Title of the article:

Progression from youth to professional soccer: A longitudinal study of successful and unsuccessful academy graduates

Short Running Title:

Fitness and progression in soccer

Submission type:

Original article

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Acknowledgments:

The authors wish to thank the players, parents, and coaches from the participating soccer academy for their efforts and co-operation during the data collection of this study. The authors also thank the academy director for his support and assistance throughout the research project. No conflict of interest is reported.

PROGRESSION FROM YOUTH TO PROFESSIONAL SOCCER: A LONGITUDINAL STUDY OF SUCCESSFUL AND UNSUCCESSFUL ACADEMY GRADUATES

Abstract

To optimise use of available resources, professional academies develop strategies to assess, monitor, and evaluate players as they progress through adolescence towards adulthood. However, few published reports exist using longitudinal study designs to examine performance throughout adolescence, and the transition from youth to professional soccer. We examined differences in the age of player recruitment alongside longitudinal performance differences on field-based fitness tests of successful vs. unsuccessful graduates across the entire age spectrum recruited by a professional soccer academy. Altogether, 537 youth soccer players volunteered to participate. We recorded the age of recruitment, biannual fitness test performance, and subsequent success in attaining a senior professional contract at the club across a period of 12 years. Only 53 (10%) of players were successful in obtaining a professional contract, with 68% of players who became professional being recruited at 12 years of age or older. Individuals recruited at an earlier age did not display a higher probability of success in attaining a professional contract. Bayesian regression models reported a consistent interaction between age and group for data on all performance measures. Moreover, "successful" academy graduates only physically outperformed their "unsuccessful" counterparts from age ~13-14 years onward, with either no differences in performance, or, performance on physical fitness tests favouring "unsuccessful" players prior to this age. Findings suggest that high achievers during childhood and early-adolescence may not develop into successful senior professionals, raising concerns about the predictive utility of talent identification models.

Key words: *Longitudinal; paediatric; physical; talent identification; success.*

Introduction

The central goal of soccer academies around the world is to develop talented youth players into valuable and high performing senior professionals.[1,2] In light of the costs and resources needed to run such academies, clubs attempt to develop strategies to assess, monitor, and evaluate players as they progress through adolescence.[3] Subsequently, metrics and data gathered from these strategies are used to support and influence decision making relating to player selection/deselection and subsequent progression throughout the academy system.[4]

A prevalent monitoring and testing strategy used within soccer for both youth and senior populations is physical fitness testing.[5–8] The purpose of such testing is to determine fitness characteristics of athletes relative to the physical demands of their given sport.[9] While the complex and multi-faceted nature of performance limits the value of assessing talent solely upon components of physical fitness,[1,10,11] fitness tests are commonly used within academies in conjunction with subjective game-based and technical evaluations.[1,12]

The potential of using physical fitness tests for the purpose of talent identification and selection/deselection in youth soccer has been extensively examined using traditional cross-sectional designs.[7,13–15] In contrast, scientists have rarely used longitudinal, repeated measures designs to examine how the predictive utility of fitness characteristics may change throughout adolescence. In particular, few have examined the ability of these measures to identify players more or less likely to progress to senior professional soccer.[5,16–18]

Published reports using retrospective designs suggest that players attaining professional contract status physically outperform players attaining amateur status only, particularly in measures of speed, power, and motor coordination.[5,16] Similarly, in their longitudinal, four year study, Mirkov *et al*. (2010)[18] identified similar physical qualities when comparing the prognostic value of physical fitness tests between elite and non-elite youth soccer players. Although these findings highlight the discriminatory utility of physical fitness qualities across adolescence, a limitation is that data were only gathered over a relatively short time, with the emphasis being more cross-sectional than longitudinal in nature.

There have been very few attempts to use longitudinal designs to examine differences in fitness test performance across longer time periods in development.[17,19,20] Emmonds *et al*. (2016)[20] evaluated differences between youth soccer players in England who were successful or unsuccessful in receiving a professional contract at 18 years of age across an 8-year period. The authors reported that successful academy players had better performance scores on the 10m/20m sprint and Yo-Yo intermittent recovery tests when compared with unsuccessful players in the U16 and U18 age groups, respectively. However, the authors reported no difference in performance across tests in age groups prior to U16. In contrast, Gonaus and Müller (2012)[19] and Leyhr *et al*. (2018)[17] report differences between successful and unsuccessful graduates across a range of physical qualities and at various stages of development in professional soccer academies. A compelling finding from Leyhr *et al*. (2018),[17] however, suggests that future successful players from their sample of elite German soccer players already possessed advanced physical capabilities upon entry into the academy, and were able to maintain their advantage over future non-elite players over time.

Soccer academies commonly recruit players as young, if not younger than, 8-9 years of age,[13,21] with a perception that early identification increases the chances of players progressing to senior, professional soccer.[22,23] Therefore, collecting data across an extended time would provide essential information for academics and practitioners when considering talent identification and development approaches.

In this study, we have two aims. First, we investigate differences in age of recruitment and the relative time spent within an academy infrastructure between successful and unsuccessful graduates to professional level. Second, we examine performance differences on field-based fitness tests of successful vs. unsuccessful graduates across the entire age spectrum recruited by a professional soccer academy. We hypothesised that players recruited at a relatively younger age, who spend relatively longer time within the academy infrastructure, would be more likely to progress to professional status. Moreover, we predicted that successful academy graduates would outperform unsuccessful academy graduates across a range of physical fitness tests, and that these differences would be particularly pronounced within older age groups as observed previously.[5,16,20]

Materials and Methods

Participants:

In a longitudinal design (February 2006 until December 2017), 537 youth soccer players (mean ± SD [range]: age 12.4 ± 1.9 [8.0-17.0] years; stature 158.4 ± 14.0 [125.0-193.4] cm; mass 48.2 ± 13.0 [22.4-89.4] kg) with years of birth ranging from 1990 to 2007, volunteered to participate. At the time of data collection, participants were affiliated to a junior-elite soccer academy in the top tier of youth soccer organised by the Scottish Football Association (SFA). Players were recruited to the academy via traditional scouting methods.[1,2] Players were categorised in terms of subsequent career progression, namely, "successful" (n = 53) vs. "unsuccessful" (n = 484) based on whether or not they were offered a professional contract following academy graduation (close of U17 season) at the current club (Scottish Premiership/Championship). Participant and parental/guardian consent was gained alongside providing comprehensive written and oral explanations. The study received institutional ethical approval from the University of Stirling General University Ethics Panel (GUEP).

Procedures:

Participants completed a generic physical fitness test battery twice per year at the beginning of the summer (July/August) and winter (December/January) training periods, starting with the first occurrence following their recruitment to the academy. At each time point, anthropometric (mass, standing stature) and performance (5/10/20m linear sprint, countermovement jump (CMJ), and Yo-Yo Intermittent Recovery Test Level 1 (YYIRT L1)) data were collected from each participant. We gathered the descriptive data (names, D.O.B) for participants from the academy database provided by the Academy Director. To account for circadian variability, we completed test sessions at the same time of day and during regular scheduled training hours.

Test sessions were completed a minimum of 48 hours following a competitive game, and in absence of strenuous exercise within 24 hours prior. We conducted test sessions indoors on a non-slip surface with a temperature of ~22°C. Players received the same standardised warm-up consisting of light aerobic activity, dynamic stretching, progressive sprinting, and sub-maximal jump variations. The research team completed tests were completed in a standardised and progressive order, with each test being progressively more physically demanding than the last one, in order to minimise cumulative fatigue. For the linear sprint and CMJ tests, participants completed three attempts with the best attempt for each distance being analysed.

Anthropometrics

Standing stature was assessed using a free-standing stadiometer (Seca, Birmingham, UK) and reported to the nearest 0.1cm, while body mass was assessed using digital floor scales (Seca, Birmingham, UK) and reported to the nearest 0.1kg.

5/10/20m sprint

Linear speed and acceleration was assessed over a distance of 5/10/20m as per previously reported match-based observations of youth soccer players.[24] Sprint data were collected via the Brower TC Timing System (Brower Timing Systems, Draper, UT), and reported to the nearest 0.01s. Timing gates were adjusted to an appropriate height as per the mean stature of the sample group, and start positions were standardised at 0.7m behind the start gate.[25]

Countermovement jump (CMJ)

We collected CMJ data using the JustJump mat (Probiotics, Huntsville, AL). Participants completed attempts using the arms akimbo position and a self-selected countermovement depth. We disqualified attempts if participants abandoned the arms akimbo position or actively flexed at the knee or hip during flight. For all CMJ attempts, participants performed a ballistic descent-ascent to their self-selected depth. We report data to the nearest 0.1cm via the JustJump handheld unit.

Yo-Yo Intermittent Recovery Test Level 1 (YYIRT L1)

The YYIRT L1 was conducted according to methods outlined by Krustrup *et al*. (2003).[26] We instructed participants to perform the test to exhaustion and they were withdrawn from the test following two consecutive failures to reach the finishing line in time. We recorded the distance covered during the test in metres. Participants were familiarised to the test by at least one pre-test.

Statistical Analysis:

The descriptive statistics associated with the age participants entered the academy and success in obtaining a professional contract at the present club, or being released, are reported as percentages (%). The descriptive statistics of physical test performance and anthropometrics for successful vs. unsuccessful players are presented as means ± standard deviations (SD). The log odds of a player obtaining a professional contract given the year they joined the academy was modelled using a Bayesian logistic regression model with a logit link function. Success in obtaining a professional contract or not (1 = successful, 0 = not successful) was modelled as the dependent variable and age on entering the academy as the predictor.

We calculated probabilities of success for all ages with odds ratios calculated for comparisons between ages.

To determine if physical performance predicted whether a player was successful vs. unsuccessful in being signed to a professional contract by the academy, a series of Bayesian regression models allowing for unequal variances between groups were fitted. We modelled the differences for 5/10/20m sprint, CMJ, and YYIRT L1, along with player stature and mass. Given measurements were made at different ages, age was included as a moderator in all models and centred using 10 years of age as a reference point – the youngest age both successful and unsuccessful players were recruited to the academy.

We calculated a Bayesian version of R-squared (R^2) for each of the statistical models to quantify fit to the data. In addition, direct probabilities of a difference between group estimates and slopes calculated from each model. Bayesian R^2 is a data-based estimate of the proportion of variance explained for new data. We interpreted probability values directly as a percentage chance of a difference in a direction. To illustrate the differences between successful and unsuccessful players at different ages, we used the models to predict each of the measured variables at each age. For example, if the model estimates the successful group to be higher than the unsuccessful group with a prob=0.9, this means there is a 90% chance that this difference is greater than zero and a 10% chance the difference is less than zero. If the model estimates a prob=0.5, this means there is a 50% chance of the difference being above zero, but also a 50% chance of it being less than zero, therefore highly uncertain. We present estimates from the models along with 95% credible intervals (95%CI).

All analyses were conducted using R (R Core Team, 2018) using the 'Bayesian Regression Models using Stan' package (brms: Bürkner, 2017).[27] Stan (Stan Development

Team, 2018), implements a Hamiltonian Markov Chain Monte Carlo (MCMC) with a No-U-Turn Sampler to estimate the intractable integrals necessary to obtain a posterior distribution for the models. All models were checked for convergence ($\hat{r}$ = 1), and graphical posterior predictive checks of the best fitting models were used detect any systematic discrepancies between simulated and observed data.[28]

Results

Age and success

The descriptive statistics suggest that at age 10, more players were recruited into the academy than any other age, with 148 players starting in an academy at this age. Only four 8 year olds were recruited to the academy (the lowest number of recruits for any age group), followed by ten 16 year olds (see **Table 1**).

Of the 537 players, only 53 (10%) players recruited to the academy were successful in obtaining a professional contract. Of the successful players, 68% were recruited to the academy at 12 years of age or older. While those recruited at 16 years of age achieved the greatest percentage of success, only two players from this age group obtained a contract. The age groups with the highest number of successful recruits were 11 and 13 year olds with eleven players successfully turning professional from these age groups.

The Bayesian logistic regression, accounting for unequal variance, predicted how likely players are to successfully obtain a contract given the age they start an academy. Findings suggest that players starting at 16 years are most likely to be successful in gaining a contract (0.17) and those starting at 8 and 9 years the least likely (0.00). However, there is high uncertainty around these predictions given the very wide credible interval for this age group (see **Figure 1**).

Indicators of success

<u>5, 10, and 20m sprints:</u>

Until the age of 14 years, successful players were observed to be slower than their unsuccessful counterparts (see **Table 2**). The results of the Bayesian regression models fitted to determine performance differences between successful and unsuccessful players suggest a meaningful interaction between age and group in explaining sprint times across all sprint distances measured (see **Table 3**).

The regression model for 5m sprint ($R^2 = 0.25$), shows that successful players reduced their sprint time by 0.03 seconds per year (prob>0.99), whereas for unsuccessful players, sprint times reduce by 0.02 seconds per year (prob>0.99). Similar age by group interaction effects were found for 10m sprint ($R^2 = 0.38$), showing that successful players reduced their sprint times by 0.05 seconds per year (prob>0.99), and unsuccessful players by 0.04 seconds per year (prob=0.99). Over 20 metres ($R^2 = 0.59$), successful players reduced their sprint times by 0.11 seconds per year (prob>0.99), and unsuccessful players by 0.10 seconds per year (prob>0.99). Predictions from the regression models suggest that unsuccessful players are initially the fastest over 5, 10 and 20 metres. Nonetheless, from 15 years onwards, successful players perform better at 5 metre sprints, at 16 years onwards for 10 metre sprints, and from 14 years onwards for 20 metre sprints (see **Figure 2**).

<u>Countermovement jump (CMJ) and Yo-Yo Intermittent Recovery Test – Level 1 (YYIRT L1):</u>

The descriptive statistics for CMJ suggest minimal differences between successful vs. unsuccessful players (see **Table 2**). The Bayesian regression model for differences in CMJ height ($R^2 = 0.53$) between successful vs. unsuccessful players suggests a meaningful age by group interaction. The model suggests that the successful group increased jump height by 2.6 cm per year (prob>0.99) compared to the unsuccessful group who increased jump height by 2.4 cm per year (prob=0.90) (see **Table 4**). Predictions from the model suggest that from age 11 years onwards, players in the successful group, on average, outperform those in the unsuccessful group on the CMJ (see **Figure 2**). The descriptive statistics suggest that, from age

13 years onwards, successful players covered more distance on the YYIRT L1 (see **Table 2**). The Bayesian regression model for differences in YYIRT L1 distance (R^2 = 0.47) between successful vs. unsuccessful players suggests a meaningful age by group interaction. The distance covered by successful players increased by 293 m per year (prob>0.99) compared to the unsuccessful group who increased distance by 213 m (prob>0.99) (see **Table 4**). Predictions from the model suggest that while initially players in the unsuccessful group, on average, covered more distance during the YYIRT L1 test than those in the successful group, from age 13 years onward, the successful group outperformed the unsuccessful group (see **Figure 2**).

Stature and Mass:

The descriptive statistics suggest successful players tended, on average, to be taller from 16 years of age. However, prior to that, there was little difference in height between successful and unsuccessful players, or the unsuccessful group were taller (see **Table 2**). The descriptive statistics for body mass for successful vs. unsuccessful players suggest minimal differences. Nonetheless, between the ages 10 to 12 years, successful players tended to be heavier than unsuccessful players (see **Table 2**). The Bayesian regression model for differences in stature (R^2 = 0.75) suggest that the height of successful players in increased by 6.1 cm each year (prob>0.99), whereas unsuccessful players height increased by 6.3 cm (prob=0.82) (see **Table 5**). The model predicts minimal differences in height between successful and unsuccessful players at 17 years of age (see **Figure 2**). The differences in body mass (R^2 = 0.70) between successful and unsuccessful players across ages are equally uncertain (see **Table 5**). Body mass of successful players increased by 5.7 kg each year (prob>0.99), whereas unsuccessful players weight increased by 5.5 kg (prob=0.77). The model predicts minimal differences in mass between successful and unsuccessful players at 17 years of age (see **Figure 2)**.

Discussion

We examined differences in recruitment age and the relative time spent within an academy in groups of successful vs. unsuccessful players; the latter being defined as those who attained a professional contract upon graduation from a professional soccer academy. Also, we examined performance differences on physical fitness tests between successful vs. unsuccessful graduates across the entire age spectrum recruited by the academy. We hypothesised that players recruited at a relatively younger age would be more likely to progress to professional status. We also predicted that successful academy graduates would outperform unsuccessful academy graduates across a range of physical fitness tests, and that within older age groups, these differences are more pronounced.

Our findings revealed that individuals recruited at an earlier age did not display higher probability of success in attaining a professional contract. Moreover, "successful" academy graduates only physically outperformed their "unsuccessful" counterparts from ~13-14 years of age, with no differences in performance or, performance on physical fitness tests favouring "unsuccessful" players prior to this age. It is argued that early recruitment into a professional academy is important when considering absolute outcomes of long-term success in soccer,[22,23,29] however, when considering physical performance characteristics, our findings suggest otherwise. Our findings are in agreement with Hertzog *et al*. (2018)[30] and Güllich (2014),[31] who highlight uncertainty around early recruitment relative to successful transition to senior soccer. While the relatively small sample numbers present at both ends of the age spectrum may have influenced our results regarding successful vs. unsuccessful player outcomes, the fact that the club recruited 68% of successful players within this sample at age 12 onwards provides support for our argument. In line with the changes in physical development experienced throughout childhood and adolescence,[32] as well as non-linear changes in skill and ability,[11,33,34] it may be difficult to identify players until later stages of development.[11,35] Practitioners working within talent identification and development programmes should approach formal testing and monitoring strategies with caution until players reach the age of 13/14 years.

We observed a consistent interaction between age and group (i.e. successful vs. unsuccessful players) for regression models fitted to performance data across all measures. While there were no differences, and on occasion, "successful" players performed worse on physical performance measures than "unsuccessful" players during earlier stages of development, these data suggest that "successful" players develop physical characteristics at a greater rate. Our findings support the premise that physical characteristics substantially develop across adolescence, and, that high achievers during childhood and early adolescence may not translate into successful senior professionals.[21,31]

Of the measures included within this study, performance on the 5m sprint and YYIRT L1 were the best indicators of success in obtaining a professional contract upon graduation. Scientists have previously highlighted the importance of YYIRT L1 and short-distance sprint ability to subsequent contract status in youth soccer players. Deprez, Fransen and colleagues (2015)[36] propose YYIRT L1 performance to discriminate between retained vs. released players from age 11 years onward, and report speed characteristics to influence future professionalism more so than any other characteristic within their comprehensive battery of physical measures. Emmonds *et al*. (2016)[20] report differences in short-distance sprint speed and YYIRT L1 performance relative to subsequent contract status in their group of academy youth soccer players in England. However, differences observed within this sample were only present towards latter years of academy soccer (U16-U18).

The anthropometric measures of stature and mass proved to be the measures least indicative of professional contract status in our study. While anthropometric and morphological characteristics influence recruitment and selection/deselection,[14,37,38] the value of such measures has yet to be fully established. Several authors have reported no differences in stature, mass, or body composition across varied performance levels or between "identified" vs. "unidentified" players.[5,39,40] Consequently, we question the value of using anthropometric characteristics for the purpose of player recruitment. The majority of our sample were recruited to the academy between the ages of 9-11 years, therefore, acute physiological performance may have influenced selection and talent identification during recruitment. Increased physiological performance during childhood and early adolescence is often accompanied by enhanced anthropometric and morphologic characteristics.[6,14,37] While we observed similar interactions to performance measures for stature and mass within this study, these observations were far less substantial, resulting in highly uncertain predictions from the regression models. We encourage coaches and practitioners to question the significance of anthropometric characteristics during adolescence when making decisions around selecting/deselecting players.

We highlight some limitations with our approach. First, while it is appreciated that we examined longitudinal performance using a limited battery of generic physical performance tests, we reiterate the prevalence of this mode of assessment to support and influence decision making related to player selection/deselection and subsequent progression throughout the academy system.[4,16] Undeniably, many unaccounted variables will have affected the success of players within this study, with physical performance being one of many significant contributors to player progression. Therefore, subsequent career progression cannot rely solely on physical performance characteristics. Scientists should consider a more comprehensive array of performance characteristics when seeking to identify more representative indicators of successful player transition from youth to senior level. Similarly, we suggest that researchers should embrace a multi-disciplinary approach by considering the multitude of variables associated with elite soccer performance when considering development activities of youth players. In this study, we gathered data from a single academy. It is well established that academies may hold differing philosophies regarding talent identification and development.[1] Therefore, while our data provide good insights into observed differences in the age of player recruitment alongside longitudinal performance differences on field-based fitness tests, we urge some caution in interpreting the findings. Similarly, it is unknown whether some players within the unsuccessful player group attained a professional contract at another club. Players who progressed to a professional contract elsewhere should be deemed “successful”, however, we do not have access to these data. In future, researchers should attempt to access larger databases, perhaps in conjunction with national associations, as well as simultaneously embracing the need for more objective measures of player performance. Finally, although we observed consistent interactions between age and group across measures, the intervals around our predictions were somewhat large in instances. We suggest that while our findings provide strong evidence for the development rather than early identification of physical characteristics, treating players as individual cases on a player-by-player basis is essential during the development of youth soccer players.

Perspective

Players recruited earlier into the academy did not have a higher success rate than those recruited later during adolescence. Moreover, when compared to their unsuccessful counterparts, successful players generally performed worse on measures of physical performance during earlier years in the academy (age 10-13 years). However, rates of development observed across adolescence were substantially greater for successful players, contributing towards increased performances during transition from youth to senior soccer (age 17 years). Findings support the notion that high achievers during childhood and early adolescence may not graduate into successful senior professionals and raise questions regarding the value of earlier talent identification into the sport.

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Table 1 Percentages of successful vs. unsuccessful players given their starting age.

Age starting academy (years)	*n*	% Successful (*n*)	% Unsuccessful (*n*)	% Players recruited (total)
8	4	0.00 (0)	100.00 (4)	0.75
9	62	0.00 (0)	100.00 (62)	11.55
10	148	7.43 (11)	92.57 (137)	27.56
11	82	7.32 (6)	92.68 (76)	15.27
12	62	16.13 (10)	83.87 (52)	11.55
13	83	13.25 (11)	86.75 (72)	15.46
14	45	13.33 (6)	86.67 (39)	8.38
15	41	17.07 (7)	82.93 (34)	7.64
16	10	20.00 (2)	80.00 (8)	1.86
			Total	100.00

Table 2. Descriptive statistics for 5/10/20m sprint, CMJ, YYIRT L1, stature, and mass for successful vs. unsuccessful players aged 10-17 years.

		Age at test							
		10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years
5m sprint (s)	Successful	1.16 ± 0.10	1.15 ± 0.09	1.11 ± 0.07	1.06 ± 0.06	1.03 ± 0.07	1.02 ± 0.07	0.99 ± 0.07	0.96 ± 0.07
	Unsuccessful	1.12 ± 0.07	1.11 ± 0.07	1.08 ± 0.06	1.05 ± 0.07	1.04 ± 0.07	1.03 ± 0.06	1.02 ± 0.07	1.01 ± 0.07
10m sprint (s)	Successful	2.03 ± 0.14	2.01 ± 0.12	1.94 ± 0.10	1.85 ± 0.08	1.82 ± 0.12	1.78 ± 0.12	1.76 ± 0.10	1.70 ± 0.08
	Unsuccessful	1.99 ± 0.11	1.95 ± 0.09	1.90 ± 0.09	1.85 ± 0.11	1.82 ± 0.11	1.79 ± 0.10	1.76 ± 0.10	1.74± 0.08
20m sprint (s)	Successful	3.63 ± 0.22	3.56 ± 0.20	3.43 ± 0.15	3.27 ± 0.12	3.13 ± 0.17	3.08 ± 0.15	3.02 ± 0.12	3.03 ± 0.10
	Unsuccessful	3.55 ± 0.16	3.49 ± 0.16	3.39 ± 0.14	3.27 ± 0.16	3.17 ± 0.15	3.08 ± 0.14	3.03 ± 0.12	3.01 ± 0.11
CMJ (cm)	Successful	22.0 ± 3.9	25.0 ± 4.1	27.8 ± 4.1	31.3 ± 4.3	33.6 ± 5.9	35.7 ± 3.3	37.8 ± 3.8	35.9 ± 3.6
	Unsuccessful	23.3 ± 3.9	25.1 ± 4.3	27.0 ± 4.5	30.0 ± 4.8	32.9 ± 4.8	36.0 ± 4.8	37.2 ± 4.4	35.5 ± 4.1
YYIRT L1 (m)	Successful	769 ± 480	993 ± 513	1425 ± 343	1728 ± 474	2139 ± 427	2238 ± 521	2349 ± 383	2320 ± 788
	Unsuccessful	1020 ± 381	1206 ± 410	1486 ± 444	1677 ± 495	1926 ± 541	2044 ± 577	2229 ± 518	1830 ± 388
Stature (cm)	Successful	143.9 ± 5.2	148.2 ± 5.6	154.0 ± 6.4	161.6 ± 7.4	169.6 ± 6.6	174.1 ± 5.8	177.1 ± 5.5	180.0 ± 4.6
	Unsuccessful	143.1 ± 6.2	147.8 ± 6.7	154.6 ± 7.4	163.0 ± 8.1	170.1 ± 7.4	175.2 ± 6.6	176.0 ± 6.2	177.7 ± 5.3
Mass (kg)	Successful	37.2 ± 6.9	39.1 ± 6.3	44.6 ± 6.5	49.8 ± 6.6	57.6 ± 7.5	64.1 ± 7.4	67.6 ± 8.3	70.2 ± 6.2
	Unsuccessful	35.3 ± 5.2	38.6 ± 8.0	43.6 ± 8.9	50.5 ± 7.8	58.2 ± 8.4	64.3 ± 7.4	67.3 ± 7.1	72.0 ± 6.0

Data are presented as mean ± SD

Table 3. Predictions and lower/upper 95%CI from the Bayesian regression model for differences in 5, 10, and 20 metre sprint times for successful vs. unsuccessful players.

			Age at test							
			10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years
5m sprint (s)	Successful	Estimate	1.16	1.13	1.10	1.07	1.04	1.01	0.98	0.95
		Lower 95 % CI	1.02	0.99	0.96	0.93	0.90	0.87	0.84	0.81
		Upper 95% CI	1.30	1.27	1.25	1.21	1.18	1.15	1.12	1.09
	Unsuccessful	Estimate	1.12	1.10	1.08	1.06	1.04	1.02	1.00	0.98
		Lower 95 % CI	0.99	0.97	0.94	0.93	0.91	0.89	0.99	0.85
		Upper 95% CI	1.26	1.24	1.22	1.20	1.18	1.15	1.14	1.11
10m sprint (s)	Successful	Estimate	2.03	1.97	1.93	1.88	1.83	1.78	1.73	1.68
		Lower 95 % CI	1.81	1.75	1.72	1.67	1.61	1.56	1.51	1.46
		Upper 95% CI	2.24	2.19	2.15	2.10	2.05	2.00	1.95	1.91
	Unsuccessful	Estimate	1.99	1.95	1.91	1.86	1.82	1.78	1.74	1.70
		Lower 95 % CI	1.80	1.75	1.71	1.66	1.63	1.59	1.55	1.50
		Upper 95% CI	2.19	2.14	2.11	2.06	2.01	1.98	1.94	1.91
20m sprint (s)	Successful	Estimate	3.61	3.51	3.39	3.29	3.18	3.08	2.96	2.86
		Lower 95 % CI	3.28	3.18	3.07	2.97	2.87	2.78	2.68	2.58
		Upper 95% CI	3.95	3.84	3.72	3.60	3.48	3.36	3.25	3.14
	Unsuccessful	Estimate	3.56	3.47	3.37	3.28	3.19	3.09	3.00	2.91
		Lower 95 % CI	3.25	3.16	3.08	3.00	2.91	2.82	2.74	2.66
		Upper 95% CI	3.88	3.78	3.68	3.57	3.48	3.37	3.27	3.17

Data are presented as parameter means

Table 4. Predictions and lower/upper 95%CI from the Bayesian regression model for differences in YYIRT L1 and CMJ performance for successful vs. unsuccessful players.

			Age at test							
			10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years
YYIRT L1 (m)	Successful	Estimate	809	1104	1402	1698	1987	2277	2561	2864
		Lower 95 % CI	104	349	571	812	1050	1239	1402	1665
		Upper 95% CI	1514	1858	2203	2611	2936	3306	3734	4084
	Unsuccessful	Estimate	1018	1235	1446	1665	1873	2095	2309	2514
		Lower 95 % CI	263	427	551	739	867	982	1117	1250
		Upper 95% CI	1756	2024	2321	2590	2862	3176	3538	3781
CMJ (cm)	Successful	Estimate	22.5	25.5	28.0	30.7	33.2	35.8	38.5	40.9
		Lower 95 % CI	14.4	17.2	19.4	21.9	23.9	26.4	28.7	30.9
		Upper 95% CI	30.6	33.7	36.6	39.4	42.1	44.9	47.9	50.9
	Unsuccessful	Estimate	23.0	25.4	27.8	30.2	32.5	35.1	37.4	39.9
		Lower 95 % CI	14.9	16.9	19.1	21.3	23.2	25.0	27.7	29.5
		Upper 95% CI	31.2	33.5	36.4	39.0	41.9	44.6	47.5	50.2

Data are presented as parameter means

Table 5. Predictions and lower/upper 95%CI from the Bayesian regression model for differences in stature and mass for successful vs. unsuccessful players.

			Age at test							
			10-years	11-years	12-years	13-years	14-years	15-years	16-years	17-years
Stature (cm)	Successful	Estimate	143.2	149.2	155.4	161.4	167.8	173.6	179.8	185.8
		Lower 95 % CI	131.8	137.7	143.2	149.1	155.0	160.0	165.6	171.1
		Upper 95% CI	155.2	160.7	167.5	173.8	181.0	187.0	193.8	200.6
	Unsuccessful	Estimate	142.8	149.1	155.3	161.9	168.0	174.4	180.7	187.1
		Lower 95 % CI	129.9	135.8	141.4	147.4	153.2	158.4	164.5	170.4
		Upper 95% CI	155.6	162.4	169.4	175.9	182.8	190.0	197.0	203.0
Mass (kg)	Successful	Estimate	34.3	39.8	45.8	51.3	57.0	62.6	68.3	73.7
		Lower 95 % CI	22.8	28.3	33.4	37.7	42.3	47.0	52.5	54.9
		Upper 95% CI	45.4	51.8	58.7	64.6	72.0	78.0	84.9	92.6
	Unsuccessful	Estimate	34.4	39.9	45.5	50.9	56.2	61.9	67.4	72.7
		Lower 95 % CI	23.5	28.2	32.5	37.3	41.2	45.4	49.2	53.7
		Upper 95% CI	45.5	51.7	58.6	64.7	71.3	78.0	84.6	92.2

Data are presented as parameter means

Figure legends

Figure 1. Bayesian logistic regression model of probability of obtaining a professional contract given a player's starting age in the academy. Data are displayed as estimates ±95%CI.

Figure 2. Interaction plots between age and success for: A) 5m sprint; B) 10m sprint; C) 20m sprint; D) CMJ; E) YYIRT L1; F) Stature, and; G) Mass. Data are displayed as estimates ±95%CI.