The influence of maturity status on movement quality among English Premier League academy soccer players

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Headline

The precise timing and tempo of maturation varies between individuals, hence, it is important to consider chronological age and maturity status separately.(6) Failure to do so exposes applied practitioners and coaches to the risk of unfairly judging young players' abilities. Since assessments of movement quality are widely used within professional soccer, a greater understanding of the influence physical maturity has on this attribute may help applied practitioners better interpret the results.(14)

Aim. The aim of the present study was to determine the influence of physical maturity status on Functional Movement Screen (FMS™) score, countermovement jump (CMJ) height and 0-10m-sprint time. Additionally, the relationships between these physical tests were investigated.

Design. Cross-sectional

Methods

Athletes. One-hundred and thirty male players registered with an English Premier League soccer club youth academy agreed to participate in the present study (age 13.8 ± 2.9 years, height 167.9 ± 13.3 cm, body mass 57.3 ± 15.1 kg). Inclusion criteria required players to be registered with the club, injury free at the time of testing and eligible for the under-11, -12, -13, -14, -15, -16 or -18 squads. Participant assent and written parental consent were obtained prior to all testing procedures. The study was approved by the Waterford Institute of Technology Research Ethics Committee and conformed to the Declaration of Helsinki. No raw data has been provided in the appendices due to legal regulations and restrictions about the sharing of player data. Therefore, only aggregated, non-identifiable data is provided in this manuscript.

Design. The present study adopted a cross-sectional design. Players meeting the inclusion criteria were assessed using the FMS™, and also performed CMJ and timed 0-10m sprints, immediately following the pre-season period of the 2015/16 soccer season. Participants' maturity status was also assessed using the method outlined by Khamis and Roche.(11)

Methodology. All physical tests were conducted by United Kingdom Strength and Conditioning Association accredited strength and conditioning coaches or chartered physiotherapists. Assessments were completed in the following order: height and body mass measurement, FMS™, CMJ and finally the 0-10m-sprint test. Height and body mass were measured using a Harpenden stadiometer (Holtain Ltd, UK) and Seca 877 scales (Seca GmbH & Co., Germany). Official FMS™test kit was used (Functional Movement Systems Inc., USA). CMJ height was measured using the Optojump-Next system (Microgate, Italy). The 0-10m-sprint times were quantified using Brower electronic timing gates (Brower Timing Systems, USA). Percentage of estimated adult height (PAH) was used to quantify maturity status for each player.(11) Participants' age, height and body mass were required for the prediction equation in addition to the heights of both biological parents. Since adults tend to overestimate their height, the self-reported height of each parent was adjusted for overestimation using a previously established equation.(8) A standardised warm up consisting of light aerobic activity and dynamic stretching was completed by all participants prior to performing the FMS™. All testers had multiple years experience in conducting the FMS™and undertook a re-cap of all procedures prior to testing each year. Standardised written instructions that followed the original test guidelines were provided for all raters and were delivered verbatim when instructing participants.(4, 5) Each participant completed all 7 sub-tests sequentially in the following order: deep squat, hurdle step, in-line lunge, shoulder mobility, active straight leg raise, trunk stability push up and rotatory stability. Participants performed CMJs as previously described; with hands on hips and knees flexed until approximately 90 degrees during the counter-movement portion of the jump.(2) Three maximal jumps were performed with the greatest height used for analysis. Similarly, players performed three maximal 0-10m sprints, separated by three minutes passive rest, with the fastest time used for analysis. All sprints were performed on an indoor third generation artificial pitch. Acceptable reliability scores for the FMS™, CMJ and 0-10m-sprint assessments have previously been reported.(7, 15, 17)

Statistical Analysis

Data are presented as the mean ± SD. Maturity groups (pre-, circa- and post-pubertal) were formed using previously established thresholds based on PAH.(6) Players with a PAH <88%, 88-96% and >96% were categorised as pre-, circa- and post-pubertal respectively.(6) Maturity groups were then compared with each other in relation to their FMS™, CMJ and 0-10m scores. Cohen's d effect sizes were calculated to demonstrate the degree of difference between groups and were interpreted as: trivial (0≤ES≤0.2), small (0.2<ES≤0.6), moderate (0.6<ES≤1.2), large (1.2<ES≤2.0), very large (2.0<ES≤4.0) and extremely large (ES>4).(3, 10) Furthermore, inference was subsequently based on the disposition of the confidence interval for the mean difference to the aforementioned effect size thresholds and calculated as per the magnitude-based inference approach using the following scale: 25-75%, possibly; 75-95%, likely; 95-99.5%, very likely; >99.5%, most likely.(10)

Table 1. The effect of maturity status (pre-, circa- or post-pubertal) on FMS™ score, CMJ height and 0-10m-sprint time

				Pre vs. circa		Pre vs. post		Circa vs post	
	Pre (n=40) Mean ± SD	Circa (n=50) Mean ± SD	Post (n=40) Mean ± SD	Mean difference (95% CI)	Qualitative inference	Mean difference (95% CI)	Qualitative inference	Mean difference (95% CI)	Qualitative inference
FMS (score)	15.5 ± 2.1	15.8 ± 2.1	17.2 ± 1.8	0.3 (-0.6-1.2)	Unclear	1.7 (0.8-2.5)	Likely moderate	1.4 (0.5-2.2)	Very likely small
0-10m (s)	2.01 ± 0.12	1.83 ± 0.11	1.71 ± 0.06	0.18 (0.13-0.23)	Likely large	0.30 (0.25-0.34)	Most likely very large	0.12 (0.08-0.15)	Possibly large
CMJ (cm)	21.6 ± 4.1	28.5 ± 4.7	35.9 ± 4.8	6.9 (5.1-8.8)	Very likely large	14.3 (12.3-16.3)	Most likely very large	7.4 (5.4-9.4)	Likely large

CI, confidence interval; CMJ, counter movement jump; FMS, Functional Movement Screen

Table 2. Relationships between FMS™ score, CMJ height and 0-10m-sprint time

	Pearson's r (95% CI)	Qualitative inference
FMS vs. 0-10m	-0.32 (-0.47 - -0.16)	Possibly moderate
FMS vs. CMJ	0.40 (0.25 - 0.54)	Likely moderate
0-10m vs. CMJ	-0.83 (-0.88 - -0.77)	Most likely large

CI, confidence interval; CMJ, counter movement jump; FMS, Functional Movement Screen

Inference was categorised as unclear if the likelihood of both a substantially positive and negative effect, based on the smallest worthwhile change (between subject SD multiplied by 0.2), exceeded 5%.(9) Finally, Pearson's product-moment correlation coefficients were used to determine the relationships between the physical tests used in the present study (FMS™, CMJ and 0-10m sprint) and were interpreted using the following scale: trivial (0≤ES≤0.1), small (0.1<ES≤0.3), moderate (0.3<ES≤0.5), large (0.5<ES≤0.7), very large (0.7<ES≤0.9) and extremely large (ES>0.9).(3, 10) Inferences were calculated for the correlation coefficients as described above using the relevant effect thresholds.

Results

Maturity group comparisons related to FMS™score, CMJ height and 0-10m-sprint time are presented in Table 1. The relationships between the fitness tests used in the present study are displayed in Table 2.

Discussion

Comparison of maturity groups revealed very large/large differences in CMJ height and 0-10m-sprint times between pre-, circa- and post-pubertal groups (Table 1). However, this pattern was not observed when considering FMS™score. While pre- and circa-pubertal groups achieved lower scores compared to the post-pubertal group, they did not differ when compared to each other. This suggests non-linear development of movement quality and potentially a stagnation of this attribute around the period of peak height velocity (PHV).

A potential explanation for this observation is the theory of 'adolescent awkwardness'.(19) While consensus on exactly what constitutes 'adolescent awkwardness' is lacking it has been broadly described as "delays or regressions in sensorimotor function relative to rapid growth spurts".(19) The theory is appealing since it makes intuitive sense that rapid changes in limb length and body mass may disrupt previously established motor patterns. In addition, Viel et al.(20) suggested that adolescence represents a period during which proprioception is still developing and postural control is impaired compared to adults. The combination of rapid changes in limb length, body mass and impaired proprioceptive ability during adolescence may explain why no difference in FMS™score was observed between pre- and circa-pubertal groups. Any potential 'adolescent awkwardness' did not appear to have the same effect on CMJ height and 0-10m-sprint times. It may be that any detrimental influence of maturation on motor control/coordination that affected movement quality was offset by increases in muscle mass contributing to sustained improvement in these other physical attributes. However, since body composition and strength were not directly measured in the present study this explanation is speculative, but may warrant further investigation.

The correlation analysis revealed that all three physical tests included in the present study were related to each other with the strength of these relationships ranging from possibly moderate to most likely large (Table 2). This observation adds to the limited evidence base proposing a desirable relationship between movement quality and other physical performance attributes.(13, 21) While movement quality assessment is widespread within professional soccer, the results are often viewed from an injury prevention perspective despite a lack of evidence to support this practice.(1, 14-16, 18) The apparently desirable relationships between movement quality assessments and other performance-related outcomes perhaps offers a more appropriate rationale for monitoring and developing this skill.(13, 21) While correlation does not equate to causation, the available evidence hints that developing movement quality may help improve other physical attributes like sprinting speed and jumping ability. At the very least, working on movement quality is unlikely to hinder any other aspect of physical development. Indeed, it is reasonable to expect that movement quality should be positively and negatively associated with tasks such as jumping and sprinting respectively since fundamental athletic traits like adequate joint range of motion, balance and inter-segmental coordination – that characterize movement quality – also underpin these more complex sporting tasks.(12, 15)

Practical Applications

- Applied practitioners should be aware of the arrested development of movement quality around PHV. They may wish to consider implementing movement quality based training interventions with players around PHV in an effort to counteract the effects of 'adolescent awkwardness'.
- While the observed relationships between the physical tests used in this study are based on correlations; hence, not necessarily causal, applied practitioners may also consider movement quality development as a useful adjunct to traditional strength training for improving jump height and sprinting speed.

Limitations

- The cross-sectional nature of the present study limits the strength of the conclusions drawn. Longitudinal investigations that address the question of whether an improvement/worsening of FMS™score has a corresponding impact on other physical qualities are warranted. Similarly, monitoring within-individual FMS™scores over multiple seasons would provide a clearer picture of the developmental trajectory associated with this attribute.

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