yet, the microstructure of practice activities in youth female soccer players in England are currently unclear (Harkness-Armstrong et al., 2022).

During adolescence this pattern continued, both groups of players rated engagement in practice and competition as more physically and cognitively effortful compared to play. However, in early adolescence, ex-academy players reported higher levels of physical effort for practice and competition compared to the professional players, whereas in late adolescence they reported higher levels of cognitive effort for competition. While we were unable to measure the skill level of the players during adolescence, in line with the Challenge Point Hypothesis (Guadagnoli

& Lee, 2004; Hodges & Lohse, 2022), it may be that the functional task difficulty was beyond the lower physical (e.g., high-intensity endurance) and perceptual-cognitive (e.g., decision-making) skill levels of the ex-academy players (Beavan et al., 2022; Datson et al., 2020), or the coaches of ex-academy players may have set the task difficulty too high or at an inappropriate level and/or age of the learner (Hendry et al., 2015; Williams & Hodges, 2023). Furthermore, given the group differences in accumulated activity, differences in cognitive effort may be underpinned by those in perceptual-cognitive-motor expertise further associated with greater engagement in soccer-specific activities (Machado et al., 2022, 2023). Findings indicate that the physical and cognitive effort of sport-specific activities throughout development differentiates levels of expertise in adulthood in soccer. Further detailed study of the characteristics of activities engaged in by expert female soccer players is still required (Hendry et al., 2019; Peters et al., 2022), perhaps by adopting systematic observation methodology to examine the microstructure of practice activities and whether they are optimal for skill acquisition (Andrew et al., 2021; Cope et al., 2017). For example, Güllich (2019) reported that within coach-led practice, the proportion of time spent in games-based activities (e.g., small-sided games; Andrew et al., 2021) was a strong discriminator of world-class vs. national-class female players in Germany. Engagement in activities that closely replicate the demands of the game provides players with greater opportunities to acquire processes that support the development of planning, selection, and execution of appropriate goal-directed actions (Eather et al., 2020; Jones et al., 2023).

Players engaged in 1–2 other sports during childhood for 3.6 h/wk over 7 × 50-wk years. Whilst higher compared to German and Canadian international female soccer players (~1–2 h/wk; Güllich, 2019; Hendry et al., 2019), this is comparable to other female international soccer players (3.0 h/wk over 7 × 50 wk years; Ford, Hodges, et al., 2020a). Though not statistically different in early adolescence compared to childhood, engagement in other-sport activities reduced to 1.4 h/wk over 3 × 50-wk years in this period. This was lower than German, Canadian and other international female soccer players (~2–3 h/wk; Güllich, 2019; Hendry et al., 2019; 4.6 h/wk over 3 × 50-wk years; Ford, Hodges, et al., 2020a). While there were commonalities between players in both groups, notable interindividual variation from the average occurred in 67% of players across childhood and early adolescence. This interindividual variation included more (21%) or equal (21%) engagement in other-sport activities compared to soccer-specific activities; very low hours engagement in other-sport activities (15%); more hours in soccer-specific play (25%) or competition (8%) than practice; no hours in soccer-specific play (37%); or less than one hour per week accumulated soccer activity (6%). The interindividual variations observed in childhood may be underpinned by other factors associated with talent development that are outside the control of youth training academies such as birthdate, birthplace, and socio-economic status (Allison & Barranco, 2021, Andrew, Finnegan, et al., 2022a; Teoldo et al., 2023). However, these variations continue during early adolescence after players enter an elite academy environment, implying that differences in talent development systems may play a contributing factor. Recently, the Football Association (FA) has implemented a female specific talent pathway (The FA, 2017) with the aim to increase contact hours, and develop more talented youth players that progress to club/national senior teams. It would therefore be beneficial to re-examine activities engaged by players who are currently within this pathway, and whether interindividual variation still exists. Furthermore, large interindividual variability has also been observed across different female soccer nations (Ford, Hodges, et al., 2020a). It is important to further understand the key characteristics and environments of these individual female soccer nations and their potential impact on the talent identification and development processes (Bennett at al., 2019; Ford, Bordonau, et al., 2020b; Larkin et al., 2023; Simpson et al., 2022).

The current study is not without limitations. The scope of the findings may not Talent development in female soccer: Developmental activities of professional players in England to other nations beyond England. For example, professional soccer players in the current study made their debut at 17–18 years of age, whereas at the same age in the United States the next step on the pathway for talented female soccer players is college soccer, where they are integrated into higher education, turning professional later at 21–22 years of age (Allison & Barranco, 2021; Markovits & Hellerman, 2003). Furthermore, the sample is low compared to all players that are competing in the WSL and thus must be acknowledged when generalising the results, yet to provide context, sample sizes were comparable to previous studies from single soccer nations ($n = 21$, Hendry et al., 2019; $n = 29$; Güllich, 2019) indicating the difficulty of studying these participants (Hornig et al., 2016). While the use of the PHQ is reliable, valid, and one the best available methods to collect activities data, retrospective recall technique is prone to possible recall error and bias which may have contributed to between and/or within and group differences (Hopwood, 2015; Güllich, 2017, 2018), particularly around the perceptions of the activities, as reliability was shown to be only partly acceptable (Hendry et al., 2019). Longitudinal studies of how the amount and perceptions of all the activities differentially affect skill acquisition during childhood is still required (Andrew, O'Brien, et al., 2022c). Finally, we did not collect performance data (e.g., psychological) and their association with engagement in developmental activities and playing status. For example, skilled alpine skiers with higher levels of grit engaged in more hours in individual practice hours compared to their peers (Fawver et al., 2020).

In summary, professional players engaged in higher amounts of soccer practice and play throughout their formative years compared to players that did not progress to professional contract, supporting previous studies in female soccer players of other soccer nations (Hendry et al., 2019). The hours of engagement in both competition and practice were rated as high in physical and cognitive effort by all players, yet ex-academy reported higher levels of physical effort during early

adolescence, and higher levels of cognitive effort for competition during late adolescence, suggesting the constraints of effort should be examined independently (Helsen et al., 1998) and may have affected progression.

Acknowledgments

The authors would like to thank Ellen Davies, Jack Clover, and Mitchell Rainsford for their assistance in data collection.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to restrictions (e.g., their containing information that could compromise the privacy of research participants).

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