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Maturity, physical ability, technical skill and coaches' perception of semi-elite adolescent Australian footballers

A Cripps
University of Notre Dame Australia, ashley.cripps@nd.edu.au

L Hopper

C Joyce
University of Notre Dame Australia, chris.joyce@nd.edu.au

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Article Title: Maturity, Physical Ability, Technical Skill and Coaches’ Perception of Semi-Elite Adolescent Australian Footballers

Authors: Ashley J. Cripps[1], Luke Hopper[2], and Christopher Joyce[1]

Affiliations: [1]School of Health Sciences, University of Notre Dame Australia, Fremantle WA, Australia. [2]WA Academy of Performing Arts, Edith Cowan University, Munt Lawley, WA, Australia.

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"Maturity, Physical Ability, Technical Skill and Coaches' Perception of Semi-Elite Adolescent Australian Footballers"
by Cripps AJ, Hopper L, Joyce C
Pediatric Exercise Science

Abstract

Purpose: To confirm the effect of maturational differences on anthropometric and physical testing and explore the effect of maturation on technical skill and coaches' perceptions of skill in adolescent Australian footballers. **Methods:** Athletes were recruited from a semi-elite under 16 competition (n = 94, age 15.7 ± 0.3 years) and completed anthropometric, physical, and technical skill tests. Coaches from each team provided subjective ratings of athletes' technical skills. Maturation groups were derived from years from peak height velocity estimates, with classifications either later, average or earlier maturing. **Results:** Effect size comparisons revealed very large to moderate effects between groups for anthropometric measures and performance in sprint and jump tasks. Small to moderate effects were reported between groups for coaches' perceptions of skill, with the earlier maturing group perceived to have better overall technical skills, marking and ball winning abilities. Small to trivial effects were reported for performance in the technical skill tests. **Conclusions:** Despite no differences in skill tests, earlier maturing athletes may be afforded significant selection and competition advantages due to advanced physical capacities and coaches' perceptions of skill.

Introduction

Adolescent sporting competitions are typically age-stratified by one or two years in the interests of competition equity and player safety (5). However, these age stratifications do not consider the large differences in biological maturity that are common in athletes of the same chronological age (1). During early to mid-adolescence, biological maturity can differ by as much as three years (16). Athletes of greater biologically maturity are likely to demonstrate advanced physical performance characteristics. Typical maturation related advantages include; increased physical stature (19), muscle strength and power (24), and running capacities (4, 13, 20). Previously maturational differences have been shown to affect performance in community level adolescent Australian footballers, with earlier maturing individuals demonstrating lower 20 m sprint times as well as; greater match running distance (m/min^{-1}), high intensity running (m/min^{-1}) and high intensity efforts ($number/min^{-1}$) (12). It is unknown if the physical performance advantages evident in more mature athletes at the community level are also evident in adolescent athletes selected into higher level semi-elite competitions.

In Australian Football matches, increased running intensities have been shown to result in athletes gaining a higher number of disposals (i.e. gaining possession of the ball and subsequently performing a kick or handball) (21). However, unless these disposals are effective (i.e. to another teammate or resulting in a score), the value of the disposal to the team is minimal (14). Whilst more mature adolescent athletes may demonstrate greater running capacities within competition such advantages may be of little benefit without matched technical skill efficiency. Previous research into skill performance and maturation has been largely inconclusive. In soccer, technical skill efficiency has been shown to be linked to biological maturity (17). However, inversely in the sports of basketball (6) and handball (20), maturity appears to have limited effect on sport specific skills. Examination of how maturation affects skill efficiency in Australian Football has yet to been conducted.

Effective talent identification systems utilise both objective performance assessments of physical ability and skill as well as subjective athlete assessments, such as coaches' perceptions of athlete ability (30). The multidimensional nature of team sports means that objective performance assessments are unlikely to comprehensively quantify an athlete's ability and should be used to support the subjective opinions and assessments of coaches or talent identification officers (28). However, given that earlier maturing athletes are likely to be at a performance advantage in testing and match situations, coaches' perceptions of player's ability may also be biased towards more mature athletes. Previously it has been shown that coaches' perceptions of long-term potential are influenced by maturational differences in semi-elite u16 Australian Footballers (8) which may be represented by the continuous selection of relatively older athletes into development pathways (9, 26). To date no research has assessed how maturational differences impact on coaches' perceptions of an athlete's technical abilities.

The aim of this study was to confirm the impact of maturational differences on anthropometric and physical testing and explore the effects of maturation on technical skill efficiency, and coaches' perceptions of skill in a sample of semi-elite Australian footballers. It was hypothesised that athletes classified as earlier maturing would out-perform their later maturing peers in all assessed variables.

Methods

Study Design

Ninety-four athletes (age 15.7 ± 0.3 years) were recruited from seven teams involved in the state-wide West Australian Football League (WAFL) under 16 (U16) competition. This study was conducted over a 3 month period prior to the commencement of the competition season and took place in three stages; the first stage assessed anthropometric and physical measures, specifically assessing; stature, maturation, and fitness characteristics. In the second stage, athletes completed two Australian Football specific skill tests; the kicking and handball tests. The final stage of the data collection involved coaches rating each of the athletes' technical skills. Coaches (n=7, age 39.68 ± 7.43. years, coaching experience 11.50 ± 3.65 years) were required to complete the coaches' perception questionnaire (CPQ) (2) prior to receiving testing data previously collected. Further explanation of the CPQ is provided later in the methods. Informed consent was obtained from both the athletes and their parents/guardians and the study protocols were approved by the Universities Human Research Ethics Committee.

Maturity Assessment

Biological maturity was estimated using an age at peak height velocity (A-PHV) predictive equation (22). The regression equation uses the non-invasive anthropometric measures of body mass, standing and sitting height to predict A-PHV.

$$A - PHV = -9.326 + (0.002708 \times [\text{leg length} \times \text{sitting height}]) - (0.001663 \times [\text{age} \times \text{leg length}]) + (0.007216 \times [\text{age} \times \text{sitting height}]) + (0.02292 \times ((\frac{\text{mass}}{\text{height}}) \times 100))$$

Height and mass were measured to the nearest 0.001 m and 0.1 kg using a stadiometer (PE, Sportforce, Australia) and electric scales (Model UC-321, A&D Mercury Pty. Ltd., Australia). Sitting height was measured by sitting athletes on a 0.42 m seat with their buttocks and shoulders against the stadiometer. This method provides a reliable and practical means of assessing biological maturation, with a coefficient of determination 0.92, a standard error of measurement 0.49 years, and a mean difference of 0.24 ± 0.65 years between a verified sample of actual and predicted boys (22). Years from PHV (Y-PHV) was calculated by subtracting A-PHV from chronological age.

Adolescent male athletes are typically of advanced biological maturity when compared to normal age matched adolescent children (20, 23, 24). As such examining maturational status in reference to population norms may be inappropriate. Maturational groups were therefore defined in reference to the studies sample average Y-PHV. Commonly research using this method to define earlier and later maturational groups use a definition of ±1-year from sample averages (3, 20) however taking into account the age of the athletes such groupings were determined to be too large. Subsequently maturational groups were set to ±0.5-year in accordance with methods previously used resulting in at least one year maturational difference between the later and earlier maturing groups (25). Maturational groups were therefore calculated by adding or subtracting 0.50 years from the samples average Y-PHV (1.67 ± 0.59 years). As a result athletes were classified as later (Y-PHV below 1.17 years, n=19) average (Y-PHV between 1.18 and 2.16 years, n=55) or earlier (Y-PHV above 2.17 years, n=20) maturing.

Assessment Protocols

Prior to testing, a standardised warm up was completed by all athletes, involving light jogging, unilateral and bilateral countermovement jumps and dynamic stretching. Lower-body power was assessed using vertical jump tests. Athletes were requested to stand under a Vertec vertical jump device (Swift Performance Equipment, Lismore, Australia), with both feet flat on the ground reach up and displace the highest vane possible. This process was repeated three times, with the highest vane displaced representing the individuals reach height. Athletes were then asked to perform three counter-movement jumps and three running vertical jumps (dominant and non-dominant leg take-offs). For the running vertical jumps athletes were allowed a 5 m run up. Jump height was measured to the nearest 0.01 m with the standing and running vertical jumps measures recorded as the difference between the jump height and the standing reach height. The largest of the three measures was recorded and used for analysis. Sprint performance was evaluated by 20 m sprint time using infra-red timing gates (Smartspeed, Fusion Sport Pty Ltd, Queensland, Australia). Athletes were instructed to self-start the test to remove the effects of reaction time. Athletes were given three attempts with the fastest of the three trials recorded to the nearest 0.01 of a second. Strong intra-individual correlations were evident between trials for the jumping and sprint tasks ($r=0.80-0.88$). Aerobic fitness was assessed using the multi-stage fitness test. Athletes were required to run back and forth along a 20 m track, keeping time with a series of audio beeps. The frequency of beeps increased as the test progressed. The tests stopped when the athlete reached voluntary exhaustion or could no longer keep up with the timing of the beeps. The stage and level achieved by each athlete was recorded. For analysis, the total distance was used which was calculated from the athletes recorded shuttle stage and level.

Skill efficiency was assessed using the AFL's two skill efficiency tests; the kicking and handball tests. Athletes were required to perform six repeated skill executions, on their dominant and non-dominant sides, across a range of Australian Football specific distances (7). For the kicking test these distances 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) (24). As per methods previously outlined (7), examiners rated each of the six skill execution from 0-5 based on accuracy and trajectory outcomes. The sum of the six executions represented the individuals test score. Previous research has reported strong levels of inter-rater reliability for both the kicking (ICC=0.96, $p<.01$) and handball tests (ICC=0.89, $p<0.01$).

Subjective coaches’ perceptions of athletes were assessed using the AFL CPQ (2). The head coach from each u16 teams was asked to rate their athletes on the technical competencies of; kicking, marking, and handball efficiency, clean hands (ability to take the ball from the ground or in the air cleanly) and ball winning ability (the ability to gain possession of the ball when the ball is in a contested situation). The CPQ uses a simple 1-5 Likert scale, with rating listed as; 5 rare, 4 excellent, 3 good, 2 marginal and 1 poor (2). Outcome descriptors were attached to the 1-5 rating scale for each skill. For example, when assessing kicking and handball ability; a 5 mark was given if the athlete was considered very accurate on both dominant, and non-dominant sides, and when under pressure; the athlete was also required to be a very good decision maker.

Statistical Analysis

Statistical analysis was undertaken using SPSS version 22 (IBM, Chicago, IL, USA). Mean and standard deviation scores were calculated for all independent variables (i.e. anthropometric, fitness characteristics, skill efficiencies and coaches’ perception). One-way between group analysis of variance (ANOVA) were used to assess differences between maturational groups. Post-hoc comparisons using Gabriel’s methods were used to compare the differences between maturational groups. This post-hoc test was selected as it is offers greater statistical power when examining groups with different sample sizes (10). To measure the effect size comparing maturational groups, Hedge’s d statistic and effect size confidence intervals were calculated. 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 (15). Multiple linear regressions were run to explore the relative contribution of body size, age, and maturation on the seven dependent variables of fitness and skill. Given the high level of inter-relatedness between height and mass, a height x mass interaction based on residuals (individual value minus the mean) was also used in the regression. This height x mass interaction term was calculated as a product of the residuals for height and mass. This method reduces the collinearity among the independent variables making them more stable predictors of fitness and skill variables. A backwardselimination protocol was used which entered all variable in the equation and then sequentially removed the variables which met the criterion for elimination (p >.10). This process was repeated until all variables which met the exclusion criterion were removed. Level of statistical significance for analyses was set at p<.05. Bonferroni adjustment was applied for the post-hoc comparisons in the ANOVA with a corrected alpha level of .017 used for the pair-wise comparisons.

Results

Hedges effect size showed generally very large to moderate (range = 1.19-6.26) differences between each maturational group for height, sitting height and mass measures (Table 1). Large to moderate (range = -0.74-1.26) differences were also found between the earlier and later maturing athletes for all fitness assessments, with the exception of the multi-stage fitness test. Small to trivial (range = 0.06-0.56) difference were reported between maturation groups and skill test outcomes.

Results from the CPQ revealed earlier maturing individuals had a significantly higher overall technical rating when compared to later maturing individuals, with small to moderate between group differences (range = 0.26-0.90). However, of the independent components of the CPQ, only marking and ball winning abilities were found to demonstrate significant between group effects. Comparison between earlier and later maturing athletes demonstrated generally moderate differences (range = 0.16-1.10) for all CPQ ratings, with the earlier maturing athletes scoring higher. Generally small to trivial differences were reported when comparing CPQ scores of the average v later and earlier v average groups (range = 0.17-0.32and -0.03-0.70, respectively).

Results from the regression analysis for the physical tests are summarised in Table 3. The predictor variables explained 6-18% of the variance in all the fitness measures, with maturation a significant predictor of performance in all fitness test except the multi-stage fitness. The performance predictor for the multi-stage fitness test was mass, which had a negative beta coefficient indicating that lighter athletes performed better in the test. The only significant predictor of kicking test performance was age which again had a negative beta coefficient and explain 10% of the variance reported. There were no significant performance predictors in the handball test.

Discussion

This study tested the hypothesis that semi-elite early maturing U16 Australian footballers will have superior anthropometric, physical, technical and perceived technical skills, when compared to their later maturing counterparts. Results from this study further highlight potential issues that maturational differences presents to age-stratified competitions. Commonly, large maturational differences are seen in adolescent boys around the time of PHV, which typically occurs around 14 years of age (1). In this study, athletes were recruited from a semi-elite U16 competition. It was found that biological age differed by as much as 3.51 years, despite the least mature boy being only 0.43 years younger than the most mature. This study confirms that earlier maturing athletes are significantly taller and heavier and outperform their later maturing counterparts in sprint and jumping tasks. Investigation into how maturity effects skill and coaches' perceptions of skill found that earlier maturing athletes are also perceived by coaches' to have superior technical abilities, despite no congruent technical skill advantage evident in technical skills testing.

The earlier maturing group was significantly taller, heavier, could jump higher and sprint faster when compared to the average and later maturing groups. These findings reinforce and build from Gastin and Bennett (12) study examining a cohort of community level adolescent U15 Australian footballers, as analysis was expanded to include a counter-movement jump and running dominant and non-dominant foot jumps. It is important to include vertical jump performance in talent identification testing for Australian Football, as vertical jump performance has been shown to be an important predictor of selection into junior teams (29, 31). In all three jumping tests, earlier maturing athletes significantly out-performed their later maturing counterparts. Further, maturity assessed as Y-PHV was found to be the one consistent predictor of performance in four of the five fitness tests, accounting for 8-19% of performance variability. This agrees with research examining youth Soccer and Basketball players of a similar age which has reported maturity to be a key predictive value in jump and sprint performance (6, 18). The only fitness test not influenced by maturity was the multi-stage fitness test, with no difference between maturational groups, supporting previous research into adolescent Australian Football (12). As with other research, we found performance in the multi-stage fitness test to be inversely related to the mass of the individual, with lighter individuals performing better in the test (6). In Australian Football smaller players typically play in more nomadic positions which require greater distances to be covered within matches. The inverse relationship demonstrated between mass and performance in the multi-stage fitness test may therefore be associated with fitness adaptions linked to key physical performance requirements of smaller players within matches.

This is the first study to examine the impact of maturation on technical skill efficiencies in Australian Football. These results conform to previous research in which weak or non-significant differences were seen with maturational differences and technical skill (6, 11, 20). Small to trivial differences of no significant effect were found between maturational groups for either technical skills test, nor was there any significant predictors of performance for the handball test. Chronological age presented as the only significant predictor of performance in the kicking test accounting for 10% of the variability in performances. Interestingly a negative beta coefficient was reported indicating that chronologically younger athletes performed better in the kicking test. One explanation for this finding may be the compensation phenomenon suggested by Tranckle and Cushion (27) whereby athletes account for deficiencies in one area of performances by demonstrating higher levels of performance in another. The results may suggest that younger athletes develop superior technical skills to compensate for inferior physical performances in order to remain competitive against older and physically more superior athletes. The development of superior technical skill to compensate for physical disadvantage may in fact prove advantageous longitudinally to individuals as physical capacities have been shown to 'catch up' as athletes mature (25) , potentially resulting in more rounded athletes .

Given the strong link between team selection and relative age in the elite junior Australian Football League Talent Pathway (9) it was hypothesised that greater maturational age would result in advantageous coaches' perception of technical skills. When compared to later maturing players, earlier maturing individuals had significantly higher overall technical rating, as well as perceived marking and ball winning abilities. Biologically, older athletes have already been shown to be at a physical performance advantage in adolescent soccer and Australian football matches (4, 12) however, it has been unclear whether these maturational advantages transitioned into technical performance. The results of this study suggest that biologically older individuals are perceived by coaches to possess superior technical skill sets, despite no congruent advantage in skill demonstrated. Interestingly previous research has demonstrated that coaches' perceptions of long-term potential is advanced in earlier maturing athletes indicating that a maturation related biasing may occur (8). The combination of advanced physical capacities and perceived technical skill demonstrated in this study may result in selection biases towards athletes of greater biological maturity.

A limitation of the predictive A-PHV protocols used in this study is that the equation was originally developed using a non-athletic population (22). Currently this equation has not been validated longitudinally using samples of adolescent athletes to compare predicted A-PHV results against established maturity indicators. However recent cross-sectional research by Gastin, Bennett (13) examined a sample of adolescent Australian footballers using both the A-PHV predictive equation and participants subjective rating of actual biological maturity (Tanners stages of pubertal development) and reported very large correlations between the two measures (r=0.80). Finally, the lack of agreement of actual and perceived technical skills is a novel finding and highlights a need for further examination. For instance research should explore if coaches' perceptions of skill are supported by match related skill outcomes.

Conclusions

The study findings supports previous research demonstrating that earlier maturing Australian footballers are significantly taller, heavier and perform better in all physical tests, with the exception of the multistage fitness test. No significant differences exist between maturational groups when examining technical skills, however coaches' perceptions of overall technical skill, marking and ball winning abilities were advanced in the earlier maturing group. The combination of anthropometric, physical and perceived skill advantages afforded to early maturing athletes are likely to result in significant competition and team selection advantages. Interestingly chronologically younger athlete performed better in the kicking test potentially highlighting a compensation phenomenon. Greater technical proficiency to compensate for physical disadvantage, may in fact provide longitudinal benefit to younger athletes as they mature and physically 'catch up' to older athletes, potentially resulting in more rounded athletes. Key sporting administrators, coaches and parents should therefore be made aware of the large maturational differences present in athletes of this age, and should attempt to develop appropriate training, competition and selection policies so as not to inadvertently discriminate against later maturing adolescent athletes.

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Table 1. Anthropometric, physical and skills outcomes comparisons for later, average and earlier maturational groups (mean ± standard deviation).

	Maturation Status			ANOVA	Average vs Later	Earlier vs Later	Earlier vs Average
	Later	Average	Earlier	F-value (df:2,93)	Hedge's *d* (CI)		
Anthropometric							
Age (years)	15.41 ± 0.26	15.64 ± 0.29	15.81 ± 0.21	12.27**	0.81 (0.28-1.33)	1.65 (0.93-2.38)	0.62 (0.09-1.15)
Height (m)	1.70 ± 0.05	1.76 ± 0.05 [a]	1.84 ± 0.05[a,b]	34.46**	1.19 (0.64-1.73)	2.74 (1.87-3.62)	1.58 (1.00-2.16)
Sitting Height (m)	0.85 ± 0.02	0.91 ± 0.02[a]	0.95 ± 0.02 [a,b]	107.28**	2.97 (2.27-3.67)	4.90 (3.64-6.15)	1.98 (1.37-2.59)
Mass (kg)	61.43 ± 5.10	68.61 ± 6.05 [a]	77.29 ± 6.84 [a,b]	33.75**	1.22 (0.67-1.77)	2.59 (1.73-3.44)	1.42 (0.85-1.99)
Y-PHV	0.83 ± 0.26	1.68 ± 0.28 [a]	2.46 ± 0.25 [a,b]	174.32**	3.06 (2.35-3.77)	6.26 (4.73-7.78)	2.83 (2.14-3.52)
Fitness and Skill							
SVJ (m)	0.48 ± 0.07	0.52 ± 0.06 [a]	0.57 ± 0.07 [a]	8.47**	0.63 (0.11-1.15)	1.26 (0.57-1.95)	0.79 (0.25-1.33)
Dominant RVJ (m)	0.54 ± 0.08	0.59 ± 0.09	0.62 ± 0.08 [a,b]	5.44**	0.57 (0.05-1.09)	0.98 (0.32-1.64)	0.34 (-0.19-0.86)
Non-Dominant RVJ (m)	0.57 ± 0.08	0.62 ± 0.06 [a]	0.66 ± 0.10 [a]	5.61**	0.75 (0.23-1.28)	0.98 (0.31-1.64)	0.55 0.02-1.08)
20m Sprint (sec)	3.20 ± 0.13	3.14 ± 0.11	3.10 ± 0.14 [a]	3.26*	-0.51 (-1.03-0.00)	-0.74 (-1.37-0.08)	-0.33 (-0.86-0.19)
Shuttle Distance (m)	2200.00 ± 259.95	2139.63 ± 288.01	2116.00 ± 296.90	0.45	-0.21 (-0.73-0.3)	-0.30 (-0.93-0.34)	-0.08 (-0.6-0.44)
Kicking Test	14.89 ± 3.70	14.27 ± 3.85	16.50 ± 4.48	2.32	-0.16 (-0.67-0.35)	0.38 (-0.25-1.02)	0.56 (0.02-1.08)
Handball Test	22.42 ± 4.26	22.62 ± 2.90	23.15 ± 3.00	0.22	0.06 (-0.45-0.57)	0.19 (-0.44-0.82)	0.18 (-0.35-0.70)

Notes: ANOVA= analysis of variance, df = degrees of freedom, CI= 95% confidence interval, **p*<.05; ***p*<.01. Post hoc comparison with groups to the left: [a] significantly different (p<0.017; Bonferroni adjusted) from Later; [b] significantly different from Average. Y-PHV= years to and from peak height velocity, SVJ= standing vertical jump, RVJ= running vertical jump

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Table 2. Comparison of coaches' perceptions of skill for later, average and early maturational groups (mean ± standard deviation).

	Maturation Status			ANOVA	Average vs Later	Earlier vs Later	Earlier vs Average
	Later	Average	Earlier	F-value (df:2,93)	Hedge's *d* (CI)		
Kicking	2.63 ± 0.60	2.78 ± 0.92	2.75 ± 0.85	0.22	0.17 (-0.38-0.69)	0.16 (-0.47-0.79)	-0.03 (-0.55-0.49)
Marking	2.37 ± 0.50	2.58 ± 0.79 [a]	3.15 ± 0.85[a,b]	6.36**	0.29 (-0.23-0.80)	1.10 (-0.47-0.79)	0.70 (0.16-1.23)
Handball	2.63 ± 0.50	2.76 ± 0.79	3.10 ± 0.85	2.10	0.18 (-0.34-0.69)	0.68 (0.02-1.31)	0.42 (-0.11-0.94)
Clean Hands	2.68 ± 0.58	2.82 ± 0.84	3.25 ± 0.91	2.79	0.18 (-0.34-0.69)	0.74 (0.09-1.39)	0.50 (-0.03-1.02)
Ball Winning	2.63 ± 0.68	2.91 ± 0.91	3.40 ± 1.05[a]	3.74*	0.32 (-0.19-0.84)	0.86 (0.20-1.51)	0.51 (-0.02-1.04)
Overall Technical Rating	12.95 ± 2.20	13.85 ± 3.69	15.65 ± 3.62 [a]	3.25*	0.26 (-0.25-0.78)	0.90 (0.23-1.55)	0.48 (-0.04-1.01)

Notes: ANOVA= analysis of variance, df = degrees of freedom, * *p*<.05; ***p*<.01. Post hoc comparison with groups to the left: [a] significantly different (p<0.017; Bonferroni adjusted) from Later; [b] from Average

Table 3. Predictors of performance in physical and skill tests using multiple regression analysis

Performance Task	Predictor	Standardized beta coefficients	R^2	Adjusted R^2	*p*
SVJ (m)	Y-PHV	0.43	0.19	0.18	<.01
Dominant RVJ (m)	Y-PHV	0.29	0.08	0.07	<.01
Non-Dominant RVJ (m)	Y-PHV	0.32	0.11	0.10	<.01
20m Sprint (sec)	Y-PHV	0.28[a]	0.08	0.07	<.01
Shuttle Distance (m)	Mass	-0.26	0.07	0.06	.01
Kicking Test	Age	-0.25	0.10	0.07	.03
Handball Test	No significant predictor				

[a] The signs of the beta coefficient were reversed because a lower time represents a better performance