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**The developmental and professional activities of female international soccer players
from five high-performing nations**

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Running head: ACTIVITIES OF FEMALE INTERNATIONAL SOCCER PLAYERS

**The developmental pathways and professional activities of female international
soccer players from five high-performing nations**

Abstract

We study the developmental and professional activities engaged in by 86 female adult soccer players from the senior national teams of Australia, Canada, England, Sweden, and the United States of America. Players completed the Participation History Questionnaire (PHQ) to elicit the amount and type of activities engaged in across their developmental and professional years, including milestones, soccer-specific activity and engagement in other sport activity. Greater specialisation than diversification characterised their childhood developmental activities, including all players starting in soccer in childhood and accumulating more hours in soccer activity than other sports during this period. However, interindividual variation further characterised these childhood activities, with a proportion of players diversifying into other sports and/or soccer play to a greater or lesser degree during childhood when compared to other players. The amount of coach-led soccer practice increased for all players across their development culminating in an average of 15-16 hrs/wk across a 40-week season in early adulthood. In contrast, the amount of engagement in other sports and soccer peer-led play varied between players, but generally decreased across adolescence to negligible amounts in late adolescence. Findings are commensurate with the deliberate practice framework and early engagement.

Keywords: Deliberate practice; talent development; motor behaviour; skill acquisition.

Introduction

Professional athletes excite us with their outstanding performances and achievements. The activities they participate in during development and across their careers contribute to the attainment of expertise. In contrast to the fairly substantive literature base on male expert athletes, and particularly male soccer players (e.g., Ford et al., 2012; Hendry & Hodges, 2018; Hornig et al., 2016), very few researchers have studied the developmental activities of female expert athletes. We address this shortcoming in the literature by assessing the developmental and professional activities of adult, international-level, female soccer players from leading nations across the globe.

The theory of Deliberate Practice (Ericsson, 1996; 1998; 2003; 2006; 2007; 2013; Ericsson et al., 1993; Ericsson & Pool, 2016; Ericsson & Towne, 2010) has been influential in shaping ideas about the development of expert performance. The central parts of the theory are the *characteristics of deliberate practice* and the *monotonic benefits assumption*. The characteristics of deliberate practice are that it is highly relevant to improving an aspect of current performance, coach-led, individualised, effortful, relatively low in inherent enjoyment, and contains error diagnosis and informative augmented feedback. The monotonic benefit assumption is that time accumulated in deliberate practice is monotonically related to performance, in that increases in the former lead directly to increases in the latter. Therefore, key claims in the framework first outlined by Ericsson et al. (1993) are that “...the level of performance an individual attains is directly related to the amount of deliberate practice accumulated” (p.370) and that “...individuals who start early and practice at higher levels will have a higher level of performance throughout development than those who start later” (p.392). In sport, these

claims have led to a belief that the start of engagement in deliberate practice should occur early in childhood and that children should specialize in a specific sport so as to maximize time spent in this activity.

However, childhood specialization in a sport has been associated with negative consequences for those involved, including increased incidence of overuse injuries, social isolation, burnout and dropout, as well as reduced success in sports in adulthood (for reviews, see Baker et al., 2009; Bergeron et al., 2016; DiFiori et al., 2014; Jayanthi et al., 2012; LaPrade et al., 2016; Mostafavifar et al., 2013; Rees et al., 2016; Wojtys, 2013). An alternative to childhood specialization in a single sport is participation in or sampling of multiple sports, with specialisation into a single sport delayed until adolescence. Sampling sports in childhood is postulated to lead to several positive consequences for those involved, including enhancing intrinsic motivation and other psychosocial variables, reducing overuse injuries, attaining expertise in adulthood, and longer sports careers (for reviews, see Côté & Erickson, 2015; Côté, Horton et al., 2009; Côté, Lidor et al., 2009; Côté et al., 2007). Moreover, an alternative to accumulating deliberate practice at this stage is deliberate play. Deliberate play is directed by the children themselves and is engaged in with the intention of fun and enjoyment, probably enhancing intrinsic motivation (Côté & Hay, 2002). Therefore, childhood sports activities can vary along at least two continuums of specialisation or diversification and accumulated practice or play (Ford & Williams, 2017; Sieghartsleitner et al., 2018).

Deliberate practice theory (e.g., Ericsson et al., 1993) has been assessed using retrospective recall methods in which the number of hours spent in developmental activities by expert performers since starting in the domain are recorded via interviews

and questionnaires. Multiple researchers have used this method with athletes from a variety of sports and countries (for reviews, see Baker & Young 2014; Güllich & Emrich, 2014). One of the stronger forms of current evidence is from cross-sectional studies involving adult athletes performing at the highest level in their sport separated into groups who are close together on the expertise continuum, such as “world class” versus “national” level adult athletes, albeit the terms used to describe athletes often differs between studies (Berry et al., 2008; Carlson, 1988; Hornig et al., 2016; Law et al., 2007; Güllich, 2014; 2016; 2018; 2019; Güllich et al., 2019; Güllich & Emrich, 2014; Moesch et al., 2011; Van Rossum, 2000; Zibung & Conzelmann, 2013). No studies exist involving longitudinal measurement of how all the activities differentially affected skill acquisition during development. Moreover, several studies involve samples of adolescent athletes that are limited because many of those athletes do not become adult athletes performing at the highest level in their sport, with those athletes confounding the data when assessing the contribution of activities to the development of expert performance. Moreover, “expert-novice” comparisons usually reveal the obvious finding that “experts” have accumulated significantly more sport-specific practice hours compared to “novices” (for a review, see Baker & Young, 2014).

Greater specialisation and practice in childhood characterised the developmental activities of Olympic and international standard adult female rhythmic gymnasts, perhaps because this sport requires peak performance in adolescence (Law et al., 2007). Greater specialisation characterised the development of some Swiss national team male soccer players in Zibung and Conzelmann (2013), some of the German national team female soccer players in Güllich (2019; 29% of group), and some of the Olympic and/or World

Champion medalist German athletes in Güllich (2014; 25% of group). However, in these three studies the developmental activities of the majority of participants demonstrated greater diversification in childhood compared to specialisation. Moreover, elsewhere, aspects of greater diversification characterised the developmental activities of the most-successful adult athletes performing at the highest level in their sport (Berry et al., 2008; Carlson, 1988; Güllich, 2014; 2016; 2018; 2019; Güllich et al., 2019; Güllich & Emrich, 2014; Hornig et al., 2016; Moesch et al., 2011; Van Rossum, 2000). The early engagement hypothesis was suggested (Ford et al., 2009) because many athletes in these studies began engagement during childhood in the sport that they later achieve expertise. For example, female and male German national team soccer players started engaging in the sport in childhood (Güllich, 2019; Hornig et al., 2016). Moreover, early engagement is hypothesised to be more likely to occur in sports that are culturally popular, have a high number of participants, are technically demanding, and/or have a well-developed child sport system (Ford & Williams, 2017).

Another contextual factor that may influence the amount and type of developmental activities is gender (Ford & Williams, 2017). Females in the general population engage in less physical activity during childhood and adolescence compared to males (e.g., Sherar et al., 2007; Thompson et al., 2003). These consistent gender-based differences in youth physical activity in the general population suggest that the developmental activities and pathways of female athletes may differ when compared to those reported for their male counterparts. Male and female athletes have been directly compared in a study of national team sport athletes in Australia (Baker et al., 2003). Females had accumulated fewer sport-specific hours during their development, but had greater diversity in sport

participation, when compared to their male counterparts. However, in another study of male and female elite Canadian triathletes, time spent in the primary sport during development did not differentiate genders (Hodges et al., 2004). Three other studies have assessed the developmental activities of female athletes. First, German female professional soccer players demonstrated greater specialisation by engaging in more soccer than other sports in childhood, but national team players had greater engagement across development in peer-led play in soccer and coach-led engagement in other sports, with lower engagement in coach-led soccer practice, later milestones and later specialisation when compared to league players (Güllich, 2019). Second, the female Olympic rhythmic gymnasts studied by Law et al. (2007) accumulated a very high amount of sport-specific practice hours and had low amounts of diversity in other sports in their youth. Third, the female, adult Canadian national team soccer players assessed by Hendry et al. (2019) demonstrated greater specialisation in childhood by accumulating a relatively high amount of sport-specific practice hours with low amounts of diversity and play. The mixed results from studies investigating the developmental activities of female athletes suggest further study is required, particularly by removing the confound that studies on athletes from single countries may only reveal the developmental system in that country, as opposed to actual common patterns of developmental activities.

In the current paper, we study the developmental and professional activities of female adult national team soccer players from around the world. Players were selected from countries playing at the highest level of the sport, representing the senior national teams of Australia, Canada, England, Sweden and United States of America. Participants completed a questionnaire assessing the number of hours spent in developmental and

professional activities since starting in the sport. Their developmental activities during childhood are likely to show greater *diversity* in childhood as per the most-successful adult athletes performing at the highest level in their sport (Berry et al., 2008; Carlson, 1988; Güllich, 2014; 2016; 2018; 2019; Güllich et al., 2019; Güllich & Emrich, 2014; Hornig et al., 2016; Moesch et al., 2011; Van Rossum, 2000). However, the developmental activities of a proportion of players (~25%) were expected to show greater *specialisation* as reported in some previous studies (Güllich, 2014; 2019; Zibung & Conzelmann, 2013), which would be demonstrated by a significant accumulation of hours in soccer during childhood with low engagement in other sports. Early engagement in soccer was expected for all players similar to German national team soccer players (Güllich, 2019; Hornig et al., 2016). In addition, the female soccer players were expected to have engaged in increasing amounts of practice in soccer across adolescence, with hours in soccer-specific play and other sports reducing across adolescence, as per previously outlined pathways (see Côté et al., 2007). We hypothesised that from late adolescence their activities would involve high volumes of soccer practice commensurate with the deliberate practice framework (e.g., Ericsson et al., 1993).

Method

Participants

Participants were 86 adult, female, international soccer players in the squads of Australia, Canada, England, Sweden, and the United States of America ($n = 16$ -18 players from each country). Their mean age at the time of data collection was 25.7 yr ($SD = 4.1$ yr). All teams were ranked in the top 10 of the Federation Internationale de Football Association (FIFA)/Coca-Cola World Ranking. Players were part of the national squads

for their respective countries at the time of data collection and had played at least one official match for their national team (*median* = 28 appearances, *IQ1* = 8, *IQ3* = 76, with 11 players over 100 appearances). Honours at the time of data collection included at least one Olympic Games medal for 29 players and World Cup winners or runner-up medals for 24 players, with 39 players winning national championships with their clubs. Many of the players have won more of these honours for club and country in the intervening time period since data collection. Informed consent was obtained and the research was conducted according to the ethical guidelines of the lead author's institution.

Questionnaire

The Participation History Questionnaire (PHQ) was used to elicit information relating to the activities that players had engaged in across their developmental and professional years. Indices related to the reliability and validity of the PHQ have previously been reported (e.g., Ford et al., 2010) and its use is widespread (e.g., Ford et al., 2010; 2012; Ford & Williams, 2012; Winn et al., 2017). The first of the three sections of the questionnaire elicited information on soccer-specific milestones. These included the age at which participants first started playing in soccer of any type, supervised soccer practice, entered a 'talent development' training programme (i.e., academy), appeared at youth international level, senior level, senior international level, and in an Olympic Games. Players were required to list their senior honours and the years they occurred. The second section solicited information on engagement in four types of soccer activities: match-play; coach-led practice; individual practice; and non-coach-led play (Côté et al., 2005; Ward et al., 2007). Match-play was defined as organised competition in a group engaged in with the intention of winning and supervised by adult(s) (e.g., league games).

Coach-led practice was defined as organised group practice engaged in with the intention of performance improvement and supervised by coach(es) or adult(s) (e.g., practice with team). Non-coach-led individual practice was defined as practice alone engaged in with the intention of performance improvement. This latter category was included because researchers have studied individual practice hours to test ideas relating to deliberate practice theory (Ericsson et al., 1993). Non-coach-led play was defined as play-type games with rules supervised by the player or their peers and engaged in principally with the intention of fun and enjoyment (e.g., game of soccer in park with friends). The hours per week and months per year in each of the soccer activities, including the number of weeks when players were injured/year, were recorded for a year. The data were recorded for every other year from the current season retrospectively to the under-6 year (U6) age group category.

The third section of the PHQ elicited information on engagement in other sport activities. It contained a list of sports, from which, participants were asked to indicate those sports in which they had participated regularly for at least three months in total (e.g., once a week for one month in each of three years). They were not required to include sport activities engaged in during physical education classes at school, although those engaged in after school were included.

Procedures

To complete the questionnaire, participants from each squad sat together in small groups in a quiet room. Verbal instructions were provided regarding the purpose of the questionnaire. Participants were instructed on how to complete each section of the questionnaire before commencing that section. At the start of the second section, players

were required to specify the team and coach that they played for in each year of their participation to aid memory recall of the hours in the soccer activities. Participants completed the questionnaire in about one hour.

Data analyses

All dependent variables are reported combined for the 86 participants. We did not make between-country comparisons, as there was no rationale to expect significant differences between countries (e.g., Ford et al., 2012). Preliminary analyses confirmed the general lack of differences between countries.

Milestones. The milestone data were reported as median and inter-quartile range 1 and 3 for the age first achieved.

Activity data. The hours in soccer activity were recorded for every other year between the current season and start age, so linear interpolation was used for the missing years (i.e., average of the year preceding and succeeding). These hours were split into childhood (6-12 yr), adolescence (13-18 yr), and early adulthood (18-25 yr) stages for practice, play and competition. The soccer-specific practice hours included the sum of individual and team practice, although the number of individual soccer practice hours was relatively low (e.g., in childhood, 62/86 participants reported and accumulated mean 682 hrs, $SD = 623$). The accumulated hours within each of the three age stages as a function of soccer activity type were used and treated as ratio data. The number of other sports (nominal data) and hours accumulated in those other sports were calculated separately for the childhood, adolescence and adulthood stages.

Childhood activities. For the soccer activity data during childhood, we conducted a one-way ANOVA between activity types (practice, play, competition) with Bonferroni

post hoc comparisons. Number of other sports and hours accumulated in those other sports during childhood were reported as descriptive statistics.

Adolescent activities. To directly test whether the amounts of practice in soccer, soccer-play and other sports activity changed across adolescence, the activity data were divided into early (13-15 yrs) and late (16-18 yrs) adolescent stages. The hours accumulated in soccer practice and play activities, as well as number of other sports and hours accumulated in other sports, were analysed separately using dependent *t*-tests comparing between age stages (early, late). Bonferroni correction to the alpha level resulted in a significance level of $p < .0125$ for these four *t*-tests. Effect size measures were calculated using partial eta squared (η_p^2).

Adult activities. The activity data for early adulthood (19-25 yrs) were calculated and are reported as descriptive statistics for any players that had reached 25 years of age. Players younger than 25 years of age were excluded from the adult data.

Results

Milestones

Table 1 contains the median age at which players reached soccer-specific milestones. The 86 players started in soccer at a median age of 5 yrs ($IQ1 = 4$; $IQ3 = 6$), with every player starting participation in childhood. Their median start age in senior soccer was 17 yrs ($IQ1 = 15$; $IQ3 = 19$). Players went on to achieve multiple honours in senior soccer and the majority represented their national team multiple times.

Table 2 shows the hours accumulated in childhood and adolescent developmental activities.

Childhood activities

During childhood (6-12 yr), players accumulated an average of 2,610 hrs ($SD = 1,830$) in all soccer-specific activities, which equals an average of 7.5 hrs/wk over each of seven, 50-week years during this period. Altogether, 80/86 players engaged in other sports during childhood ($M = 3.2$ sports, $SD = 1.9$; accumulated $M = 1,040$ hrs, $SD = 874$, equating to an average of 3.0 hrs/wk). The start age in other sports varied across childhood (*median* = 9 yrs; *IQ1* = 7; *IQ3* = 12).

Figure 1 and Table 2 show the hours accumulated in the three soccer activities during childhood. There was a significant difference in hours accumulated between the three soccer activities, $F_{2, 164} = 18.48$, $p < .01$, $\eta_p^2 = .18$. *Post-hoc* tests showed that hours in competition were lower (p 's $< .01$) compared with practice, and play, but there was no difference between practice and play ($p = .11$). All players engaged in soccer practice and competition in childhood, but not play.

There was notable interindividual variation from the average data for hours accumulated during childhood, with only four players within 350 hrs (1 hr per week over 7 x 50-wk years of childhood) of both means for total hours accumulated in soccer and in other sports. Table 3 shows the frequency of players who notably varied from the hours accumulated averages and the types of variation, with 55/86 (64%) players having at least one notable interindividual variation from the average in childhood.

Adolescence

Soccer activities. Players accumulated $M = 3,485$ hrs (11.6 hrs/wk across six 50-week years; $SD = 1,836$) in soccer activities across adolescence. Figure 2 shows the hours accumulated in the three soccer activities during the two stages of adolescence. Hours accumulated in soccer practice were greater in late ($M = 1,303$ hrs across 3 years / 8.7

hrs/wk across 50-wk years, $SD = 638$) compared to early adolescence ($M = 1,002$ hrs across 3 years / 6.7 hrs/wk across 50-wk years, $SD = 648$), $t_{85} = 6.86$, $p < .0125$. Hours accumulated in soccer play were lower in late ($M = 219$ hrs, $SD = 514$) compared to early adolescence ($M = 377$ hrs, $SD = 750$), $t_{85} = 4.45$, $p < .0125$. However, 28 and 32 players did not engage in soccer play during early and late adolescence, respectively. The actual mean for the 58 players who did engage in play during early adolescence was 560 hrs (3.7 hrs/wk, $SD = 857$) and for the 54 players in late adolescence, $M = 350$ hrs (2.3 hrs/wk, $SD = 615$).

Up to the age of 18 yrs, which is the mean age that the 86 players first represented their national team, the players accumulated an average of 6,004 hrs ($SD = 3,450$) in all soccer activities (sum of practice, play and competition).

Other sports. Altogether, 80 players engaged in other sports in early adolescence, dropping to 54 in late adolescence. Based on repeated measures, comparisons of $n = 54$, the number of other sports was greater in early ($M = 3$ other sports, $SD = 2$) compared to late adolescence ($M = 2$ other sports, $SD = 2$), $t_{53} = 5.92$, $p < .0125$. Hours accumulated in other sports during early adolescence for those players ($M = 697$ hrs across 3 years / 4.6 hrs/wk across 50 wk/yr, $SD = 489$) were greater when compared to late ($M = 485$ hrs across 3 years / 3.2 hrs/wk across 50 wk/yr, $SD = 520$), $t_{50} = 5.01$, $p < .0125$. Table 4 shows the type of sports that players participated in across their youth. Players engaged in 41 different additional sports, with basketball, swimming, athletics and cross-country running being the most common. Players ended participation in other sports at various ages across their youth, but mainly in adolescence (*median* = 14 yr; *IQ1* = 12; *IQ3* = 18 yr). The age of specialisation in soccer and cessation of other sports was $M = 16$ years

($SD = 2$) when using a criterion of within participant other sport end ages up to 18 years of age.

Adulthood

During early adulthood, between 19-25 yrs, the 46 players who had reached 25 years of age accumulated an average of 4,385 hrs ($SD = 1,914$) in soccer-specific coach-led practice activities, which equates to 15-16 hrs/wk across a 40-week season or 12.5 hrs over 50-weeks, mainly in coach-led practice, as well as playing one match/wk over a 40-week season. A total of 19 players engaged in $M = 1.4$ ($SD = 0.8$) other sports between 19-25 yr.

Discussion

We evaluated the developmental and professional activities engaged in by female adult national team soccer players. Our aim was to identify the activity pathways engaged in by these players relative to existing developmental pathways and previously reported data from male players. Greater diversity characterises the childhood developmental activities of the most-successful adult athletes performing at the highest level in their sport (Berry et al., 2008; Carlson, 1988; Güllich, 2014; 2016; 2018; 2019; Güllich et al., 2019; Güllich & Emrich, 2014; Hornig et al., 2016; Moesch et al., 2011; Van Rossum, 2000), so we expected to find the same in our sample. In addition, childhood engagement in soccer was expected for all players similar to German national team soccer players (Güllich, 2019; Hornig et al., 2016). However, greater specialisation was expected for around a quarter of all players similar to previous studies with professional soccer players (Güllich, 2019; Zibung & Conzelmann, 2013). We anticipated increasing amounts of practice hours from early adolescence onwards.

All players engaged in soccer at an early age, and on average accumulated over twice as many hours in soccer by 12 years of age when compared to other sports combined, demonstrating a focus on early engagement in soccer with some diversification into other sports. The median start age in soccer for all players was in early childhood (5 yrs), similar to start ages for elite, male players (Ford et al., 2009; 2012; Hendry et al., 2014; Hendry & Hodges, 2018; Hornig et al., 2016; Ward et al., 2007) and German (Güllich, 2019) and Canadian (Hendry et al., 2019) female national team players. During childhood, the players averaged 7.5 hrs/wk of soccer activity, comparable with elite males (Ford et al., 2012; Hornig et al., 2016; Ward et al., 2007) and German female national team players (Güllich, 2019), but more so than Canadian players (Hendry et al., 2019). All players engaged in practice and competition in childhood, accumulating more hours in practice during childhood compared to competition, but not play, as found previously for Canadian (Hendry et al., 2019) and German female national team players (Güllich, 2019), as well as male European youth players (e.g., Ford et al., 2012). The mean start age of players in a youth training academy occurred in early adolescence ($M = 13.6$ yrs), slightly later than reported with male players (e.g., 12 yrs, Ford et al., 2012). This latter finding suggests that the early engagement in soccer activity occurred prior to entry into an elite training academy system. In addition, the players engaged in an average of three other sports during childhood for around 3 hrs per week, which is lower than reported elsewhere, but not insignificant (Berry et al., 2008; Carlson, 1988; Hornig et al., 2016; Güllich; 2019; Güllich et al., 2019; Moesch et al., 2011). Our findings generally highlight a stronger focus on specialisation rather than diversification in the childhood developmental activities of the players.

While there were commonalities in developmental activities and milestones between players, including an early childhood start in soccer, engagement in coach-led soccer activities during childhood, and the volume of practice increasing, notable interindividual variation from the average occurred in the developmental activities of 55 players in childhood. This interindividual variation included a proportion of players accumulating in childhood more or equal hours in other sports compared to soccer (19%), very low or no hours in other sports (23%), more hours in soccer play than practice (19%), no hours in soccer play (23%) or very low hours in soccer (2 players), with one player accumulating more hours in match-play than practice. The proportion of players ($n = 20$) demonstrating even greater specialisation than the average by engaging in low or no other sports in childhood was similar to that found for German athletes (Güllich, 2014; 2019) and Swiss male players (Zibung & Conzelmann, 2013). Another proportion of players ($n = 16$) demonstrated greater diversification than the average by accumulating in childhood more or equal hours in other sports compared to soccer and approximately twice as many mean hours in other sports as the average. The hours in other sports during childhood for those 16 players is comparable to the British athlete super-elite group in Güllich et al. (2019), but greater than German (Güllich, 2019) and Canadian (Hendry et al, 2019) female national team players and other athlete samples (Güllich, 2014; 2018; 2019). An explanation for the interindividual variation in childhood developmental activities is that soccer has relatively small numbers of registered female players worldwide (< 5 million players, FIFA, 2014) compared to several other sports (e.g., ~35 million registered male football players, FIFA, 2007), potentially allowing greater variation in childhood

activities by players before later specialisation, intensification and becoming a professional.

As expected, across adolescence, players increased hours in coach-led, soccer practice and decreased hours in soccer play and other sports, as well as having a median end age in other sports of 14 yrs, supporting data from elite, male (e.g., Ford et al., 2012; Hornig et al., 2016; Ward et al., 2007) and female players (Güllich, 2019). This pattern of results would be predicted based on deliberate practice theory (Ericsson et al., 1993) and other models of developmental activities (e.g., Côté, et al., 2007). It is similar to other studies of expert athletes (Berry et al., 2008; Carlson, 1988; Güllich, 2016; Hornig et al., 2016). By 18 years of age, the mean hours accumulated in all soccer activity were 6,004 hrs ($SD = 3,450$), which is lower when compared to German male national team players (Hornig et al., 2016), but is similar to German female national team players (Güllich, 2017) and their male Olympic Champion field hockey team (Güllich, 2014). Players increased hours in soccer practice activity further in adulthood with no or very low diversification when compared even to adolescence, likely becoming full-time athletes.

A limitation of the current study is that we examined engagement in macro-activities (practice, play, competition) and we did not study the microstructure of these activities or the effects of those activities on skill acquisition (for a review, see Hendry et al., 2015). We are unable to make causal statements about engagement in the various activities and skill acquisition. Longitudinal research to address this limitation is still required. Another limitation of this study is that no measure of player performance or outfield position was included, so the observed variation, particularly in childhood, could be attributable to player skill level and positional differences. In future, researchers should

seek a single objective measure that can capture long-term player performance in soccer. Moreover, the interindividual variation in childhood developmental activities suggest that any potentially harmful adult-oriented coaching processes are not required during this stage in female football. Although this study is informative in helping describe developmental pathways that have preceded success in female soccer, it is important to remember that studies based on practice history profiling only describe the current (or near past) development system(s) in that sport and country. These systems may not be optimal in terms of developing all athletes and other potential systems may be as, or more, effective. What is clear from these data, however, is that early childhood involvement in soccer defined all participants; the amount of coach-led practice activity increased linearly across development, as did competition to a far lesser degree, whereas all other activities decreased across adolescence.

In summary, greater specialisation than diversification characterised the childhood developmental activities of the 86 female adult professional soccer players from the national teams of Australia, Canada, England, Sweden and the United States of America. However, interindividual variation existed in childhood, with some players diversifying into other sports to a greater or lesser degree during childhood when compared to the other players. The hours accumulated in coach-led practice increased significantly across age phases, whereas hours accumulated in other sports and soccer play decreased to low levels by the end of adolescence. Soccer became a full-time activity for the players in adulthood.

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Table 1. Median (*IQR* 1 to 3) age in years for soccer milestones achieved by national team soccer players from Australia, Canada, England, Sweden, and United States. * = 78 players; ** = 51 players.

<i>Start age in soccer</i>	<i>Start age in supervised training</i>	<i>Start age in leagues</i>	<i>Start age in academy</i>	<i>Non- soccer training activities</i>	<i>Start age youth international</i>	<i>Start age senior soccer</i>	<i>Start age senior international</i>	<i>First Olympic Games</i>
5 (4 to 6)	6 (5 to 7)	7 (6 to 9)	14 (12 to 16)*	14 (12 to 16)	15 (15 to 16)*	17 (15 to 19)	19 (16 to 21)	24 (22 to 27)**

Table 2. Mean (*SD*) hours accumulated in soccer and other sports as a function of developmental age stage by national team soccer players from around the world. * = 54 players. ** SD uncalculatable due to different *n* in each stage.

	<i>Soccer</i>			<i>Other sports</i>	
	<i>Practice</i>	<i>Competition</i>	<i>Play</i>	<i>Total</i>	<i>All</i>
<i>Childhood</i>	1,337 (1,087)	361 (383)	911 (1,393)	2,610 (1,830)	1,040 (874)
<i>Adolescence</i>	2,305 (1,221)	587 (367)	593 (1,243)	3,485 (1,836)	1,182 (963)*
			<i>Total</i>	6,004 (3,450)	2,222 (n/a)**

Table 3. Frequency of players with notable interindividual variations from the average hours accumulated in developmental activities during childhood (adolescence). Nb. * All England players.

<i>Variation</i>	<i>No. of players</i>	<i>Other factors in childhood</i>
1. More hours in other sports than soccer	13 (2)	Median soccer hrs = 1,410 hrs (887 to 1,707)
2. Equal hours in other sports and soccer	3 (0)	Soccer hrs = 866 hrs, 1,303 hrs, 1,935 hrs
3. Very low hours in other sports	20 (22)	6/19 had no hours in other sports
4. More hours in soccer play than practice	16 (4*)	3/16 more hrs other sports than soccer; 3/16 very low hrs other sports
5. No hours in soccer play	20 (22)	3/20 more hrs other sports than soccer; 1/20 very low hrs other sports
6. More hours in soccer competition than practice	1 (1)	No child soccer play and an eminent professional player
7. Less than 350 hrs accumulated in soccer (< 1 hr/wk across 7 x 50 week years of childhood)	2 (0)	More hrs accumulated in other sports = 670 hrs, 800 hrs
Total players with at least one notable variation	55 (42)	

Table 4. The type of other sports engaged in and the number of players who engaged.

<i>Type of sport</i>	<i>No. of players</i>
Athletics	45
Basketball	34
Swimming	28
Cross Country	27
Tennis	20
Volleyball	19
Gymnastics	15
Baseball	12
Netball	9
Field Hockey	8

Figure captions

Figure 1. Mean hours accumulated (SD) for all players, in the three soccer activities (practice, play and competition) across seven years of childhood (6-12 yr).

Figure 2. Mean hours accumulated (SD) for all players, in the three soccer activities (practice, play and competition) across three years each of early (13-15 yr) and late adolescence (16-18 yr).