Title: Anthropometric, Speed and Endurance Characteristics of English Academy Soccer Players: Do they influence obtaining a professional contract at 18 years of age?

Running Title: Characteristics of future professional soccer players

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Abstract

This study evaluated the anthropometric, speed and endurance characteristics of English academy soccer players, comparing players who obtained a 'professional' contract at 18 years old with those that did not ('academy'). 443 male academy soccer players from an English professional club undertook anthropometric (height and body mass), speed (10 and 20 m sprint) and endurance (Yo-Yo intermittent endurance test level 2 [Yo-Yo]) assessments between 2005-2012. Significant improvements with age were found for speed and endurance at each annual age group up until U18 age category. Significant differences were only observed between 'professional' and 'academy' players for 10 m ($p = 0.003$, $\eta^2 = 0.01$) and 20 m ($p = 0.001$, $\eta^2 = 0.01$) speed at U16 and U18 and Yo-Yo performance ($p = 0.001$, $\eta^2 = 0.12$) at U18 age category. Practitioners should use speed and endurance assessments for monitoring physical development of players rather than for talent identification purposes.

Key Words: Youth Soccer, Fitness, Talent Identification, Development

INTRODUCTION

Soccer performance depends upon a number of variables including technical, tactical, psychological and physiological characteristics [1]. It is accepted that successful players have well developed endurance characteristics as a 90 minute competitive match requires players to work at approximately 70% of maximum oxygen uptake, covering 10-12km [2, 3, 4, 5]. Furthermore, players are also required to undertake 1000–1400 short activities, with a change in activity every 4–6 seconds and a sprint every 90s [2, 5, 6, 7], thus it would be assumed speed would also be a requirement for successful players.

Measures of anthropometric, speed and endurance characteristics are regularly performed in soccer academies for aiding player identification and selection [8, 9], in addition to monitoring training adaptations [10]. Despite this there is limited research [7, 11] available that describes the descriptive characteristics of youth soccer players by annual age category. To the author's knowledge, there is no published data available describing the anthropometric, speed and endurance characteristics of English academy players or data on young soccer players below the U14 age category. Such data may be beneficial for soccer academy clubs and coaches as it provides comparative data at each annual age category of the academy.

In elite soccer academies identifying and developing young talent at an early age [12] is dependent on the subjective perceived idea of 'talent' [13] which may lead to misjudgment, given that talent potential is not a stable trait throughout youth development [14]. This is confounded by the interacting and overlapping nature of the development of skill, physiological and psychological variables, which all influence performance in soccer. Physical characteristics that discriminate between elite professionals and sub-elite players may not be evident until late adolescence

[15, 16, 17]. Despite some studies examining the physiological differences of academy aged young French [18] and Austrian [15] soccer players in relation to career progression, no study has made comparisons between anthropometric, speed and endurance characteristics in youth English players who achieved a professional soccer contract at 18 years old, with those that did not.

Therefore, the first purpose of this study was to evaluate the anthropometric, speed and endurance characteristics of English academy soccer players by annual-age category (Under 9s to Under 18s). The second purpose was then to compare the anthropometric, speed and endurance characteristics of male academy soccer players who did or did not obtain a professional soccer contract at 18 years of age.

METHODS

Experimental Approach to the Study

Academy soccer players from a professional English club's academy were assessed on a range of performance tests over a 8-year period. Players were assessed on anthropometric (height and body mass) and physical (10 m and 20 m sprint, and Yo-Yo intermittent recovery test level 2) characteristics across 9 annual-age categories (Under 9s - Under18s). This approach allowed comparisons between academy soccer players across annual-age categories and between players who achieved a professional contract at 18 years of age and those who did not.

Subjects

A total of 443 academy soccer players selected to a professional English club's academy (Under 9s – Under18s) between 2005 and 2012 participated in the

study. As players could be (de) selected at each annual-age category, this resulted in a total of 1,287 player assessments across the 8 year period (U9, n = 78; U10, n = 98; U11, n = 105; U12, n = 149; U13, n = 170; U14, n = 144; U15, n = 151; U16, n = 123; U18, n = 269). The U9-U11 age categories trained for 6 hours per week, U12-U15 age categories trained for 8 hours a week, and U16-U18 age categories trained for 12 hours per week. Data in this study was collected as part of a long-term athlete monitoring programme at the club. All experimental procedures received ethical approval from Leeds Beckett University Ethics Committee and informed consent or assent from parents and children was obtained.

At 18 years of age, players were either offered a full time professional contract or were released from the club. Players were therefore classified as 'professional' or 'academy' in terms of whether they received a professional contract or not at 18 years of age. A total of 21 players signed a professional contract at 18 years of age, which resulted in available data at the U12 (n = 5), U13 (n = 11), U14 (n = 11), U15 (n = 14), U16 (n = 14) and U18 (n = 21) age categories. This allowed the anthropometric, speed and endurance characteristics of 'professional' (players who received a professional contract at U18s) players to be compared with 'academy' players (players who were not offered a professional contracts at U18s and left the club) at each respective age category.

Procedures

All academy soccer players performed a testing battery between 2005 and 2012. Players were assessed on anthropometric (height and body mass), speed (10 m and 20 m sprint) and endurance (Yo-Yo intermittent endurance test level 2) measures with all testing taking place at the start of each season. A standardised warm up

including jogging, dynamic movements and stretches was used prior to testing followed by full instruction and demonstrations of the assessments. All testing was undertaken by the club's strength and conditioning department throughout the 8 year period.

Anthropometry: Height was measured to the nearest 0.1cm using a Seca stadiometer. Body mass, wearing only shorts, was measured to the nearest 0.1kg using calibrated Seca alpha (model 770) scales.

Speed: Sprint speed was assessed over 10 m and 20 m using timing gates (Brower Timing Systems, IR Emit, USA). Players started 0.5 m behind the initial timing gate and were instructed to set off in their own time and run maximally past the 20 m timing gate. Times were recorded to the nearest 0.01 s with the quickest of the three times used for the sprint score. ICC and CV's for 10 m and 20 m sprint speed was r = 0.85, CV = 4.5% and r = 0.91, CV = 3.0% respectively.

Endurance: Endurance was assessed using the Yo-Yo intermittent endurance test level 2 (YYIE2). The test consisted of repeated 20 m shuttle runs at progressively increasing speeds dictated by an audio bleep emitted from a CD player. Between each shuttle a recovery period of 5-s is allowed involving jogging around a marker placed 2.5 m behind the finishing line. Failure to achieve the shuttle run in time on two occasions resulted in termination of the test and the total number of successful shuttles was recorded and represented the test result. ICC and CV's for the YYIE2 test was r = 0.71, CV = 4.9% [19].

Statistical Analysis

Mean and standard deviation (SD) scores were calculated for all 'academy' and 'professional' players respectively, with annual-age category acting as the

independent variable. A univariate analysis of variance (ANOVA) test was used to examine the differences between annual-age categories for all academy players with a Tukey post-hoc test used. A two-way mixed factor ANOVA, considering playing status ('professional' and 'academy') and age category (Under12s-Under18s) was used to evaluate the differences between career outcome. Where significant effects were found for 'professional' and 'academy' players, Bonferroni adjustment was applied to identify where significant differences occurred between age categories . Partial eta squared effect sizes (n^2) were calculated with 0.01 = small, 0.06 = medium and 0.14 = large effect (11). Cohen's D was calculated where a main effect was observed. Using a modification to the effect size scale of Cohen [20], 0 – 0.2 was considered to be a trivial effect, 0.2 – 0.6 a small effect, 0.6 – 1.2 a moderate effect, 1.2 – 2.0 a large effect, and >2.0 a very large effect [21]. SPSS version 19.0 was used to conduct analysis with all statistical significance set at $p<0.05$.

RESULTS

Table 1 shows the anthropometric, speed and endurance characteristics of English 'academy' soccer players by annual-age category (U9 – U18). Overall significant effects for annual-age category were found for height ($F_{8, 1235} = 454.7$, $p<0.001$, $\eta^2 = 0.80$), body mass ($F_{8, 1235} = 535.6$, $p<0.001$, $\eta^2 = 0.78$), 10 m speed ($F_{8, 770} = 198.4$, $p<0.001$, $\eta^2 = 0.67$), 20 m speed ($F_{7, 770} = 517.2$, $p<0.001$, $\eta^2 = 0.74$) and YYIE2 scores ($F_{4, 656} = 143.5$, $p<0.001$, $\eta^2 = 0.47$). Post-hoc analysis revealed significant increases in 10 m speed between the U9 and U11 and between the U14 and U15. Similarly there were significant improvements in 20m speed at each annual-age category except for between the U15 and U16 age categories. Significant improvements in YYIE2 scores were observed at each annual age category except

for between the U13 and U14 age categories. Overall findings demonstrated as age increased so did height, body mass, speed and endurance.

When 'professional' and 'academy' players were compared, no significant effect was found for height and body mass. However, significant main effects were found between ‘professional’ and ‘academy’ players for 10 m speed ($F_{1, 649} = 8.8$, $p = 0.003$, $\eta^2 = 0.01$), 20 m speed ($F_{1, 1091} = 11.4$, $p = 0.001$, $\eta^2 = 0.01$) and YYIE2 scores ($F_{1, 515} = 62.1$, $p = 0.001$, $\eta^2 = 0.12$). No playing status x age category interactions were found for any variable. Figure 1 illustrates the differences between ‘professional’ and ‘academy’ players for 10 m and 20 m speed. Post-hoc analyses identified that U16 ‘professional’ players significantly outperformed ‘academy’ players in 10 m ($p = 0.037$, $d=0.70$) and 20 m ($p = 0.019$, $d=0.37$) sprint speed. Similar findings were observed at the U18 age category with 'professional’ players significantly outperforming ‘academy’ players in 10 m ($p = 0.001$, $d=1.09$) and 20 m ($p = 0.001$, $d=1.26$) sprint speed. No significant differences were identified between ‘professional’ and ‘academy’ players for 10 m or 20 m sprint at the U12 – U15 age categories. Figure 2 illustrates the difference between ‘professional’ and ‘academy’ players for the YYIE2 scores with post-hoc analyses identifying ‘professional’ players significantly outperformed ‘academy’ players at the U18 age category, although this differences was small ($d=0.72$). No significant differences were identified between ‘professional’ and ‘academy’ players for endurance performance at the U14, U15 or U16 age categories.

DISCUSSION

Findings demonstrated an effect of annual-age category for anthropometric (height and body mass), speed and endurance performance with increasing characteristics at each age category. This study is the first to show that 'professional' players significantly outperformed 'academy' players for 10 m and 20 m sprint at the U16 and U18 age categories and endurance performance at the U18 age category. Furthermore, this is the first study to show there was no difference between 'professional' and 'academy' players <U15 for speed characteristics, <U18s for endurance characteristics and no difference was observed for anthropometric characteristics (height and body mass). Caution should be expressed when using the characteristics explored in this study as part of a recruitment strategy in players <U18 as this study shows it does not predict career progression. Therefore coaches should focus on the technical, tactical and psychological characteristics of the player.

As expected, height and body mass significantly increased with age from U9 to U18 in English academy soccer players, consistent with previous research in Spanish [4] and Belgium [9] academy soccer players due to the normal adaptations related to growth [11]. Again as expected, both speed and endurance demonstrated significant effects with annual-age category with both characteristics improving with age, consistent with previous research in soccer [4, 9]. This study is the first to provide data on English Academy football players across annual-age groups, providing comparative data for soccer academy clubs and coaches for players aged 9 to 18 years.

Table 1: Anthropometric, Speed and Endurance Characteristics of English Academy Soccer Players aged between Under 9s and Under 18s

	U9 (n=67)	U10 (n=94)	U11 (n=168)	U12 (n=172)	U13 (n=211)	U14 (n=195)	U15 (n=151)	U16 (n=123)	U18 (n=321)	Post Hoc
	1	2	3	4	5	6	7	8	9	
Chronological Age (y)	8.87 ± 0.34	9.83 ± 0.38	10.88 ± 0.31	11.95 ± 0.35	12.95 ± 0.31	13.84 ± 0.32	14.84 ± 0.30	15.73 ± 0.33	17.61 ± 0.45	
Height (cm)	132.0 ± 4.9 (118.0-141.0)	136.9 ± 5.2 (119.5-148.3)	141.4 ± 7.2 (126.0-161.6)	147.3 ± 7.5 (129.2-175.0)	155.5 ± 9.1 (133.5-177.6)	161.0 ± 8.4 (139.0-183.4)	169.6 ± 7.5 (151.9-191.6)	174.1 ± 8.1 (149.0-193.0)	178.1 ± 7.9 (157.1-197.4)	1<2<3<4<5<6<7<8<9
Body Mass (kg)	29.4 ± 3.2 (22.5-38.4)	33.2 ± 3.9 (26.1-46.7)	36.8 ± 5.7 (27.1-56.6)	40.7 ± 6.4 (28.0-68.2)	46.6 ± 8.0 (30.1-69.6)	51.8 ± 7.8 (34.7-74.9)	61.0 ± 7.6 (42.7-85.4)	66.7 ± 8.6 (44.6-86.6)	72.5 ± 8.6 (55.0- 88.5)	1,2,3<4<5<6<7<8<9 1<3
10 m Speed (s)	2.19 ± 0.07 (2.04-2.36)	2.13 ± 0.06 (1.96-2.31)	2.06 ± 0.09 (1.90-2.27)	2.00 ± 0.11 (1.85-2.26)	1.99 ± 0.10 (1.76-2.26)	1.90 ± 0.10 (1.67-2.18)	1.84 ± 0.03 (1.65-1.99)	1.82 ± 0.07 (1.66-1.97)	1.79 ± 0.05 (1.65-1.92)	1<2<3<4,5<,6,<7,8,9
20 m Speed (s)	3.85 ± 0.16 (3.26-4.23)	3.66 ± 0.11 (3.20-4.11)	3.64 ± 0.14 (3.18-4.00)	3.51 ± 0.13 (3.00-3.96)	3.43 ± 0.18 (2.99-3.87)	3.28 ± 0.09 (2.91-3.47)	3.15 ± 0.17 (2.90-3.32)	3.09 ± 0.08 (2.82-3.29)	3.03 ± 0.12 (2.78-3.21)	1<2,3<4<5<6<7,8,9 7<9
YYEI2 (n)					13 ± 3 (7-21)	13 ± 4 (7-23)	19 ± 4 (8-27)	21 ± 6 (9-30)	24 ± 6 (12-38)	5,6<7<8<9

Notes: Data presented is Mean ± SD with Ranges stated below in parentheses. The numbers in parentheses in column headings relate to the numbers used for illustrating significant ($p<0.05$) differences in the post-hoc analysis between annual-age categories

Figure 1(a): Comparison of 10 m speed between 'academy' and 'professional' soccer players at respective annual-age categories

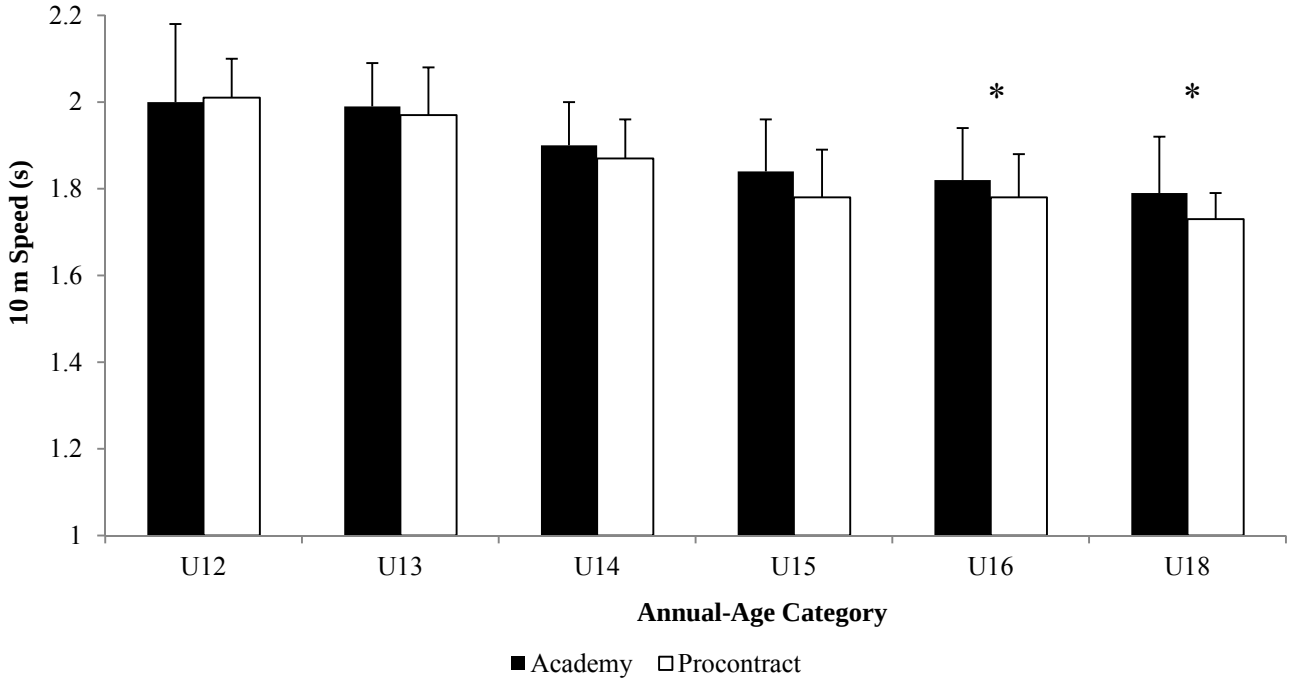
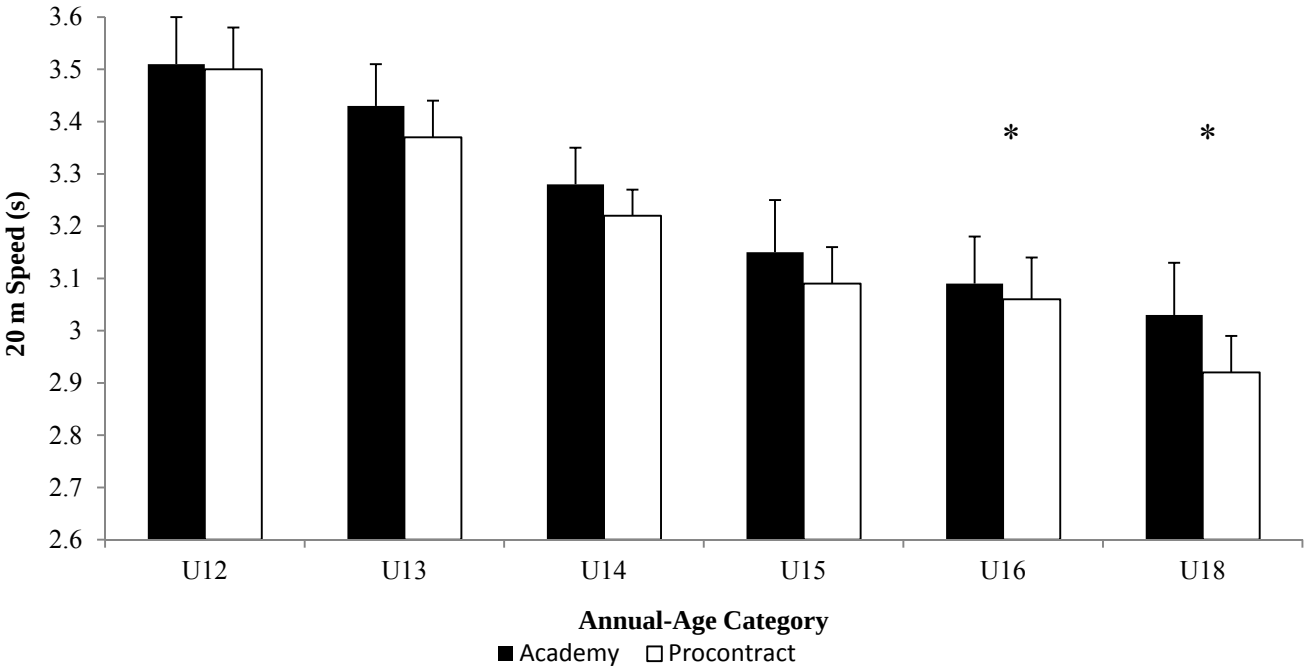
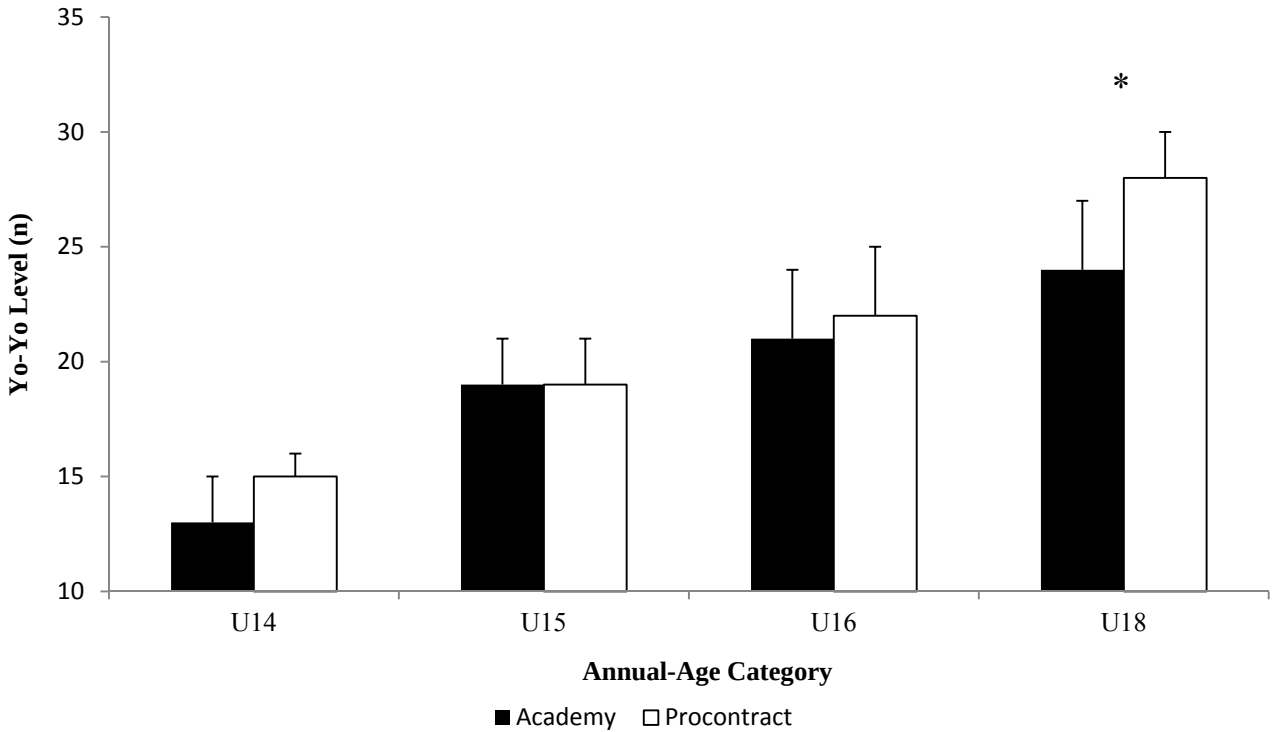


Figure 1(b) Comparison of 20 m speed between 'academy' and 'professional' soccer players at respective annual-age categories



* Sig different between 'academy' and 'professional' ($p<0.05$)

Figure 2: Comparison of Yo-Yo shuttles between ‘academy’ and ‘professional’ soccer players at respective annual-age categories



* Sig different between ‘academy’ and ‘professional’ ($p<0.05$)

The findings of this study demonstrate no significant difference in height and body mass between 'professional' and 'academy' players which appears contrary to previous research, that suggests body size is an important attribute in talent selection within youth soccer [4, 22, 23] and selection biases (e.g., relative age effects, 24; maturational inequalities, 25) are common in elite youth soccer players. Further research is required to evaluate the professional journey of these players, but this study does suggest that coaches should be cautious when using *size* in the identification of junior players.

'Professional' players were significantly quicker (10 and 20 m speed) than 'academy' players, although this was only a small main effect size and was not apparent until late adolescence (i.e., U16 and U18), with moderate to large differences not apparent until the U18 age category. The significant differences highlighted, correspond with characteristics suggested to distinguish between playing level and progression of youth players into the professional game in previous research [7, 25, 26]. Further, current findings support and negate the findings of Le Gall et al., [18] who demonstrated no significant differences in speed between male soccer graduates from an elite French academy who obtained amateur, professional or international status at the U14, U15 and U16 age categories. It may be difficult to separate highly selected players as other more complex factors may determine the players' ability to reach the professional level. It is not clear if advanced speed at U16 and U18 age categories contributed to obtaining a professional contract from an English soccer academy, although given the crucial impact of speed within a match [27] and its respective outcome, regarding winning and losing [23] it would be assumed developed speed capabilities would be advantageous.

At the U18 age category, players who obtained a professional contract showed significantly greater YYEI2 performance in comparison to 'academy' soccer players. Despite the findings supporting previous research [9, 15, 28] suggesting endurance capacity is important in discriminating future playing status at later stages of adolescence, the differences observed were only small (d=0.72) and not identified until the U18 age category (17-18 years) in English academy players. Previous research has suggested 15 years was the critical age when differences in aerobic capacity were evident between professional players and unsuccessful Austrian [15] and Dutch [28] academy players. It is accepted that varying methods were used to determine aerobic capacity (YYEI2 versus MSFT, 15), although it is not clear if this confounds comparisons between studies. This study supports the consideration of speed and endurance capacity from late adolescence in the identification and selection of youth soccer players, however de-selecting a player on the basis of speed and endurance test performances is questionable. Recent evidence [3] has reported the unstable nature of speed during adolescence and questioned the predictability of such measures throughout the adolescent period. It is acknowledged that the traits required to make it as a professional player are multifaceted and the players' technical and psychological qualities are also critical. It may be more beneficial for practitioners working with academy players to track individuals on a longitudinal basis, as it is difficult to separate players already highly selected and exposed to systematic training and players who achieve a professional contract.

This study is not without its limitations as assessments of anthropometric, speed and endurance characteristics were the only variables explored, which must be considered in the context of the technical, tactical and psychological attributes of the player. Due to the long-term nature of this project, only preseason testing was

analysed for consistency in testing dates and procedures, therefore this does not answer the question of whether speed and endurance levels change within a season and if the differences between professional and academy players' increase or decrease throughout a season. Similarly measures of lower body power and agility were not included in this study due to the variability in testing methods utilised to assess such characteristics over the years. Since all players came from the same academy, the significant homogeneity of the group may have limited some of the group differences between academy and professional players. Future research, should aim to explore the influence of additional performance characteristics (such as agility, lower body power, technical skill level and psychological variables) on career progression of academy players and repeat testing throughout the season, with an additional control group to determine if differences between groups increase or decrease throughout the season.

PRACTICAL APPLICATION

The current study provides comparative data for the development of anthropometric, speed and endurance characteristics of English academy soccer players aged 9 to 18 years, which could be used in monitoring and evaluating the development of such players. More importantly, the current study highlighted that differences between 'professional' and 'academy' players for speed and endurance performance were only identified at the U16 age category and beyond with no differences identified for anthropometric characteristics. Such findings suggest that coaches should not focus on size in the identification of academy soccer players with speed and endurance assessments only used for talent identification and selection purposes post 16 years of age. Coaches should not (de) select players within their

academy programs at earlier age categories based upon physical capacities. Instead, it is advised that coaches and practitioners working with academy soccer players, track players on an individual and longitudinal basis and that talent identification and development programs should be dynamic, providing opportunities for changing parameters in a long-term development context.

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Figure Captions

Figure 1(a): Comparison of 10 m speed between ‘academy’ and ‘professional’ soccer players at respective annual-age categories

Figure 1(b) Comparison of 20 m speed between ‘academy’ and ‘professional’ soccer players at respective annual-age categories

Figure 2: Comparison of Yo-Yo shuttles between ‘academy’ and ‘professional’ soccer players at respective annual-age categories