Early majority engagement pathway best defines transitions from youth to adult elite men's soccer in the UK: A three time-point retrospective and prospective study

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Abstract

Objectives: We evaluated the relative importance of developmental soccer activities engaged in during childhood and adolescence and their relationships with attainment of youth and adult professional status.

Design and Methods: A mixed retrospective and prospective study was conducted whereby youth academy soccer players in the UK completed demographic and practice history questionnaires at Time 1 (T1; n = 102; 13-15 yr) and T2 (for those retained on a professional contract at ~17 yr; n = 26; termed Professional-youth). At T3 (~20 yr), players were further differentiated on the basis of progression to adult professional soccer (Adult-professional, n = 9; Youth-professional only, n = 17).

Results: Less than 10% of the sample specialized only in soccer from childhood and no early specializers progressed to Adult-professional. Soccer was the majority sport from early childhood for nearly all players. Players that attained Professional-youth status (T2) accumulated more hours in organized soccer practice during childhood and started in an academy earlier than those that did not. The future adult and youth professionals did not differ on these childhood variables. However, a separate comparison of the professional groups showed that the Adult-Professionals accumulated more hours in play (and proportionately more hours in play) when estimates were based on T1 and T2, than the youth professional.

Conclusions: These findings support the early-engagement pathway as a model for successful transitions in professional soccer amongst male youth elite players. This pathway is primarily defined by majority engagement in high volumes of domain specific practice and play in childhood.

Early majority engagement pathway best defines transitions from youth to adult elite men's soccer in the UK: A three time-point retrospective and prospective study

Talent development has been described as a complex, non-linear and dynamic process with the attributes for success being multifaceted (Collins & MacNamara, 2012; Williams & Reilly, 2000). Thus far, researchers have attempted to identify commonalities in pathways and profiles of elite athletes to aid an appreciation of key variables that potentially facilitate the development process. These efforts have included descriptions of the developmental activities in which athletes engage (such as practice, play and competition; for a review see Ford, Coughlan, Hodges, & Williams, 2015).

The world of sport, and in particular soccer, offers researchers a valuable environment to facilitate the understanding of expert performance, primarily due to the vast worldwide participation base and the relatively small proportion of players that reach the professional (expert) level. Although the nature of sports expertise is multifaceted, it is relatively well established that extensive experience in the primary domain is largely related to future levels of skill and expertise (Ford, Hodges, & Williams, 2013). In the current study, we use a combined retrospective and prospective design to evaluate how the early developmental activity experiences (e.g., soccer practice and play) of elite-youth soccer players (~ 14-15 yr) related to the attainment of a professional contract first at age 16-17 yr (youth-professional) and then at 19-20 yr (adult-professional).

The theory of deliberate practice (Ericsson, Krampe & Tesch-Römer, 1993) has been the prevailing theory upon which the study of expertise development in sports is based. Accordingly, there is a monotonic relationship between expertise and cumulative hours in deliberate practice activities, engaged with the primary intent of performance improvement. Although Ericsson

originally made specific reference to the solitary nature of deliberate practice (see also Ericsson, 2014), a number of sports' expertise researchers showed similar positive relationships between performance attainment and accumulated hours in both team and individual practice activities (e.g., Ford & Williams, 2012; Helsen, Starkes & Hodges, 1998; Hodges, Kerr, Starkes, Weir & Nananidou, 2004; Ward, Hodges, Starkes, & Williams, 2007; Starkes & Hodges, 1996; Zibung & Conzelmann, 2013). In recent years, the deliberate practice framework has been scrutinized by expertise researchers, particularly in sports (e.g., Côté, 1999; Côté, Baker, & Abernethy, 2007; Côté, Murphy-Mills, & Abernethy, 2012; Hambrick et al., 2014; Macnamara, Hambrick, & Oswald, 2014). Recent meta-analyses have shown that hours spent in practice activities have only accounted for 18% of the variance in sport expertise (Macnamara et al., 2014). Further, within groups of elite athletes, accumulated practice only accounted for ~1% of the variance in skill (Macnamara et al., 2016).

It has been argued that the requirement of deliberate practice can be circumvented by participation in other, potentially related, sports during childhood (5-12 yr) or by participation in play-type activities rather than formal, structured practice (e.g., street soccer/hockey, Côté et al., 2007, 2012). A strong view is that play-type activities and diversified sport experiences during childhood circumvent the need for deliberate practice and that they are necessary for the development of sport expertise (e.g., Côté et al., 2012; Côté & Hancock, 2014).

The Developmental Model of Sports Participation (DMSP; Côté, 1999; Côté, et al., 2007) offers a framework for describing and studying sport expertise, highlighting childhood (5-12 yr) as an important time period for long-term athlete development and continued engagement in sport (see Côté, et al., 2012). Accordingly, there are two primary pathways towards sports' expertise: (i) early specialization, involving high volumes of domain specific deliberate practice

in one sport from an early age and (ii) early diversification, involving participation in a variety of different sports and play activities during childhood and later specialization. We also advocate that a third pathway should be considered, that is a less extreme version of the "specialization" pathway. This third pathway is in line with what has been termed "the early engagement hypothesis" (Ford et al., 2009). Because children at an early age may spend the majority of their time within one sport, but not at the exclusion of any others (which is the extreme version of the early specialization route), this route likely captures expertise in many sports. In addition to skill impediments to playing at a high level after a late entry, political or social barriers often prevent later involvement. For example, in sports such as soccer and field hockey, although exclusive specialization in the main sport may not have been until adolescence (e.g., in German field hockey, this was ~15 yr for the Olympic team), athletes had started to play field hockey at the age of 5 yr (Güllich, 2014). In soccer, age of engagement for successful players is routinely about 4-5 yr, but the players continue to engage in other sports throughout their childhood into adolescence (e.g., Ward et al., 2007).

Considerable debate exists as to which pathway is most beneficial for the attainment of sport expertise and related, positive youth development (e.g., Côté et al., 2012; Ford et al., 2013). Some researchers claim distinct benefits from sampling a variety of different sports and play experiences during childhood that are associated with future success, motor skill acquisition, decreased risk of drop-out or injury (e.g., Baker, Côté, & Abernethy, 2003; Côté et al., 2007, Côté, Lidor, & Hackfort, 2009) and potentially increased intrinsic motivation (Côté et al., 2009, 2012). In a recent comparison of international athletes, those who had medaled at international competitions had spent more time engaging in sports other than their primary sport in comparison to non-medalists (Güllich, 2016). Others present evidence to show that early

specialization in the primary domain frequently defines individuals who attain success, based on retrospectively collected developmental reports (e.g., Ford & Williams, 2012; Hodges et al., 2004; Ward, Hodges, Starkes, & Williams, 2007; Zibung & Conzelmann, 2013) and that time in other sports or in play-type activities fails to differentiate across skill groups or predict future motivation type (e.g., Hendry et al., 2014; Ward et al., 2007).

These apparently contrasting findings detailed above may be related to several factors. For example, sports such as gymnastics and ice skating, which have an early age for peak sport attainment, demand engagement in an early specialization pathway (Côté, Ericsson, & Law, 2005). Conversely, there is evidence of talent transfer programs which take adult athletes from one sport and "transfer" them into another due to a high emphasis on specific anthropometric or physiological capacities (e.g., from 100 m sprinter to the winter Olympic sport of skeleton; see Bullock et al., 2009). In sports such as men's soccer, where the participation base is large and the opportunities to achieve expertise are low (~0.04 % of registered players reaching professional status, FIFA, 2007), there appears to be a greater necessity for early and large volumes of soccer specific activity during development (e.g., Ford & Williams, 2012; Haugaasen & Jordet, 2012; Zibung & Conzelmann, 2013).

Two of the primary elements of both the early specialization pathway and early diversification pathway; practice and play, are important components of the early engagement pathway (Ford et al., 2009). Emphasis is placed not only on early engagement in the primary sport but also engagement in play-type activities (i.e., informal, sport-specific activities that are primarily engaged in for fun, rather than improvement). Evidence in support of this pathway has been primarily from studies of elite soccer players. Elite, male youth soccer players engaged in more soccer specific practice and more informal "play" activities during childhood than non-elite

youth players (Ford, Ward, Hodges, & Williams, 2009). Follow-up of the elite players showed that only time in domain-specific play during childhood distinguished between players that later achieved a professional contract at age 16 yr from those that did not (Ford et al., 2009). Considering the implications of these ideas for formal versus informal practice time during childhood, additional verification of these findings is important.

Distinctions between what has been considered play and practice have sometimes been blurred across studies. For example, elements of play can be included in practice and vice versa (e.g. free play during practice and individual practice during play time). Some authors have attempted to retrospectively measure play and practice amounts based on whether activities were engaged in for fun or improvement (e.g., Ford & Williams, 2012; Ward et al, 2007). In the DMSP, Côté and colleagues (Côté, 1999; Côté, et al., 2007, 2012) have argued that engagement in fun, play activities defines a positive, development route. However, retrospectively assessing time spent in activities that are primarily engaged in for fun or improvement is problematic, particularly when based on retrospective, survey methods (Côté et al., 2005). Hence, in the current paper, we distinguish formal soccer practice, defined as structured, coach or adult-led soccer activities, mainly directed to skill improvement (such as drills, small-sided games), from play, defined as unorganized, self-led soccer activities conducted without a coach (including fun games, general kick around or individual play/practice). These distinctions allow athletes to recall activities spent in and outside of formal/organized practice. This is arguably easier, more reliable and potentially of more direct relevance to athletes and parents in helping determine "optimal" amounts of coach-structured practice than judging whether a past activity was engaged in for fun. However, a potential conceptual limitation of this approach is what is judged as "play" will likely include some activities that constitute practice.

Being retained by (or brought into) a professional soccer academy at the age of 16 yr has been used as a benchmark of success in UK soccer and as evidence of adult 'expertise' (Ford et al., 2009; Ford & Williams, 2012). However, this method has been criticized due to its relatively early age of assessment and the finding that many of the players that achieve this milestone, do not go on to play first team, professional soccer (Swann, Moran, & Piggott, 2015). The transition from receiving a professional youth team player contract to establishing playing time in the club's first team(s) as an adult can be extremely difficult (e.g., Cook, Crust, Littlewood, Nesti, & Allen-Collinson, 2014).

In the following study, we tracked elite youth soccer players over a 5 year period to determine how well their developmental practice and play activities (collected between ages 13-15 yr) discriminated later attainment of a professional contract at age 17 yr, and later progression to adult, first-team soccer (~20 yr). This type of extended follow-up into adult-professional soccer has not been conducted. The advantage of this design is that we have data from individuals that are typically excluded from analysis of solely "expert" groups (i.e., those who drop out or are forced to leave). We additionally collect practice data from the youth professional players (at age 17 yr), such that practice activities can be tracked at two time points to evaluate how well more recent estimates predict later adult success in comparison to childhood estimates. Because of the elite nature of our sample, we are able to make more refined, within skill-class comparisons concerning success, rather than the more typical between skill class comparisons (i.e., expert-novice) where differences in practice activities are almost always demonstrated.

Based upon previous research (e.g., Ford et al., 2009; Ford & Williams, 2012; Rees et al., 2016), we expected that future professional players would show early engagement in their sport, but not early specialization as defined by exclusivity of soccer, and more hours in practice and

play during childhood than those not selected as youth (~17 yr) or adult professionals (~20 yr). Because sport-specific play hours had differentiated future successful players from non-successful (released) players in an earlier study with English soccer players at age 16 yr (Ford et al., 2009), we expected sport-specific play hours to discriminate the professional players from the non-professional players. We did not know whether this variable would distinguish at a more elite level, between the Youth-professional only and Adult-professional groups. With respect to early childhood sporting diversity, our predictions were mixed. In line with predictions from the DMSP, more sports engaged in childhood should engender general sport-related competences which would be related to later success. However, in past work with elite soccer players, these groups have been characterized by relatively low amounts of sporting diversity (e.g., Ward et al., 2007). As such, there was also reason to suspect that diversity would be inversely related to successful skill/age-group progressions.

Methods

Participants

Male, elite youth soccer players (N = 102, born in 1996/1997), were recruited from the youth academies of five professional soccer clubs competing at the highest level of youth soccer in Scotland. These players were followed up within the academy system up to 5 years after initial data collection to determine successful age-group progressions onto youth-professional and adult-professional contracts. At T1 (Oct. 2011), players were aged 13-15 yr (M = 14.85 yr; SD = .63) but all were playing at the U15 age group, albeit some players were still eligible to play U14. This sample was drawn from a larger cohort of players (U13-U17 yr), reported in a previous paper (Hendry et al., 2014).

At T2 (May 2014), players were now 16-18 yr (M = 17.34 yr, SD = .69) and eligible to receive a full-time (youth) professional contract. Players that received such a contract we termed "Professional-youth" (n = 26) and those players which did not we termed the "Academy-only" group (n = 76). These latter players were subsequently deselected from their respective academies between T1 and T2 and no further data were collected on these players (although we know that no players from this group progressed to Adult-professional status at T3). At T3 (Oct. 2016), the remaining players were now 19-20 yr (M = 20.56 yr, SD = .61) and were further delineated based on whether they had been selected to play first-team, adult soccer in the UK, what we termed "Adult-professional" (n = 9). Therefore n =17 of the youth-professional sample were not successful at the adult level, termed "Youth-professional only". No data were collected from youth-professional players that had entered the Academy system after T1 data collection. There were no between group age differences at T1, $F<1$ (i.e., Academy-only, Youth-professional only or Adult-professional).

Participants were recruited and procedures approved in accordance with the ethical guidelines of the University of British Columbia. Parents provided informed passive consent for their sons to complete questionnaires before players' gave written informed assent. At the time of initial data collection, consent was obtained to follow-up players at later time points.

Procedure

At T1 and T2 separately, participants completed a demographic and retrospective developmental practice activity questionnaire. The T2 questionnaire focused primarily on the developmental activities engaged in by participants between T1 and T2 (~2.5 yr). Academy-only players did not complete the questionnaire at T2 since they were no longer within the Academy system. At T3, only information about success as an adult professional was recorded.

Information regarding successful transitions to the youth and adult professional levels was collected from the academy directors and coaches from participating clubs (who were contacted individually at separate time periods). At the initial data collection period, participants agreed to be contacted again for future follow up. To aid convergent validity, a sample of parents (T1, n = 15; T2 n = 4) provided estimates of soccer practice and play using the same practice history questionnaire as their sons. Similarly, coaches (n = 8) provided estimates of hours/week in a typical weeks' organized practice session at T1 and T2 (see Hopwood, 2015 for recommendations regarding these validation methods).

Measures

Practice Questionnaires

A developmental activity questionnaire adapted from previous research and the Participation History Questionnaire (PHQ, e.g., Ford, Low, McRobert & Williams, 2010, Hodges et al., 2004) was used to gain sport and soccer specific practice activity data. This retrospective, survey method remains one of the best available method for collecting practice history estimates from elite athletes (see, Hopwood, 2015). Basic demographic information relating to participants' date of birth, start age in soccer and the academy system were first ascertained.

Estimates of time spent in soccer activities across athlete's careers were collected in table format. Operational definitions and examples of organized practice and play were provided and explained. Practice was defined as activities conducted with a coach/adult used mainly to improve skills. Play was defined as unorganized, self-led activities not conducted with a coach/teacher. Players recorded: (i) number of organized practice sessions/week, (ii) average length of each session and (iii) hours/week in soccer play. These estimates were for a typical

week/training session and were solicited from 5 years of age to present in 2-year intervals (i.e. 5–6 yr, 7–8 yr, etc.). Significant breaks from soccer were also recorded. Linear interpolation was used to estimate data during intervening years to enable calculation of accumulated hours in practice and play. Accumulated hours in practice during childhood were calculated by multiplying the number of hours/session by the number of sessions/week. This figure was multiplied by the number of weeks of practice/year (~46 weeks in a typical season), subtracting reported weeks lost through illness/injury. This procedure was repeated for soccer play.

In a separate section of the questionnaire, indices of sporting diversity were ascertained. Players first indicated the number and type of other sports engaged in during childhood (from 5 yr – 12 yr). In addition to providing information about start and end age in these sports, players were also asked to provide estimates of average practice hr/week for up to a maximum of 5 sports, which included soccer, for two-time periods (5-8 yr and 9-12 yr). Because separate estimates of hr/week in soccer practice were given within the same questionnaire, these data provided a measure of intra-person reliability (what we refer to as player-player reliability). However, we acknowledge that players may have recognized their previous answers, which could artificially increase player-player reliability. We also used data from these questions to determine age of specialization or majority engagement in soccer.

The questionnaire used at T2 consisted of the same demographic and developmental soccer activity questions as T1 (from the first sections only), but differed in that data were only collected in yearly intervals from the end of T1 to T2.

Statistical analyses

Reliability and validity

Intra-class correlations (ICCs) provided a measure of strength of the association between two measures and percent agreement (PAs) was also calculated to provide a measure of similarity. These were based on methods recommended by Atkinson and Nevill (1998) and Hopwood (2015). Player-player reliability of practice estimates were calculated based on comparisons of accumulated practice hours across the two sections of the questionnaire. Estimates derived from the soccer practice history tables, where data was collected in 2 yr intervals, were compared to estimates from a separate section where data was ascertained pertaining to 4 year time spans (5-8 yr, 9-12 yr). We did expect some variation here due to the fact that players were providing only one average value for longer time periods in this second section. Player-player reliability for practice and play during the overlapping time period between T1 and T2 was also calculated for the Professional-youth players (n=26) who had completed questionnaires at each time point. Player-parent estimates of accumulated hours in soccer activities (practice and play), and player-coach estimates of weekly practice were analyzed at T1 and T2.

Group differences

We used a difference-based ANOVA approach, rather than prediction based, logistic regression analysis due primarily to differences in sample size between the groups and associated issues in testing against the null hypothesis based on expected probabilities. The data were checked for normality using the Shapiro-Wilk test. When the magnitude of skewness was less than 1, indicating only a tendency towards positive skewness (Bulmer, 1979), and there were no significant differences in homogeneity of variance between the groups, we used parametric methods for our analyses based upon the robustness of this technique to violations in normality (Glass, Peckham, & Sanders, 1972; Pallant, 2007). In cases where assumptions were not met,

(number of other sports, accumulated hours in play and practice up until T2 for the Professional-youth groups), we performed a log transformation to normalize these data. This allowed us to continue with parametric based methods, particularly more powerful, pre-planned orthogonal group contrasts. The first contrast allowed us to compare Academy-only to the Professional-youth group. For the second contrast, the two professional groups (Youth-professional only and Adult-professional) were compared to each other (see Figure 1 for illustration of analyses). Cohen's d and partial eta-squared (η_p^2) are provided as measures of effect size for between group comparisons. Statistical analyses were conducted using IBM SPSS version 22.

Stage 1

Our primary analyses were designed to determine whether childhood practice and sport-specific play estimates (collected at T1), as well as sport-specific demographic information related to start age and sport involvement, were related to eventual expertise at T3 (Academy only, Youth-professional only, Adult-professional). We refer to this as our Stage 1 analysis and we have illustrated the two stages of our analysis in Figure 1.

We first used MANOVA to assess for overall differences between the groups for a) Soccer Milestones; including start age in soccer and start age in the academy system, and b) Soccer Activities; including accumulated hours in soccer play and practice. Significant group effects from the MANOVA were followed up with preplanned contrasts based on univariate ANOVAs. We also used separate preplanned group contrasts to compare the proportion of time accumulated in soccer play during childhood. Our rationale for including this relative measure, rather than just relying on absolute practice/play amounts, was based on the fact that this variable normalizes across overall practice volume and provides a standard assessment of play versus

practice time. This allows consideration of whether formal versus informal soccer activity ratios also vary as a function of later skill attained.

With respect to sporting diversity, two analyses were conducted. The number of sports participated in during childhood were compared across the 3 groups in a univariate ANOVA and a 3 Group X 2 Age period (5-8 yr, 9-12 yr), mixed design ANOVA was used to compare average estimates of hours/week in practice across all reported sports (other than soccer). Again, preplanned contrasts were used to test group effects. We provide only descriptive statistics pertaining to age of majority engagement in and specialization in soccer, due to fact that there was little variation in these measures.

Stage 2

We also studied differences between soccer activity estimates collected up until T2 between the Youth-professional only and Adult-professional groups, which were the only two groups that had practice data from both these time points. Following MANOVA, independent t-tests were conducted to test for group differences on each variable (practice and play), as well as proportion of time in play.

Results

Reliability and validity

Player-coach reliability measures pertaining to soccer practice hours were high at T1 (*PA* = 91.44%, *ICC* = .90, $p < .001$) and T2 (*PA* = 94.12%, *ICC* = .94, $p < .001$). At T1, player-player estimates of time in practice (from estimates within the same questionnaire) were moderate (5-8 yr, PA= 69.8%, ICC =.50, $p < .05$; 9-12 yr, PA= 72.7%, ICC =.65, $p < .05$). When we compared across questionnaires, from T1 and T2 for the overlapping year the reliability indices were high (practice, *PA* = 94.80%, *ICC* =.92, $p < .001$; play, *PA* = 83.43%, *ICC* = .86, $p < .001$). Player-

parent estimates of accumulated hours in T1 practice (*PA* = 62.31%, *ICC* = .60, *p* = .01) and play (*PA* = 58%, *ICC* = .62, *p* = .01) were moderate at T1 and high at T2, for both practice (*PA* = 82.46%, *ICC* = .85, *p* = .01) and play (*PA* = 74.0%, *ICC* = .70, *p* = .01).

Between group comparisons

Stage 1

Average data showing start ages in soccer and in the academy system as a function of group are displayed in Table 1. The MANOVA analysis based on these start ages showed general group differences accounting for ~10% of the variance, $F(4, 196) = 3.73$, $p < .01$, Wilks' $\lambda = .81$, $\eta_p^2 = .10$. Pre-planned comparisons showed that Academy-only players started later in the academy-system than the professional groups ($p < .01$, $d = 1.04$) but there were no differences between Adult- and Youth-professional only groups ($p = .64$, $d = .07$). The groups did not differ in terms of initial start age playing soccer.

With respect to accumulated hours in childhood soccer activities (play and practice), also shown in Table 1, overall group differences were observed at the $p = .05$ level, $F(4,196) = 2.34$, Wilks' $\lambda = 91$, $\eta_p^2 = .05$. For illustration, we have provided Figures for practice and play comparing accumulated hours across the ages and three groups (see Figure 2a & b). The professional groups (Youth and Adult) had accumulated ~300 more hours in practice during childhood than the Academy-only players. Preplanned contrasts confirmed this effect statistically ($p = .01$, $d = .60$) but there were no practice differences between the two professional groups. Although play estimates were higher for the Adult-professional group (~700 hours more than both the Academy-only and Youth-professional only, see Table 1 and Figure 2b), there was significant variation between athletes in each of the groups such that there were no significant group effects at contrast 1 ($p = .30$, $d = .02$) or contrast 2 ($p = .14$, $d = .71$). There was also no

difference in the relative proportion of time in play versus practice during childhood (between 51% and 59% of overall time spent in play versus practice for all groups).

For the log transformed, number of sports engaged until age 12 yr, there were no significant differences between groups for either contrast (overall ANOVA, $F(2, 99) = 2.05$, $p = .13$, $\eta_p^2 = .04$; contrast 1, $p = .07$, $d = .05$; contrast 2, $p = .78$, $d = .02$). The non-transformed data are displayed at the end of Table 1, showing general engagement in ~4-5 other sports. Estimates of average hours/week in other sports (summed across all reported sports) from 5-8 years and from 9-12 years are also shown in Table 1, along with hours/week in soccer activities reported for these same time periods, for comparison only. A mixed design ANOVA revealed no group differences in hours/week in other sports across both time periods, $F(2, 99) = 1.56$, $p = .23$, $\eta_p^2 = .06$; contrast 1; $p = .09$, $d = .07$; contrast 2; $p = .34$, $d = .03$. Participants engaged in fewer other sports from 5-8 yr than 9-12 yr, $F(1,100) = 13.64$, $p < .001$, $\eta_p^2 = .15$, but this did not interact with group, $F(2,99) = 1.37$, $p = .21$, $\eta_p^2 = .04$.

Less than 10% of the total sample specialized in soccer exclusively from childhood through to adolescence. No Adult-professional players specialized in soccer and only 2/17 (12%) of the Youth-professional only group specialized. Apart from 4 athletes (<5% of the sample, of which only 1 progressed to Youth-professional), players spent the majority of their time in soccer during childhood (than in other sports). Players spent ~6 times more hours in weekly soccer practice (~3 hr) from age 5-8 yr than the next most popular sport (~.5 hr), and almost 5 times as many hours in soccer practice (~7 hr) as the next most popular sport from age 9-12 yr (~1.5 hr). The type of sports engaged by participants was quite varied, ranging from golf to boxing.

Stage 2

We calculated practice and play estimates across the careers of the players (up until T2) for the professional groups. These data are shown in the middle of Table 1. Based on an overall MANOVA, the groups were not differentiated with respect to accumulated hours in all career soccer activities, $F(3, 22) = 2.02$, $p = .14$, Wilks' $\lambda = .78$, $\eta_p^2 = .22$. However, separate analyses on practice and play showed that although the two groups did not differ with respect to practice hours, $t(24) = .14$, $p = .89$, $d = .06$, they were differentiated with respect to sport-specific play, $t(24) = 2.37$, $p = .03$, $d = 1.00$. The Adult-professional group reported more time in play and they also spent relatively more time in play than practice than the Youth-professional only group, $t(24) = 2.13$, $p < .05$, $d = .93$.

Discussion

Based on a combined retrospective and prospective study of elite-youth male soccer players in the UK, we evaluated the relative importance of developmental soccer activities engaged in during childhood and adolescence and their relationships with attainment of youth and adult professional status. This research was conducted in reference to models of youth-sport development, particularly the DMSP and postulates emanating from this model with respect to practice, play and specialization. We were interested in the role of informal, self-led "play" activities in childhood (within the primary sport) in comparison to more prescribed, organized practice, for determining later soccer success. Analysis of variables related to start age, majority engagement in soccer, and assessment of sporting diversity during childhood allowed additional insight into the role of early sport engagement in later success at the adult level in soccer.

Professional-youth players (~17 yr), accumulated more hours in organized practice, but not play, during childhood than Academy-only players. For athletes that attained Adult-

professional status (~20 yr), although small in numbers, this group had accumulated more hours in play (up until T2) than the Youth-professional only group. In addition, the Adult-professional group engaged in high volumes of domain specific practice from an early age (i.e., majority engagement), gained early entry into an elite academy and participated in a moderate number of other sports during childhood. In this sense, Adult-professionals potentially received benefits from both the broad base "sampling/play" approach advocated by Côté and colleagues (2007, 2012) as well as the sport-specific performance and learning benefits specified in the early engagement hypothesis (e.g., Ford et al., 2009; Ford & Williams, 2012; Roca, Ford, McRobert, & Williams, 2013; Roca, Williams, & Ford, 2012). This combined retrospective and follow-up approach fills a gap in the extant literature, allowing better identification of the consistencies in the developmental trajectories of expert performers across key time periods. One benefit of this approach is the inclusion of data from unsuccessful groups of players which are typically not captured when practice estimates are only gained from current elite players.

Notably, few participants met criteria pertaining to either a specialization/practice or a sampling/play pathway, as outlined in the DMSP. Rather, participants engaged in high volumes of soccer practice from an early age through adolescence but also participated in several sports other than soccer and partook in high volumes of sport-specific play (particularly after age 10 yr). These results are more consistent with the early engagement hypothesis and supported by other soccer expertise research (e.g., Hornig, Aust, & Güllich, 2016; Rees et al., 2016; Zibung & Conzelmann, 2013). Consequently, we recommend that a third pathway be considered within the DMSP framework, which is based on early and majority engagement in a primary sport, but not exclusive engagement as implied by the specialization route. In fact, less than 10% of the sample truly specialized in one sport based upon this exclusive definition outlined within the DMSP, and

none of those players progressed to Adult-professional status. Professional players (Adult & Youth) participated in several different sports during childhood, speaking to a diversified involvement among all players. However, the reported average hours/week in these other sports were ~1-3 hours, compared to ~4-8 for soccer (based on similar 5-8 yr and 9-12 yr time periods respectively). Across all groups, the type of sporting activity varied considerably across participants. Despite our data being limited to soccer, we argue that a blended, early-engagement approach, including elements from both pathways outlined in the DMSP, is likely applicable to other sports where early engagement is a necessity to remain competitive, often due to the popularity of that sport for a culture and hence a large participation base.

Several conceptual mechanisms have been forwarded to explain the importance of play in the development of expertise related to benefits of implicit learning (Masters, Poolton, Maxwell, & Raab, 2008), non-linear pedagogies (e.g., Chow, Davids, Renshaw, & Button, 2013), and the development of creativity (Memmert, Baker, & Bertsch, 2010; for a review see: Côté & Erickson, 2015). From these data we are unable to specify what types of activities that players engaged in during sport-specific play. It is of course possible that play time at these youth elite levels merely afforded the athlete a way to accrue extra practice and as such it is the volume, rather than the type that is the critical variable. When looking at the relative proportions and total activity amounts in Table 1, it can be seen that this is indeed a possibility as the Adult-professional players spent ~59% of their time in play activities and organized practice hours did not distinguish the groups.

Notably, our definition of play was based on distinguishing formal (structured/externally-directed) practice hours from more informal (unstructured/self-directed) activities. We did not isolate activities primarily engaged in for fun, from those engaged in for improvement, although

fun games/kick around were provided as examples of "play" activities in the questionnaires. This differs from Ford et al. (2009), who specified "fun" as a defining characteristic of play, along with the self-directed nature of the activity (based on DMSP, Côté et al., 2007, 2012). Despite differences in terminology, our practice and play hours were similar to those obtained from English soccer players (Ford et al., 2009), suggesting that the addition of "fun" did not impact estimates of play and that the distinction between self and coach led hours might be driving these differences in activity. Given the age of the children and primary time span under investigation, it is unlikely that self-initiated activities in early childhood (i.e., before 12 yr) are not engaged in primarily for fun. The types of activities that make up play will most likely be a product of the constraints on the child, such as the availability of a yard or nearby park, a flat(ish) surface, siblings/neighborhood peers, school playground conditions and climate.

Early recruitment into a professional soccer academy (within one's country of origin) is an important factor in achieving success at the youth level, which effectively acts as a precursor to adult professional status (Le Gall, Carling, Williams, & Reilly, 2010; Meylan, Cronin, Oliver, & Hughes, 2010; Zibung & Conzelmann, 2013). This apparent advantage for players entering the UK academy system early (when comparing Academy-only and professional groups) could be viewed positively in that the developmental soccer philosophy of the club and/or country is successful in developing and producing players. Conversely, this could be viewed as an organizational or social bias towards players that have been within the system for a prolonged period and exhibit most strongly the behaviors valued within the system (Cushion & Jones, 2012). Based on the current data, we are unable to ascertain the degree to which the players' expertise was a cause or consequence of this extended practice and exposure. It may be that the "best" players were selected into the Academies early because they were the most "talented" and

that future success reflects this initial talent. Likely there is some interaction between both factors (i.e., initial early prowess/evidence of skill and extended exposure to quality practice; see Boccia, Rainoldi, & Brustio, 2017). In looking at the distributions of birthdates (not included in the results), there was some indication that selection into the Academies and later retention within the professional system was aided by factors related to early birthdate (including physical maturity), referred to as the relative age effect (for discussions of these effects in sport see Cobley, Baker, Wattie, & McKenna, 2009; Helsen et al., 2012; Votteler & Höner, 2017). Compared to an expected 25% based on birthdate distributions across four quartiles, 47% of the Professional-youth players were born in the first quarter of the selection year (Jan-Mar), and this was 33% for the Academy-only and Adult-professional players. This might suggest a relative age effect towards more physically mature players at the professional youth level, but diminishing early age benefits in terms of success as an adult (for similar age-related pattern in German soccer see Votteler & Höner, 2017).

In addition to potential strengths of conducting a prospective study, there are some methodological limitations with our study. While the athletes' developmental profile aligned with those reported in other studies (~5000 hr, Ford et al., 2012, 2009; Hornig et al., 2016; Zibung & Conzelmann, 2013), the developmental pathway of players who progressed to a professional status might still just reflect unique features of the cohort. This is further compounded by the relatively small number of players that progressed to professional status (both at the youth and adult level), which causes issues for both power and external validity. Despite these concerns, we would argue that the elite status of our group, the retrospective and prospective design and the natural attrition associated with elite youth development in soccer helps to underscore the validity of the methods and subsequent conclusions derived from these

data. Although less than 10 % of participants made it to the adult professional level, data suggest that less than 20 % of current European first team squads are comprised of academy players across multiple age groups (Poli, Ravenel & Besson, 2015). Thus, to have this number in our sample at U15 yr progress to professional adult status is likely quite reflective of what is typical in elite professional soccer where adult players are brought in to clubs from other academy systems across their own country as well as from different countries.

There are also potential issues associated with retrospective recall of practice activities, even though our questionnaires have received previous validation (Hodges, Huys, & Starkes, 2007; Hopwood, 2015) and steps were taken to validate these estimates in the current study. In comparison to many studies relying on this retrospective technique, players in the current study were still children at the time when estimates were collected. Therefore, these individuals were questioned about ages that were in close proximity to their current age (at both T1 and T2). Although activity estimates were collected via questionnaires, they were administered in an environment that was facilitated by the study-team in order to overcome potential issues from collecting such data from children. Both parent and coach estimates corroborated estimates given by the children (being moderate to high), although the strength and similarities were higher for formal practice hours rather than play hours and for more recent estimates. Player-player estimates from different sections of one questionnaire and across different time points were all moderate to high in terms of similarity and strengths. Moreover, there was no reason to suspect group differences in recollection/estimates, given that the sample was relatively homogenous in terms of age and experience at T1.

One of the strengths of our study was that we determined adult success at ~20 yr, based on match play in the first team of a professional soccer club in the UK. In prior work, age 16 yr,

when players received professional youth contracts, was taken as an indicator of "adult" success. Although there is the possibility that some players will still progress to achieve adult professional status after our cut-off date (Oct., 2016), we know that no players from the original Academy-only group progressed to Adult-professional status at T3. Although continued follow-up of all players from the original sample (n = 102) at age 25-26 yr would be one way to better check adult success, it is unlikely that any more, or more than 1 or 2 would make it into this elite, adult sample. A more likely scenario is that some of the original sample would no longer be playing first team professional soccer, thus decreasing our sample size from n = 9, causing issues for further analyses. In future work, one way to potentially increase sample size and get a better understanding of pathways to success, would be to measure practice history profiles of new players at each stage of follow up as well as to find a way to track players which get deselected.

In summary, players that transitioned to adult-professional status from early youth elite levels gained early entry into a soccer academy, engaged in high volumes of soccer specific practice and play activities throughout their youth careers (defined by majority engagement in soccer from childhood), and participated in several sports other than soccer during childhood. Thus athletes that successfully transition to adult professional soccer are best characterized by an early (majority) engagement pathway (Ford et al., 2009). This hybrid pathway, incorporates aspects of both deliberate practice and deliberate play models. What is different is that the player starts in their "selected" sport early in childhood and although not specializing in one sport, they devote the majority of their time in this sport during childhood. They also engage in high amounts of deliberate play in this sport in addition to practice during childhood. Notably, accumulated hours in soccer play did not distinguish Academy-only players from those that received a professional youth contract at ~17 yr. However, when comparing players who further

progressed to the adult professional level at ~20 yr, play hours accumulated in later childhood (>10 yr) did discriminate across groups (both in absolute terms and proportionally relative to practice).

In future work, it will be important to consider how these data generalize to other youth Academy sport systems, where elite athletes are identified at a young age, yet only a restricted number progress into adult elite systems (both in team sports such as rugby or hockey and also individual sports such as tennis). It would also be of interest to identify and compare adult elite athletes who have progressed through traditional (academy) and non-traditional systems to determine what types of activities are potentially compensating for academy-related practice hours and/or show positive transfer.

With respect to models of skill development, the question as to whether emphasis should be placed on early diversified sports experiences and self-led play, outside of more externally-regulated, structured activities for later adult success continues to be debated. When combined with early majority engagement in a primary sport, there may be some potential ancillary benefits of engaging in other sports, but the data in our study do not show any benefits with respect to differentiating adult from youth professionals. Given that players engaged in high volumes of soccer activities from an early age, it appears prudent to advise against participating in other sports at the expense of soccer specific activities, at least if adult success is the ultimate goal. Whether this generalizes to other sports, where participation rates are lower, such as rugby, hockey or even women's soccer remains to be tested. Unstructured, self-led "play" hours in later childhood distinguished across groups at the highest level, suggesting that there is something about these types of activities which is related to elite attainment in sport. However, the Adult-professionals amassed approximately 600 mores hours in soccer activities in general compared to

the Youth-professionals. Thus, there is rationale to argue that play hours simply added to practice volume in a general sense and that the nature of the activity (i.e., self- or externally-led or engaged in for fun or improvement) was of less importance. This may be particularly true for this population whose formal practice hours are highly regulated and hence less likely to show variation between players. Moreover, doing more, including engagement in activities outside of formal, structured practice may just reflect more intrinsically motivated players or players who show greater competence. As such, more hours in play might reflect greater initial prowess and/or high motivation in addition to helping to develop these skills and positive forms of motivation. In future work, there will be a need to better understand the athletes reasons for engagement in self-led play and the specific activities that comprise this category as a function of age of development, perhaps through a combination of diary, questionnaire and interview methods.

References

Atkinson, G., & Nevill, A. (1998). Statistical Methods for Assssing Measurement Error (Reliability) in Variables Relevant to Sports Medicine. *Sports Medicine*, *26*(4), 217–238.

Baker, J., Côté, J., & Abernethy, B. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, *15*(1), 12–25. http://doi.org/10.1080/10413200305400

Boccia, G., Rainoldi, A., & Brustio, P. R. (2017). Relative age effect in males, but not females, undergraduate students of sport science. *Sport Sciences for Health*, *13*(2), 349–353.

Bulmer, M. G. (1979). *Principles of Statistics*. New York: Dover.

Chow, J. Y., Davids, K. W., Renshaw, I., & Button, C. (2013). The Acquisition of Movement Skill in Children through Nonlinear Pedagogy. In J. Côté & R. Lidor (Eds.), *Conditions of children's talent development in sport* (pp. 41–60). Morgantown, WV: Fitness Information Technology.

Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual age-grouping and athlete development: a meta-analytical review of relative age effects in sport. *Sports Medicine (Auckland, N.Z.)*, *39*(3), 235–56.

Collins, D., & MacNamara, Á. (2012). The Rocky Road to the Top. *Sports Medicine*, *42*(11), 907–914. http://doi.org/10.1007/BF03262302

Cook, C., Crust, L., Littlewood, M., Nesti, M., & Allen-Collinson, J. (2014). "What it takes": perceptions of mental toughness and its development in an English Premier League soccer academy. *Qualitative Research in Sport, Exercise and Health*, *6*(September 2014), 329–347. http://doi.org/10.1080/2159676X.2013.857708

Côté, J. (1999). The influence of the family in the development of talent in sport. *Sport*

Psychologist, *13*(4), 395–417.

Côté, J., Baker, J., & Abernethy, B. (2007). Play and practice in the development of sports expertise. In G. Eklund & R. Tenenbaum (Eds.), *Handbook of sport psychology* (3rd ed., pp. 184–202). New York: Wiley.

Côté, J., & Erickson, K. (2015). Diversification and deliberate play during the sampling years. In J. Baker & D. Farrow (Eds.), *Routledge handbook of sports expertise* (pp. 305–316). London: Routledge.

Côté, J., Ericsson, K. A., & Law, M. P. (2005). Tracing the development of athletes using retrospective interview methods: A proposed interview and validation procedure for reported information. *Journal of Applied Sport Psychology*, *17*(1), 1–19. http://doi.org/10.1080/10413200590907531

Côté, J., & Hancock, D. J. (2014). Evidence-based policies for youth sport programmes. *International Journal of Sport Policy and Politics*, *8*(1), 51–65. http://doi.org/10.1080/19406940.2014.919338

Côté, J., Lidor, R., & Hackfort, D. (2009). ISSP position stand: To sample or to specialize? Seven postulates about youth sport activities that lead to continued participation and elite performance. *International Journal of Sport and Exercise Psychology*, *7*(1), 7–17. http://doi.org/10.1080/1612197X.2009.9671889

Côté, J., Murphy-Mills, J., & Abernethy, B. (2012). The development of skill in sport. In A. M. Williams & N. J. Hodges (Eds.), *Skill acquisition in sport: Research, theory and practice* (2nd ed., pp. 269–86). London: Routledge.

Cushion, C. J., & Jones, R. L. (2012). A Bourdieusian analysis of cultural reproduction: socialisation and the "hidden curriculum" in professional football. *Sport, Education and*

Society, *19*(3), 276–298. http://doi.org/10.1080/13573322.2012.666966

Ericsson, K. A. (2014). Why expert performance is special and cannot be extrapolated from studies of performance in the general population: A response to criticisms. *Intelligence*, *45*(1), 81–103. http://doi.org/10.1016/j.intell.2013.12.001

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*.

Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., … Williams, M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, *30*(15), 1–11. http://doi.org/10.1080/02640414.2012.701762

Ford, P. R., Coughlan, E. K., Hodges, N. J., & Williams, A. M. (2015). Deliberate practice in sport. In J. Baker & D. Farrow (Eds.), *Routledge handbook of sports expertise* (pp. 347–363). London: Routledge.

Ford, P. R., Ward, P., Hodges, N. J., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. *High Ability Studies*, *20*(1), 65–75. http://doi.org/10.1080/13598130902860721

Ford, P. R., & Williams, A. M. (2012). The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. *Psychology of Sport and Exercise*, *13*(3), 349–352. http://doi.org/10.1016/j.psychsport.2011.09.004

Glass, G. V, Peckham, P. D., & Sanders, J. R. (1972). Consequences of failure to meet assumptions underlying the fixed effects analyses of variance and covariance. *Review of Educational Research*, *42*(3), 237–288. http://doi.org/10.3102/00346543042003237

Güllich, A. (2014). Many roads lead to Rome - Developmental paths to Olympic gold in men's field hockey. *European Journal of Sport Science, Ahead of P*(0), 1–9. http://doi.org/10.1080/17461391.2014.905983

Güllich, A. (2016). International medallists' and non-medallists' developmental sport activities – a matched-pairs analysis. *Journal of Sports Sciences*, 1–8. http://doi.org/10.1080/02640414.2016.1265662

Hambrick, D. Z., Oswald, F. L., Altmann, E. M., Meinz, E. J., Gobet, F., & Campitelli, G. (2014). Deliberate practice: Is that all it takes to become an expert? *Intelligence*, *45*(1), 34–45. http://doi.org/10.1016/j.intell.2013.04.001

Haugaasen, M., & Jordet, G. (2012). Developing football expertise: a football-specific research review. *International Review of Sport and Exercise Psychology*, *5*(2), 177–201. http://doi.org/10.1080/1750984X.2012.677951

Helsen, W. F., Baker, J., Michiels, S., Schorer, J., Van winckel, J., & Williams, a. M. (2012). The relative age effect in European professional soccer: Did ten years of research make any difference? *Journal of Sports Sciences*, *30*(15), 1–7. http://doi.org/10.1080/02640414.2012.721929

Hendry, D. T., Crocker, P. R. E., & Hodges, N. J. (2014). Practice and play as determinants of self-determined motivation in youth soccer players. *Journal of Sports Sciences*, *32*(11), 1091–9. http://doi.org/10.1080/02640414.2014.880792

Hodges, N. J., Huys, R., & Starkes, J. L. (2007). Methodological review and evaluation of research in expert performance in sport. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of Sport Psycology* (Vol. 53, pp. 161–183). New Jersey: John Wiley & Sons. http://doi.org/10.1017/CBO9781107415324.004

Hodges, N. J., Kerr, T., Starkes, J. L., Weir, P. L., & Nananidou, A. (2004). Predicting performance times from deliberate practice hours for triathletes and swimmers: What, when, and where is practice important? *Journal of Experimental Psychology: Applied*, *10*(4), 219–237.

Hopwood, M. J. (2015). Issues in the collection of athlete training histories. In J. Baker & D. Farrow (Eds.), *Routledge handbook of sports expertise* (pp. 156–165). New York: Routledge.

Hornig, M., Aust, F., & Güllich, A. (2016). Practice and play in the development of German top-level professional football players. *European Journal of Sport Science*, *16*(1), 96–105. http://doi.org/10.1080/17461391.2014.982204

le Gall, F., Carling, C., Williams, M., & Reilly, T. (2010). Anthropometric and fitness characteristics of international, professional and amateur male graduate soccer players from an elite youth academy. *Journal of Science and Medicine in Sport / Sports Medicine Australia*, *13*(1), 90–5. http://doi.org/10.1016/j.jsams.2008.07.004

Macnamara, B. N., Hambrick, D. Z., & Oswald, F. L. (2014). Deliberate practice and performance in music, games, sports, education, and professions: A meta-analysis. *Psychological Science*, *25*(8), 1608–1618. http://doi.org/10.1177/0956797614535810

Macnamara, B. N., Moreau, D., & Hambrick, D. Z. (2016). The relationship between deliberate practice and performance in sports: A meta-analysis. *Perspectives on Psychological Science*, *11*(3), 333–350. http://doi.org/10.1177/1745691616635591

Masters, R. S. W., Poolton, J. M., Maxwell, J. P., & Raab, M. (2008). Implicit motor learning and complex decision making in time-constrained environments. *Journal of Motor Behavior*, *40*(1), 71–9. http://doi.org/10.3200/JMBR.40.1.71-80

Memmert, D., Baker, J., & Bertsch, C. (2010). Play and practice in the development of sport-specific creativity in team ball sports. *High Ability Studies*, *21*(1), 3–18. http://doi.org/10.1080/13598139.2010.488083

Meylan, C., Cronin, J., Oliver, J., & Hughes, M. (2010). Reviews: Talent identification in soccer: The role of maturity status on physical, physiological and technical characteristics. *International Journal of Sports Science and Coaching*, *5*(4), 571–592.

Pallant, J. (2007). *SPSS survival manual: a step by step guide to data analysis using SPSS*. *Step by step guide to data analysis using the SPSS program* (3rd ed.). Sydney: McGraw-Hill.

Rees, T., Hardy, L., Güllich, A., Abernethy, B., Côté, J., Woodman, T., … Warr, C. (2016). The Great British Medalists Project: A Review of Current Knowledge on the Development of the World's Best Sporting Talent. *Sports Medicine*, *46*(8), 1041–1058. http://doi.org/10.1007/s40279-016-0476-2

Roca, A., Ford, P. R., McRobert, A. P., & Williams, a M. (2013). Perceptual-cognitive skills and their interaction as a function of task constraints in soccer. *Journal of Sport & Exercise Psychology*, *35*(2), 144–55.

Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, *30*(15), 1643–52. http://doi.org/10.1080/02640414.2012.701761

Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport and Exercise*, *16*, 3–14. http://doi.org/10.1016/j.psychsport.2014.07.004

Votteler, A., & Höner, O. (2017). Cross-sectional and longitudinal analyses of the relative age effect in German youth football. *German Journal of Exercise and Sport Research*, 1-11.

Ward, P., Hodges, N. J., Starkes, J. L., & Williams, A. M. (2007). The road to excellence: deliberate practice and the development of expertise. *High Ability Studies*, *18*(2), 119–153. http://doi.org/10.1080/13598130701709715

Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, *18*(9), 657–67. http://doi.org/10.1080/02640410050120041

Williams, a. M., Ward, P., Bell-Walker, J., & Ford, P. R. (2012). Perceptual-cognitive expertise, practice history profiles and recall performance in soccer. *British Journal of Psychology*, *103*(3), 393–411. http://doi.org/10.1111/j.2044-8295.2011.02081.x

Zibung, M., & Conzelmann, A. (2013). The role of specialisation in the promotion of young football talents : A person-oriented study The role of specialisation in the promotion of young football talents. *European Journal of Sport Science*, *13*(5), 452–60. http://doi.org/10.1080/17461391.2012.749947

Table 1. Soccer milestones and soccer activity average estimates (and SDs) of accumulated hours during childhood (i.e., until T1) for the Academy-only and the professional (pro) groups (groups determined at T2) and for accumulated hours up until T2 for the Professional-youth group, latterly subdivided into Youth-professional only and Adult-professional (at T3).

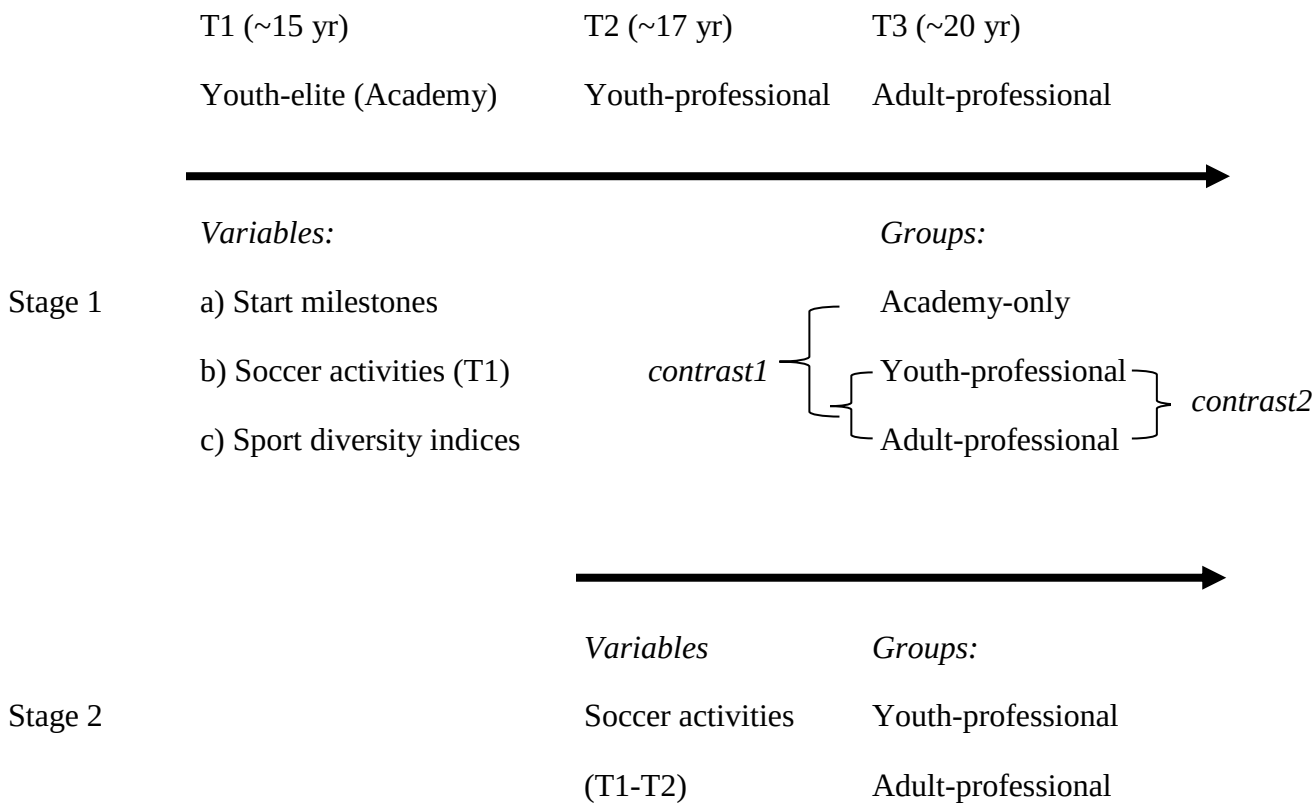
			Professional-youth	
	Academy-only (n = 76)	Professional-youth (n = 26)	Youth-Pro only (n = 17)	Adult-Pro (n = 9)
Soccer milestones (yr)				
Start age in soccer	5.42 (1.63)	5.08 (1.35)	5.18 (1.51)	4.89 (1.65)
Start age in Academy	11.39 (2.09)	9.53 (2.18)	9.59 (2.20)	9.44 (2.24)
Soccer activities				
Accumulated hr until T1				
Practice estimates	1221.73 (523.06)	1529.00 (493.76)	1518.65 (517.64)	1548.56 (474.68)
Play estimates	1736.20 (1221.79)	1945.77 (952.83)	1701.47 (791.47)	2407.22 (1103.09)
% time in play	54.98 (14.87)	54.40 (12.94)	51.84 (12.70)	59.22 (12.71)
Total practice + play	2960.30 (1495.85)	3474.77 (1148.95)	3220.17 (1017.82)	3955.78 (1286.55)
Accumulated hr until T2				
Practice estimates		2710.86 (829.10)	2737.10 (205.03)	2661.28 (281.79)
Play estimates		3127.17 (1426.64)	2688.57 (318.67)	3955.71 (437.97)
% time in play		52.26 (13.05)	48.56 (13.53)	59.26 (9.04)
Total practice + play		5838.03 (1684.61)	5425.67 (1604.99)	6616.99 (1634.74)

Sport diversity indices					
Hr/week					
5-8yr:	Soccer	2.88 (2.18)	4.39 (3.18)	4.63 (3.82)	4.06 (2.49)
	Other sports	1.25 (1.07)	.97 (1.87)	1.06 (1.19)	1.10 (1.87)
9-12yr:	Soccer	6.38 (3.75)	8.34 (5.37)	9.23 (5.48)	7.13 (5.33)
	Other sports	3.83 (3.80)	3.06 (3.17)	3.23 (2.30)	3.50 (3.35)
Total # other sports (range)		5.42 (1-13)	4.27 (1-8)	4.18 (1-8)	4.44 (2-7)

Figure headings

Figure 1: Schematic to show the two stages of analysis designed to discern group based differences based on variables related to soccer milestones related to start age, soccer activity amounts and sport diversity. At Stage 1, two orthogonal preplanned contrasts were conducted to compare i) Academy-only to the two professional groups and then ii) the two professional groups to each other.

Figure 2a&b. Average number of hours accumulated (and between-subject SDs) in a) soccer practice and b) play as a function of skill and age.



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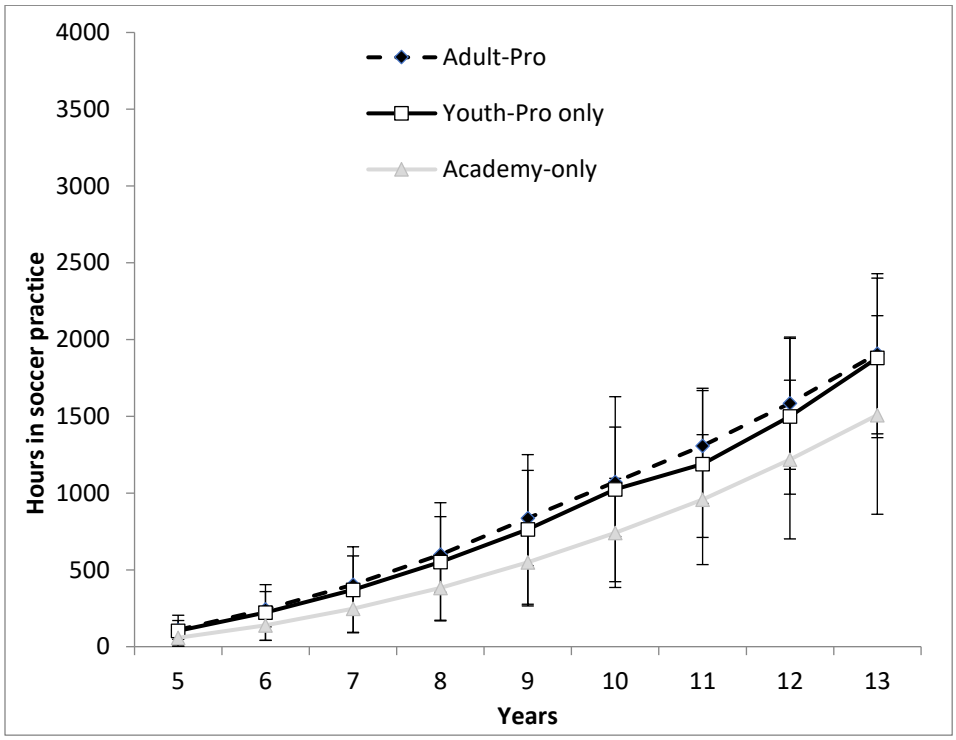
a)



b)