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Biological maturity and the anthropometric, physical and technical assessment of talent identified U16 Australian footballers

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Abstract

This study compared biological maturation, anthropometric, physical and technical skill measures between talent and non-talent identified junior Australian footballers. Players were recruited from the under 16 Western Australian Football League and classified as talent (state representation; n = 25, 15.7 ± 0.3 y) or non-talent identified (non-state representation; n=25, 15.6 ± 0.4 y). Players completed a battery of anthropometric, physical and technical skill assessments. Maturity was estimated using years from peak height velocity calculations. Binary logistic regression was used to identify the variables demonstrating the strongest association with the main effect of 'status'. A receiver operating characteristic curve was used to assess the level of discrimination provided by the strongest model. Talent identified under 16 players were biologically older, had greater stationary and dynamic leaps and superior handball skill when compared to their non-talent identified counterparts. The strongest model of status included standing height, non-dominant dynamic vertical jump and handball outcomes (AUC = 83.4%, CI = 72.1%-95.1%). Biological maturation influences anthropometric and physical capacities that are advantageous for performance in Australian football, talent identification methods

should factor biological maturation as a confound in the search for junior players who are most likely to succeed in senior competition.

Keywords:

Talent identification, adolescent, development, team sport

Introduction

The assessment of anthropometric and physical capacities for talent identification in team sports is common as successful team sport players require a range of well-developed physical attributes [1, 2]. Considerable research has explored the link between physical testing performance and talent identification in Australian football at an under 18 (U18) level [3-5]. However, Australian football research has highlighted that only 47.5% of athletes selected into elite U18 squads had previously been selected into elite under 16 (U16) squads, highlighting issues with the talent identification process at the U16 level [6]. Recent research in adolescent team sports demonstrates that differences in maturity are likely to contribute to anthropometric and physical performance variation [7, 8] and coaches perceptions of player skill and potential [9, 10], which in turn are likely to impact on talent identification outcomes. Effects of maturational differences on performance outcomes are strongest in younger players around the time of peak height velocity [11]. However, there is a lack of research examining factors which explain the talent identification of young (< 17 years) Australian footballers. Educating coaches as to the potential influence of biological maturation on physical performance outcome assessments may assist with the reduction of talent misclassification. Specifically, this education process may make coaches cognisant of avoiding acute selection bias associated with superior physical and/anthropometric measures underpinned by biological maturation.

The Australian Football League Talent Pathway (AFL TP) is the primary developmental pathway for talent identified junior Australian footballers seeking to compete in elite senor competitions (i.e., within the AFL) [6]. The AFL TP is designed to accelerate the development of talented juniors to ensure the sustained supply of senior talent to the AFL. The AFL TP provides talent identified player's access to experienced coaches, advanced training resources, support staff and participation in elite junior competitions. The AFL TP has three selection stages which are associated with; U16 and U18 state representative teams, and into the professional AFL teams. Recent research exploring the effectiveness of the AFL TP reported that only 27.7% of drafted players had previously been selected onto elite U16 teams [6]. Further, only 47.5% of athletes selected at the U16 level were retained onto U18 squads. Poor retention of juniors may be linked to the relative age effect repeatedly reported in adolescent competitions [6, 12, 13], which suggests that older players are looked upon more favourably in the initial identification process due to maturational advantage. This suggestion is supported by recent findings that Australian football coaches' perceive earlier maturing individuals to possess advanced technical skills and greater long-term potential [9, 10]. However, despite these findings there is no available research exploring factors which drive identification into the AFL TP at the U16 level. It may be postulated that earlier maturing athletes at the U16 level could experience identification advantage as they have been shown to possess both superior physical attributes and be perceived by coaches' to have greater long-term potential [9, 10]. Whilst later maturing players may fail to be identified due to acute performance disadvantages associated with being less mature. Such identification outcomes may negatively affect pathway efficiency as physical performance advantages and disadvantages associated with maturity reduce with age, which may result in later maturing players catching up and replacing those initially talent identified at the U16 level.

The poor retention of players initially identified onto the AFL TP may represent an inefficient use of pathway resources and may reduce the developmental capacity of the pathway. However to date, no research has explored if biological maturity or other measures such as anthropometric, physical or technical skill impact on talent identification of elite U16 Australian footballers, making it unclear what factors drive identification at the initial stage of the AFL TP. Therefore, the aims of this study were twofold, firstly to identify if maturational, anthropometric, physical or technical skill measures differ between junior Australian footballers according to status (talent identified / non-talent identified). A secondary aim of this study was to explore which measures could explain talent identification into the AFL TP at the U16 level.

Methods

Participants

Participants (n=282, age 15.7 ± 0.3 years) were recruited from the U16 Western Australian Football League competition. From this sample, two groups were examined; a talent identified group (n=25, age 15.7 ± 0.3 years; defined as representatives of the 2015 Western Australian State U16 Academy) and a non-talent identified group (n=25, age 15.6 ± 0.4 years; defined as players not identified on the 2015 West Australian State U16 Academy). The non-talent identified players were randomly selected from the remaining 257 players not selected into the Academy using the random sample function in SPSS version 22 (IBM, Chicago, IL, USA). In accordance with Woods et al. [14], this randomisation process was implemented in order to generate a representative sample of the larger cohort for comparative reasons. Further, between group differences were analysed to ensure the included randomly selected non-talent identified sample were representative of the larger non-talent identified sample, with no between-group differences evident ($p > 0.05$). To participate in the testing, players were required to declare themselves to be injury free at the time of testing. The relevant Human Research Ethics Committee provided ethical approval for the study with players and their guardians required to provide informed consent prior to testing.

Procedures

Upon arriving at the testing session, the players initially had anthropometric information recorded, being followed by the completion of two technical skill tests, and a series of five physical tests. Anthropometric variables collected were standing and sitting height and body mass. All players were then required to complete a standardised warm-up prior to the skills tests; the AFL's kicking and handball efficiency test. Physical test completed included; a 20 m sprint, a stationary vertical jump (SVJ), a dynamic vertical jump on both the dominant (DVJD) and non-dominant foot (DVJND), and the 20 m multistage fitness test. A maximum of 40 players were tested at a time in three hour testing sessions during the preseason phase of training.

Both standing and siting height and body mass values were measured to the nearest 0.1 cm and 0.01 kg using a stadiometer (PE, Sportforce, Australia) and electric scales (Model UC-321, A&D

Mercury Pty. Ltd., Australia), respectively. To measure sitting height, players sat on a 42 cm seat, with their buttocks and shoulders against the stadiometer. For all anthropometric measures players removed their footwear. Biological maturity was estimated using the anthropometric measures collected, with years to and from peak height velocity calculated using a standardised predictive equation [15]. This method of assessment provides a reliable and practical method of assessing biological maturity and has been used in a number of studies with similar populations [7, 9, 16].

The warm-up conducted prior to the skills testing included a light jog, a series of dynamic stretches, and a basic handballing and kicking drill. The skills tests were conducted outside on an outdoor playing field. All players were directed to wear their regular football boots. Both skills tests used in this study were developed by the AFL and required the players to deliver a handball or kick to a series of six targets across a range of Australian football specific distances. A reliable score of 0-5 was given by assessors [17] to rate each disposal for accuracy and trajectory. Previous research using athletes and assessors of a similar demographic reported strong levels of inter-rater reliability for both the kicking (ICC=0.96, $p<.01$) and handball tests (ICC=0.89, $p<.01$) [17]. Disposal distances for the kicking test were short (20 m), medium (30 m) and long (40 m); whilst the handball test was short (6 m), medium (8 m) and long (10 m). For each distance a disposal was completed on the player's dominant and non-dominant hand or foot, with skill executions to be completed in succession. Prior to testing players nominated their preferred hand and foot, with players performing each test once.

After completion of the skill testing the group was taken inside to a gymnasium with hardwood floors to complete the physical testing. Players wore standard running shoes for all physical assessments. The physical tests were complete in a circuit fashion, with players randomly sub-divided into four groups of approximately 10 and assigned to one of the four vertical jump or 20m sprint tests stations. The 20 m multistage fitness test was conducted after the completion of all other tests, with the players split into two equal groups to complete the test. Vertical jump tests were completed to assess lower limb power. Prior to each jump, players were required to stand under a Vertec vertical jump device (Swift Performance Equipment, Lismore, Australia), with both feet flat on the ground, then reach up and displace the highest vane possible. This process was repeated three times, with the highest vane displaced representing the individuals reach height. Players were asked to perform three counter-movement jumps and three running vertical jumps on their dominant and non-dominant feet. Foot dominance was defined as the players preferred kicking foot. For the running vertical jumps, players were allowed a 5 m run up. Standing reach height was subtracted from each of the individual jumps to give a relative jump height. Jump height was measured to the nearest 1 cm, with the largest of each jump reported.

Sprint performance was evaluated by 20 m sprint time using infra-red timing gates (Smartspeed, Fusion Sport Pty Ltd, Queensland, Australia). Players were instructed to self-start the test to remove the effects of reaction time. Players were given three attempts with the fastest of the three trials recorded to the nearest 0.01 of a second.

Aerobic fitness was conducted last to prevent fatigue in other tests and assessed via the multi-stage fitness test. Players were required to run back and forth along a 20 m track, keeping time with a series of audio beeps, with the frequency of beeps increasing as the test progressed. The test stopped when the player reached voluntary exhaustion, or could no longer keep up with the beep frequency. The stage and level achieved by each player was recorded. For analysis, the total distance was used which was calculated from the players recorded shuttle stage and level.

Statistical analysis

Statistical analysis was undertaken using SPSS version 22 (IBM, Chicago, IL, USA). Mean and standard deviation scores were calculated for all dependent variables (i.e. anthropometric, physical, and technical skill measures). Prior to analysis, all data was screened for normality. A multivariate analysis of variance (MANOVA) was used to explore the main effect of 'status' (two levels: talent identified, non-talent identified) on the biological maturity, anthropometric, physical and technical skill variables. The effect size (ES) of status on all measures was calculated using Cohen's *d* statistic. The magnitude of the effect sizes were interpreted using a scale where values <0.2 are deemed trivial, 0.2–0.6 small, 0.6–1.2 moderate, 1.2–2.0 large and >2.0 very large [18]. For all analyses, the Type-I error rate was set at $\alpha<0.05$.

Binary logistic regression was used to determine which measures best explained the main effect of selection (two levels: 1 =talent identified and 0 =non-talent identified). The full model was created using all significant measures from the MANOVA. Subsequent models were constructed using a backwards elimination method with the measure affecting the model the least subsequently removed until only significant measures remained. Model fit was determined using the Akaike information criterion (AIC). Odds ratio (OR) and 95% confidence intervals (95% CI) were reported for each significant measure. Additionally, a receiver operator curve (ROC) was built to examine the discriminative capability of the most parsimonious model by examining the area under the curve (AUC). In accordance with recommendations provided by [4], the point on the curve at which the sum of the talent identified and non-talent identified scores were maximised was considered the value of which a "cut off" score can be considered for identifying players.

Results

According to Pillai's trace (*V*), the MANOVA revealed a significant effect of status ($V = 0.57$, $F(11, 38.000) = 4.56$, $p<.01$). Follow up univariate analysis revealed a significant effect of status on biological maturity, standing and sitting height, DVJD foot, DVJND foot and the handball test (Table 1).

******INSERT TABLE 1 ABOUT HERE******

******INSERT TABLE 2 ABOUT HERE******

******INSERT FIGURE 1 ABOUT HERE******

The six significant variables from the MANOVA were then included in the full logistic regression model. A total of four models were developed (see Table 2), however the best reduced model (AIC=52.52) included only standing height (OR=0.90, CI= 0.81-1.00, p=.04), DVJND foot (OR=0.73, CI= 0.58-0.92, *p*=.03) and handball score (OR=0.88, CI= 0.78-0.98, *p*<.01) as the strongest model of status (AUC=83.4%, CI= 72.1%-95.1%). The ROC was maximised when a cut-off score of 270.2 was applied, with the final reduced model correctly identified 84% of the talent identified and 76% of the non-talent identified players (Figure 1). According to the AUC the most robust single measure to explain status was handball score (AUC=76.0%, CI= 62.5%-89.5%), with a value of 24.5/30 found to optimise the ROC and correctly explain 60% of the talent identified and 80% of the non-talent identified players. A standing height (AUC=72.8%, CI= 57.8%-87.8%) with a cut-off value of 179.9cm correctly identifying 20 (80%) of the talent identified and 15 (60%) of the non-talent identified players. The weakest measure from the most parsimonious model was the DVJND foot (AUC=72.6%, CI= 58.5%-86.6%) with a cut-off value of 68.5 cm correctly classifying 16 (64%) of the talent identified and 17 (68%) of the non-talent identified players.

Discussion

Talent identified junior Australian footballers were biologically more mature than non-talent identified players, and in addition were taller, and performed better in the DVJD foot, DVJND foot and handball tests. Gastin and Bennett [7] reported maturational differences between community U15 Australian footballers, however this is the first study to demonstrate that age-matched talent identified U16 Australian footballers are more mature than their non-talent identified counterparts. Between group variations in maturity reported in this study are likely to contribute to the anthropometric and physical performance differences demonstrated between the talent identified and non-talent identified groups, as players of advanced maturational age are typically taller, heavier and have been shown to possess greater vertical leaps than their less mature counterparts [7, 9, 19]. Maturational variation has previously been shown to account for between 8-19% of physical performance variability and affect coaches' perceptions of skill and potential in U16 Australian footballers [9, 10]. The greater anthropometric and vertical jump measures reported in this study conforms to previous results examining U18 Australian footballers who were talent identified [3, 4]. However at a U16 level this may be problematic as performance advantages are likely related to biological maturity, rather than raw talent and long term potential. Identification resulting from advanced maturity may negatively affect pathway efficiency as physical advantages due to maturity have been shown dissipate with age [12], elevating the risk of subsequent de-selection.

Handball performance was found to differ between talent identified and non-identified players confirming the importance of technical skills to talent identification and selection in Australian football [14, 20]. Currently it is unclear if performance in the AFL skill tests associate with skilful performance in matches, which presents as a limitation to this study. However unlike anthropometric and physical measures, performance in Australian football skill tests do not appear to be influenced by biological maturity [9]. Coaches at an U16 level may therefore consider prioritising performance in skills tests over anthropometric and physical measures during talent identification due to its unbiased nature. Greater consideration of measures unaffected by maturity may improve talent identification processes and development pathway efficiency. For example measures may also be extended to include examination of psychological markers and decision-making tasks which have been shown to discriminate between talent identified and non-talent identified U18 Australian footballers [20]. However, the effects of maturational variance on new identification assessments need to be explored before including in the talent identification processes.

Australian football is a multidimensional team sport which requires players to possess well developed physical, technical and tactical skills to perform at a high level [14]. As such, several studies have examined if physical [4, 5, 22], skill [20] and decision making [21] measures can explain talent identification in U18 Australian football. The results of this study demonstrate a combined set of physical and technical measures can explain talent identification into an elite U16 Australian football team. The strongest model correctly identified 84% of the talent identified and 76% of the non-talent identified players, with this model including the measures of standing height, DVJND foot and handball efficiency. Using this model and the ROC a score of 270.2 was determined to be an acceptable cut-off value for identifying potentially elite U16 Australian footballers. This study, when coupled with the findings of Woods, Raynor [14] further highlights the need for a multidimensional approach to talent identification in junior team sports, such as Australian football. However when considered in conjunction with the low retention of players from U16 to U18 squads [6], this study highlights a clear need to factor assessments of biological maturity in identification measures of U16 players. Consideration of maturity and prioritisation of tests unbiased by maturation may help improve long-term pathway outcomes by ensuring later developing adolescent players are not misidentified early in development pathways due simply to disadvantages associated with being biologically younger.

Conclusion

This research provides first evidence that players identified onto the AFL TP at the U16 level are likely to be more biologically mature than their non-talent identified counterparts. Further, differences were evident between talent identified and non-talent identified players in measures of standing and sitting height, DVJD foot, DVJND foot and handball test scores. The results of this research have implications for current talent identification methods as both standing height and DVJND foot have previously been shown to be influenced by maturational variation [9]. The strongest measures able to define status where reduced to three variables, standing height, DVJND foot and handball score. Given that handball test performance is unaffected by maturational variation [9], coupled with the results of this study, coaches should prioritise performance in technical skill assessments over physical testing measures during the talent identification process. The consideration of biological maturity and prioritisation of talent identification measures unbiased by maturation such as technical skills tests, may improve athlete retention outcomes in the AFL TP by preventing the initial misidentification of players potentially physically advantaged or disadvantaged at 16 years of age.

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Table 1. Between group differences for anthropometric, physical and technical skill measures (mean ± standard deviation).

Measure	Talent Identified	Non-talent Identified	Effect size (Cohen's *d*)
Height (cm) [b]	183.06 ± 9.75	176.39 ± 6.05	0.82
Sitting Height (cm) [a]	92.65 ± 4.45	90.04 ± 4.04	0.61
Weight (kg)	72.21 ± 7.84	67.79 ± 9.40	0.52
Y-PHV [a]	1.98 ± 0.66	1.55 ± 0.68	0.65
SVJ (cm)	60.20 ± 5.28	57.80 ± 6.18	0.42
DVJD (cm) [a]	66.00 ± 7.36	61.00 ± 8.50	0.63
DVJND (cm) [b]	73.40 ± 8.11	66.72 ± 6.58	0.91
20m Sprint (s)	3.04 ± 0.11	3.09 ± 0.10	0.48
Shuttle Distance (m)	2282.88 ± 320.96	2167.64 ± 214.73	0.42
Kicking Test	14.44 ± 3.04	13.60 ± 3.14	0.27
Handball Test [a]	24.84 ± 3.26	21.04 ± 4.68	0.94

[a] $p < .05$. [b] $p < .01$

Table 2. Model summary relating to the binary logistic models run.

	Model 1				Model 2			
Measure	β (SE)	χ^2	*p*	OR (95%CI)	β (SE)	χ^2	*p*	OR (95%CI)
Constant	12.57 (26.64)	0.22	0.64		4.86 (23.93)	0.04	0.84	
Standing Height (cm)	-0.19 (0.11)	3.21	0.07	0.82 (0.67-1.02)	-0.17 (0.10)	2.97	0.08	0.84 (0.69-1.02)
Handball	-0.34 (0.13)	6.61	0.01	0.71 (0.55-0.92)	-0.34 (0.13)	7.18	0.01	0.71 (0.55-0.91)
DVJD (cm)	-0.12 (0.06)	3.63	0.06	0.88 (0.78-1.00)	-0.13 (0.06	4.62	0.03	0.88 (0.78-0.99)
Sitting Height (cm)	0.49 (0.39)	1.59	0.21	1.63 (0.76-3.48)	0.53 (0.38)	1.94	0.16	1.70 (0.81-3.57)
Y-PHV	-2.15 (2.09)	1.09	0.30	0.12 (0.01-7.01)	-2.57 (1.99)	1.67	0.20	0.076 (0.01-3.77)
DVJND (cm)	-0.05 (0.07)	0.46	0.49	0.96 (0.84-1.01)				
AIC		55.89				54.34		
	Model 3				Model 4			
Measure	β (SE)	χ^2	*p*	OR (95%CI)	β (SE)	χ^2	*p*	OR (95%CI)
Constant	33.07 (11.37)	8.47	<0.01		34.97 (11.08)	9.96	0.02	
Standing Height (cm)	-0.15 (0.09)	2.66	0.10	0.86 (0.72-1.03)	-0.10 (0.52)	3.94	0.04	0.90 (0.81-1.00)
Handball	-0.32 (0.12)	7.07	0.01	0.73 (0.57-0.92)	-0.31 (0.12)	6.95	<0.01	0.73 (0.58-0.92)
DVJD (cm)	-0.12 (0.06)	4.41	0.04	0.88 (0.79-0.99)	-0.13 (0.06)	4.93	0.03	0.88 (0.78-0.98)
Sitting Height (cm)	0.11 (0.18)	0.39	0.54	1.12 (0.79-1.58)				
AIC		54.14				52.52		

Abbreviations: β, beta coefficient; SE, standard error; χ^2, Wald chi-squared; AIC, Akaike information criterion. Statistical significance accepted at $p<0.05$.

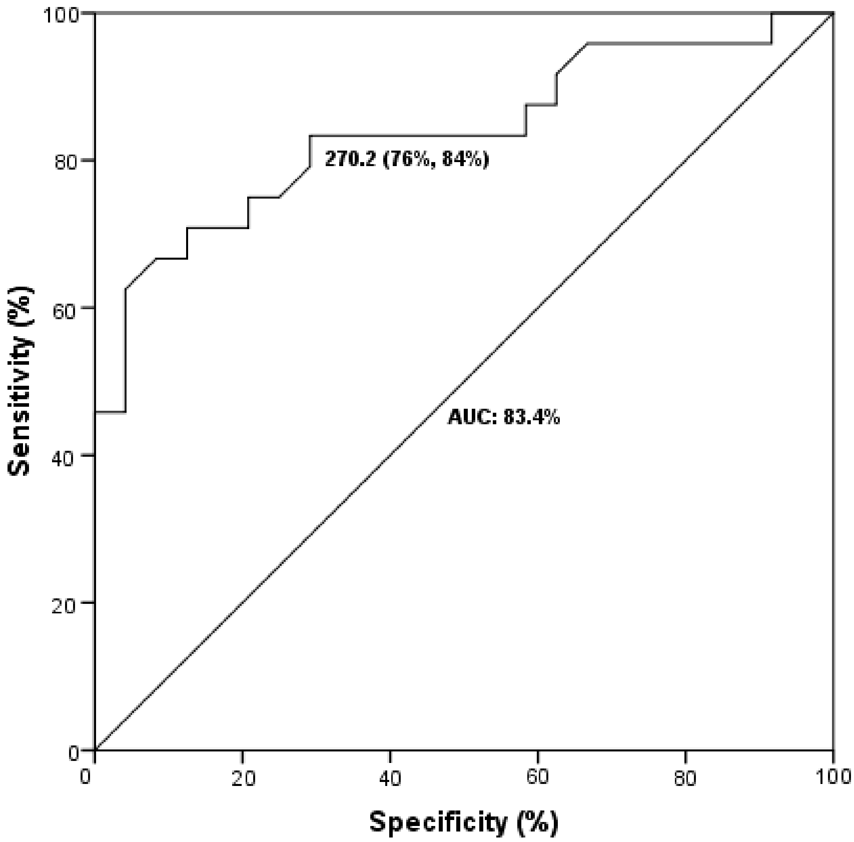

Figure 1. Receiver operating curve for the most parsimonious model which included standing height, DVJND foot and handball parameters.