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Fundamental movement skills and perceived competence, but not fitness, are the key factors associated with technical skill performance in boys who play grassroots soccer

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ABSTRACT

Objective: This study examined the association between fitness, fundamental movement skills (FMS) and perceived competence on technical skills in boys engaged in grassroots soccer. Methods: Sixty boys (8-12 years of age, Mean ± SD = 10 ± 1 years) undertook assessment of FMS, perceived competence, physical fitness (15m sprint speed, standing long jump distance and seated 1kg medicine ball throw as a composite z-score) and technical skills (dribbling, passing and shooting as a composite z-score).

Results: Multiple backwards linear regression was used to determine to amount of variance in technical skill explained by FMS, perceived competence and fitness. Results indicated a significant model (F 3,58= 42.04, P = .0001, Adj R2 = .680) which explained 68% of the variance in technical skills. Perceived competence (β=.316, P =.001), Total FMS (β=.140, P =.002), and chronological age (β=.863), P =.001) significantly contributed to the model.

Conclusion: This study demonstrates that better technical skills (passing, dribbling, shooting) in youth soccer are explained, alongside age, by being competent in FMS and having a more positive perception of competence. Coaches should therefore seek to encourage development of these factors during childhood for the benefit of technical skill performance.

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KEYWORDS
Motor competence; children; grassroots; passing; dribbling; shooting

Introduction

Irrespective of playing level, soccer is a dynamic, multidimensional, and complex sport, reliant on technical, tactical, physical and psychological factors (Forsman et al. 2016). From grassroots to professional levels there is a continual focus on the development of soccer-related skills during childhood and into adolescence (Huijgen et al. 2013). Technical skills such as passing, dribbling, and shooting are considered critical prerequisites for success in soccer (Rampinini et al. 2009). There are also studies that have focused on physical fitness as prerequisite factors in youth soccer (Meylan et al. 2010; Unnithan et al. 2012; Höner et al. 2017; Serrano et al. 2017; Morris et al. 2020; Leyhr et al. 2018).

More recently there has been an acknowledgement that general motor competence and the development of fundamental movement skills (FMS) may be an important consideration in the development of soccer talent in youth (Vandendriessche et al. 2012; Deprez et al. 2014, 2015a, 2015b; Rommers et al. 2018; Kokstejn et al. 2019). General motor competence is a significant long term predictor of physical performance (aerobic fitness and explosive power) in youth soccer players (Rommers et al. 2018). Despite the wealth of information suggesting FMS play an important role in future sport performance, and specifically underpin performance in soccer (Jukic et al. 2019), and their inclusion as key pillars in frameworks for youth movement development such as the Athletic Skills Model (Wormhoudt et al. 2017), there remains a lack of research examining how FMS link with or interact with other aspects of soccer performance in young players including physical abilities and technical skills. This is despite the fact that national governing body coaching awards in soccer explicitly focus on the development of FMS within their curricula (FAI 2009; North et al. 2014; The FA, 2016).

Only two studies to date appear to have examined this issue. In a sample of 23, 9–10-year-old boys, Jukic et al. (2019) reported that first team players, compared to second team players, demonstrated no significant differences in physiological fitness (Multi-stage fitness test, 10–40 m sprint, standing long jump, sit and reach) but significant differences in FMS, as assessed by the Test of Gross Motor Development-2. Jukic et al. (2019) did not include any assessment of soccer skill in their work, limiting the conclusions that could be drawn from their results. Most recently, Kokstejn et al. (2019) used path analysis to examine relations between FMS, fitness and speed dribbling in 40 elite, Czech youth players. Inclusion of FMS in their model significantly strengthened the association between fitness and dribbling performance leading the authors to conclude that FMS play an important role in the acquisition of sport-specific skill. Although the study by Kokstejn et al. (2019) offers a useful first step to determine the extent to which FMS are important in youth soccer development, their study only included one measure of technical skill and did not consider any measure of psychological aspects related to performance and were both cited as limitations by Kokstejn et al. (2019). Given that factors

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such as self-efficacy and perception of competence are related to movement skill performance in children (Peers et al. 2020), understanding how such factors alongside FMS and fitness relate to technical skills in soccer remains an unanswered question.

The current study therefore sought to address this issue by examining the relationship between fitness, FMS, and perception of competence on technical soccer skills in boys who were engaged in grassroots soccer.

Methods

Participants

Sixty boys aged 8–12 years of age (Mean ± SD = 10 ± 1 years, 137.8 ± 10.9 cm, 33.6 ± 9.1 kg) who were regularly engaged in grassroots soccer participated in the study following institutional ethics approval, informed parental consent and child assent, in line with the Declaration of Helsinki (1964). The Fédération Internationale de Football Association (FIFA 2011) defines grassroots soccer as recreational soccer taking place, predominantly in children from the age of 6 years on to promote mass participation in soccer. The definition of grassroots soccer employed in the current study adhered to the FIFA (2011) definition as well as aligning with the structure of grassroots soccer in England. To be eligible to participate, children had to be registered (and playing) with a grassroots soccer club with at least 1 year playing experience prior to taking part, and including participation in training and organised fixtures against other grassroots teams within the County FA structure in England. Mean ± SD of years playing experience for the sample was 3.5 ± 1.3 years. All participants in the current study were engaged in three grassroots football sessions per week, including one organised fixture against another grassroots soccer club within the same County FA. Participants were recruited from junior grassroots clubs (n = 7) within the Nuneaton and Bedworth Junior Football League, within Birmingham County FA, via contact with club secretaries who disseminated the opportunity to take part. Players then volunteered to participate, provided they were eligible.

Procedures

All assessments took place over two days. On the first day of assessment psychometric questionnaires were completed first followed by anthropometric assessment. This was followed on the second day by technical skill assessment and fitness assessment. All assessments were conducted by trained researchers and the participants' soccer club coaches were not involved in any way.

Anthropometry

Stature (cm) and body mass (kg) were assessed to the nearest 0.1 cm and 0.1 kg using a SECA anthropometer and weighing scales (SECA Instruments Ltd, Hamburg, Germany), respectively.

Fundamental movement skills

Fundamental movement skills were assessed using the Test of Gross Motor Development-2 (TGMD-2, Ulrich 2001). The following skills were selected: run, jump, hop, overhand throw, catch, and strike to reflect a balance of locomotor and object control skills, without the inclusion of kick to avoid confounding the assessment of FMS and technical soccer skills. Each skill is comprised of 3–5 components, and skill mastery on the TGMD-2 requires each component to be present. Trials of each skill were video-recorded (Sony Handycam CX405b, Sony, UK) and subsequently edited recordings into single film clips of individual skills with Quintic Biomechanics analysis software v21 (Quintic Consultancy Ltd., UK). Scores from two trials were summed to create a total FMS score (scored 0–50) following recommended TGMD-2 test administration guidelines (Ulrich 2001).

Perceived competence

The Perceived Physical Ability Scale for Children (PPASC, Colella et al. 2008) was used to assess perceived competence. The PPASC is a valid and reliable tool for children of the ages taking part in this study which assesses physical self-efficacy. It is a 6-item measure comprising questions reflecting strength, speed and coordinative abilities. Items are structured in response scales with a 1 to 4 format. Labels are attached to each point of the response scales to assist giving meaning to the items for the children. For example, scores for the first item range from 1 (I run very slowly) to 4 (I run very fast). The children were asked to think of themselves when playing/training in soccer and were asked to choose one of the four sentences that best represented their perceived ability. Administration followed recommended guidelines (Colella et al. 2008) with a potential score of 6–24 and higher score representing a high self-perception of physical competence.

Technical skills

Three different tests of technical skills were completed by the participants reflecting three different aspects of skill performance in soccer; dribbling, passing, shooting. All testing took place on a vinyl sprung surface (as typically used for Futsal) in a sports hall with participants wearing soccer training shoes. All testing was completed with the official ball size for age band (Size 3 for U8-U9, Size 4 for U10-12) as recommended by the Football Association. Testing was completed individually by the participants to minimise any peer pressure to perform. A full description of procedures used to assess technical skills is provided in the supplementary material, but, in brief, soccer dribbling was assessed using the Ghent University (UGent) dribbling test as previously described by Vandendriessche et al. (2012). Soccer passing was assessed using the Haaland and Hoff (2003) passing test. Fifteen passes were attempted using each foot with one point awarded per successful attempt, with a total score possible of 30. Soccer shooting was assessed using the Rosch et al. (2000) shooting test. Five attempts were made with a total possible score of 30.

On completion of the tests, we calculated each participant's Z-score for each of the three measures of soccer technical skill and summed these Z-scores to create a composite measure of technical skill reflecting dribbling, passing and shooting performance. Recognising that lower scores on the UGent dribbling test reflect better performance, scores on this task were made negative before creating the summed z-score. The use of a composite Z-score was employed as a means to bring together three aspects of technical skill as a theoretical concept as per Song et al. (2013).

Physical fitness

Three measures of physical fitness were employed; 15 m sprint time, standing long jump, and seated medicine ball (1 kg) throw. Each participant's 15 meter sprint time was assessed using infrared timing gates (Fusion Sport, Coopers Plains, Australia) with sprint time converted to speed in m/s. Standing long jump was determined as distance from take-off line to the back of the closest heel on landing and assessed using a tape measure. Participants performed the seated medicine ball throw, as a measure of upper body strength, using a 1 kg medicine ball. Participants sat on the floor before throwing the medicine ball forward like a chest pass three times. Distance thrown (in centimetres) as assessed with a tape measure. For sprint speed and long jump, the best of two trials (fastest speed in m/s; longest jump in centimetres) was selected for analysis and for seated medicine ball throw the furthest distance thrown was used for subsequent analysis. Intraclass correlation coefficients for the three product measures of fitness were .9 for the 10 m sprint, .94 for the standing long jump, and .86, for the seated medicine ball throw indicating good reliability. As with technical skills, testing was completed individually and we calculated a Z-score for each of our three measures of fitness and summed these Z-scores to create a composite product measure of physical fitness.

Statistical analysis

In order to examine the relationship between technical skills and FMS, fitness, perceived ability and age, multiple backwards linear regression was employed. Pearson's product moment correlations between variables were also determined and prior to analysis data were inspected to ensure the assumptions for multiple linear regression were met including lack of multicollinearity in the data that values of residuals were independent and the variance of the residuals was constant and were normally distributed. The Statistical Package for Social Sciences (SPSS version 25) was used for all analysis. Backwards elimination to achieve a parsimonious solution was employed for a number of reasons. Guidelines for variable selections strategies (Chowdhury and Turin 2020) were followed in informing model selection for the regression, where backwards elimination holds several advantages over enter or forwards elimination models. Notably backwards elimination has the advantage to assess the joint predictive ability of variables as it begins with a fully saturated model (Chowdhury and Turin 2020). Within backwards elimination variables are automatically removed from the model one by one until the remaining variables are considered to have some significant contribution to the outcome (Ratner 2010).

Table 1. Mean ± SD and 95% confidence intervals of age, technical skill z-score, physical fitness z-score, total FMS and perceived physical competence.

	Mean	SD	95% CI
Age (Years)	9.8	1.4	9.4–10.2
Technical Skill (z-score)	.09	2.6	−.60-.79
Physical Fitness (z-score)	.48	2.2	−.099–1.06
Total FMS (0–50)	35.6	6.6	33.9–37.4
Perceived Competence (6–24)	18.7	2.3	18.1–19.3

Table 2. Pearson's product moment correlations between variables (**P > .01, *P > .05).

	Technical Skill	Physical Fitness	Total FMS	Perceived Competence
Age	r = .72**	r = .71**	r = .67**	r = .10
Technical Skill		r = .72**	r = .72**	r = .42*
Physical Fitness			r = .79**	r = .29*
Total FMS				r = .31*

Results

Mean ± SD and 95% confidence intervals for all variables are presented in Table 1.

Pearson's product moment relationships were significant between all variables (P > .05 or better, see Table 2) with the exception of the relationship between age and perceived ability.

Results from multiple backwards linear regressions indicated a significant model ($F_{3,58}$ = 42.04, P = .0001, Adj R^2 = .680) which explained 68% of the variance in technical skills. Perceived competence (β = .316, P = .001), Total FMS (β = .140, P = .002), and chronological age (β = .863), P = .001) significantly contributed to the model. Physical fitness (P = .289) was excluded from the parsimonious solution as non-significant predictors. Of note, beta values indicated that perceived competence was a more important contributor in the model than actual FMS, with a one unit change in perceived competence being associated with a .316 unit change in technical skill, more than double that of actual FMS, where a one unit change in FMS was associated with a .140 unit change in technical skill.

Discussion

The present study examined the relationship between fitness, FMS, and perception of competence on technical soccer skills in boys who were engaged in grassroots soccer. The findings of the current study suggest that, in youth recreational grassroots soccer players, competence in FMS and a positive perception of one's own ability are key in explaining technical skills. In prior studies there has been an emphasis on development of physical fitness (Deprez et al. 2015b) as a key variable for successful soccer performance. However, there is a recognised theory-practice gap in coaching behaviour and practice from

grassroots to elite levels of youth soccer (Cushion et al. 2012) and a recognised over reliance on physical attributes and body size in coach decisions relating to selection/deselection or practice design for youth soccer players (Vaeyens et al. 2008). Key theoretical models such as the Athletic Skills Model (Wormhoudt et al. 2017) have emphasised the importance of developing FMS as a foundation for more specialised sport performance. Kokstejn et al. (2019) also recently suggested that FMS was a key factor in the relationship between fitness and soccer dribbling performance in elite youth players. The current study agrees with these assertions and extends research in this area, providing evidence that FMS, alongside perceived ability are key variables in explaining technical performance in soccer using a composite of technical skills reflecting the main aspects of youth soccer performance (dribbling, passing and shooting).

The results of the current study would support the assertions of the Athletic Skills Model in regard to the importance of FMS and might suggest youth soccer coaches at grassroots levels may benefit from refocusing away from solely concentrating on soccer-specific practices during training (Wormhoudt et al. 2017). It is also a key, but often overlooked consideration, that perceived competence was a significant contributor to predicting technical skills. Our results indicated that a child's perception of their own competence was a more important contributor to technical skill performance than actual FMS, with beta values for perceived competence being more than double than those for actual FMS. There is an acknowledgement that self-efficacy plays a role in the use of wider psychological skills in adolescent soccer players (Munroe-Chandler et al. 2008) and perceived competence has been identified as a contributor to the impact of FMS on habitual physical activity (Stodden et al. 2008) and children with lower perceived competence have poorer movement skills (Duncan et al. 2018). In the context of the current study, although prior work has examined the importance of perceived competence in FMS (Barnett et al. 2011; Liong et al. 2015), no work appears to have examined how perceived competence might be related to sport-specific technical skills in children. This is important as the pre-pubertal period is one where technical skills develop more rapidly (Valento-dos-santos et al. 2012) and one where perception of competence becomes refined (Barnett et al. 2011). Focusing on broader capacities during this period may therefore have greater applicability to overall sporting potential than focusing on sport-specific assessment of perceived competence. The results of the current study suggest that coaches should be mindful to encourage positive perceptions of competence in addition to practices to develop actual fundamental movement skills.

The participants in the present study were all grassroots soccer players, engaged in regular training and fixtures against other teams. FIFA (2011) definition of grassroots soccer was employed when recruiting participants for the present study, and it is useful to highlight that for FIFA (2011), grassroots soccer is seen as developing relationships, team spirit and fun through soccer. A question could be asked relating to how relevant technical skill development and the development of perceived competence might be in this context. While the development of relationships and fun is a serious deliberation for soccer coaches, structuring training situations which develop competence (i.e. technical skills) and confidence (via perceived competence) are considered cornerstones in enhancing children's experiences through sport including enjoyment and involvement through the development of physical literacy (Warner et al. 2020). The results of the present study highlight a need to consider alignment of theory to practice for the benefit of overall movement in children engaged in grassroots soccer. The participants in the current study were all drawn from English grassroots soccer clubs and are thus reflective of the development system at grassroots level employed by the English FA. It is possible there are cross-cultural differences in practices of coaches at grassroots levels in their philosophy related to developing FMS and perceived competence through their football coaching. The association between fitness, FMS, and perceived competence may therefore differ depending on which country the participants are drawn from.

The current study of course has limitations. The participants in the current study were all boys and, as a consequence, the conclusions drawn here should not be inferred for girls. Given the growing number of girls participating in grassroots soccer, future work should examine the potential association between FMS, perceived competence, physical fitness and technical skills in girls. Longitudinal designs would be particularly welcome as would an examination of how FMS and perceived competence might be associated with technical skills in different age groups of children. Age is likely confounded by the amount of practice the participants had undertaken, with practice being critical to technical skill development. Although we did not have detailed information on the types of practice the participants had also undertaken, all the children in the present study were engaged in three, sixty-minute sessions of training/game play per week, including one competitive game. Post-hoc analysis of the relationship between chronological age and years of playing experience in organised, competitive grassroots football indicated a significant, positive relationship ($r = .798$), reinforcing the association between age and years playing experience. We used a composite measure of both fitness and soccer related technical skills as a means to address suggestions for future research in prior work (Kokstejn et al. 2019). In this way we sought to provide a holistic overview reflecting technical skills for soccer beyond simple dribbling. However, a useful next step would be to establish how fundamental motor skills might relate to tactical as well as technical ability in youth soccer. It should be recognised that creation of such a composite assumes each contributor to the composite (passing, dribbling and shooting in this instance) do not need to be weighted. We followed Rampinini et al.'s (2009) assertion that the three aforementioned technical aspects of soccer are prerequisites for success. There is currently no indication in the literature in terms of which of these might need to be weighted more or less and without this, we felt it acceptable to consider the composite as an equally weighted Z-score (Song et al. 2013). An interesting avenue for future research would be determination of which particular aspects of technical skill might be more or less important in overall technical skill development. The use of TGMD-2 as a measure of FMS is

potentially limited due to ceiling effects, where children have already achieved mastery. In the present study mastery levels for the skills examined were relatively low but were slightly higher than those reported for school children in the United Kingdom (Duncan et al. 2018) potentially reflecting the fact that they are grassroots players who are not in an explicit talent development structure but also are regularly engaged in football/sport. No participant in the present study had mastered all of the FMS skills making a true ceiling effect unlikely. No data was available relating to the habitual physical activity or other organised sports the children undertook, and this should be regarded as a limitation of the present study. We are also conscious that biological maturation may be an important confounder of the relationship between fitness, FMS and technical skills in children. Without a measure of seated height there was no way to reliably assess maturation, taking into account the differential growth of the extremities and the torso which are key considerations when estimating maturational status in children. Freitas et al. (2016) noted limited influence of maturation on fitness and coordination in children younger than 12 years of age but we are cognisant of the lack of measure of biological maturation in the present study. Likewise, our inclusion of a measure of self-perceived competence addresses a need for considering psychological factors alongside FMS, fitness and technical skills identified in prior work (Kokstejn et al. 2019). However, there is potential that other psychological skills and cognitive factors might be important in the development of technical skills.

Conclusions

This study demonstrates that better technical skills (passing, dribbling, shooting) in youth soccer are explained, alongside age, by being competent in FMS and having a more positive perception of individual competence. Coaches should therefore seek to avoid one-sided delivery of practice by not solely focusing on football type drills, and focusing on a range of sports, with children aged 8–12 and instead should balance this focus alongside efforts to enhance a broad foundation of fundamental movement skills and strategies to positively shape a child's perception of their own competence.

Disclosure statement

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References

Barnett LM, Morgan PJ, Van Beurden E, Ball K, Lubans DR. 2011. A reverse pathway? Actual and perceived skill proficiency and physical activity. Med Sci Sports Exerc. 43:898–904. doi:10.1249/MSS.0b013e3181fdfadd.

Chowdhury MZI, Turin TC. 2020. Variable selection strategies and its importance in clinical prediction modelling. Family Med Community Health. 8: e000262. doi:10.1136/fmch-2019-000262.

Colella D, Morano M, Bortoli A, Robazza C. 2008. A physical self efficacy scale for children. Soc Behav Personal. 36:841–848. doi:10.2224/sbp.2008.36.6.841.

Cushion C, Ford PR, Williams AM. 2012. Coach behaviours and practice structures in youth soccer: implications for talent development. J Sports Sci. 30(15):1631–1641. doi:10.1080/02640414.2012.721930.

Deprez D, Valente-dos-santos J, Coelho-e-silva M, Lenoir M, Philippaerts RM, Vaeyens R. 2014. Modeling developmental changes in the yo-yo intermittent recovery test level 1 in elite pubertal soccer players. Int J Sports Physiol Perform. 9:1006–1012. doi:10.1123/ijspp.2013-0368.

Deprez D, Valente-Dos-Santos J, Coelho-e-silva MJ, Lenoir M, Philippaerts R, Vaeyens R. 2015a. Longitudinal development of explosive leg power from childhood to adulthood in soccer players. Int J Sports Med. 36:672–679. doi:10.1055/s-0034-1398577.

Deprez DN, Fransen J, Lenoir M, Philippaerts RM, Vaeyens R. 2015b. A retrospective study on anthropometrical, physical fitness, and motor coordination characteristics that influence dropout, contract status, and first-team playing time in high-level soccer players aged eight to eighteen years. J Strength Condition Res. 29:1692–1704. doi:10.1519/JSC.0000000000000806.

Duncan MJ, Jones V, O'Brien W, Barnett LM, Eyre ELJ. 2018. Self-perceived and actual motor competence in young British children. Percept Mot Skills. 125:251–264. doi:10.1177/0031512517752833.

FAI. 2009. The fundamental phase. Dublin: FAI. https://www.fai.ie/domestic/news/phase-1-%E2%80%93-the-fundamental-phase .

FIFA. 2011. Grassroots football. Zurich: FIFA. https://www.fifa.com/who-we-are/news/grassroots-goes-live-fifa-com–1462069 .

Forsman H, Gråstén A, Blomqvist M, Davids K, Liukkonen J, Konttinen N. 2016. Development of perceived competence, tactical skills, motivation, technical skills, and speed and agility in young soccer players. J Sports Sci. 34:1311–1318. doi:10.1080/02640414.2015.1127401.

Freitas DL, Lausen B, Maia JA, Gouveia ER, Thomis M, Lefevre J, Silva RD, Malina RM. 2016. Skeletal maturation, body size, and motor coordination in youth 1114 years. Med Sci Sports Exerc. 48:1129–1135. doi:10.1249/MSS.0000000000000873.

Haaland E, Hoff J. 2003. Non-dominant leg training improves the bilateral motor performance of soccer players. Scand J Med Sci Sports. 13:179–184. doi:10.1034/j.1600-0838.2003.00296.x.

Höner O, Leyhr D, Kelava A. 2017. The influence of speed abilities and technical skills in early adolescence on adult success in soccer: a long term prospective analysis using ANOVA and SEM approaches. PLoS One. 12:e0182211. doi:10.1371/journal.pone.0182211.

Huijgen BC, Elferink-Gemser MT, Ali A, Visscher C. 2013. Soccer skill development in talented players. Int J Sports Med. 34:720–726. doi:10.1055/s-0032-1323781.

Jukic I, Prnjak K, Zoellner A, Tufano JJ, Sekulic D, Salaj S. 2019. The importance of fundamental motor skills in identifying differences in performance levels of U10 soccer players. Sports. 7:178. doi:10.3390/sports7070178.

Kokstejn J, Musalek M, Wolanski P, Murawska-Cialowicz E, Stastny P. 2019. Fundamental motor skills mediate the relationship between physical fitness and soccer-specific motor skills in young soccer players. Front Physiol. 10:596. doi:10.3389/fphys.2019.00596.

Leyhr D, Kelava A, Raabe J, Höner O. 2018. Longitudinal motor performance development in early adolescence and its relationship to adult success: an 8-year prospective study of highly talented soccer players. PLoS One. 13:e0196324. doi:10.1371/journal.pone.0196324.

Liong GH, Ridgers ND, Barnett LM. 2015. Associations between skill perceptions and young children's actual fundamental movement skills. Percept Mot Skills. 120:591–603. doi:10.2466/10.25.PMS.120v18x2.

Meylan C, Cronin J, Oliver J, Hughes M. 2010. Talent identification in soccer: the role of maturity status on physical, physiological and technical characteristics. Int J Sports Sci Coach. 5:571–592. doi:10.1260/1747-9541.5.4.571.

Morris RO, Jones B, Myers T, Lake J, Emmonds S, Clarke ND, Till K. 2020. Isometric midthigh pull characteristics in elite youth male soccer players: comparisons by age and maturity offset. J Strength Condition Res. 34:2947–2955. Epub ahead of print.

Munroe-Chandler K, Hall C, Fishburne G. 2008. Playing with confidence: the relationship between imagery use and self-confidence and self-efficacy in youth soccer players. J Sports Sci. 26(14):1539–1546. doi:10.1080/02640410802315419.

North J, Lara-Bercial S, Morgan G, Rongen F, Broche D, Nentwig G, Frederic S, Sargison J. 2014. The identification of good practice principles to inform player development and coaching in European youth football. Zurich: UEFA.

Peers C, Issartel J, Behan S, O'Connor N, Belton S. 2020. Movement competence: association with physical self-efficacy and physical activity. Hum Mov Sci. 70:70, 102582. doi:10.1016/j.humov.2020.102582.

Rampinini E, Impellizzeri FM, Castagna C, Coutts AJ, Wisløff U. 2009. Technical performance during soccer matches of the Italian serie a league: effect of fatigue and competitive level. J Sci Med Sport. 12:227–233.

Ratner B. 2010. Variable selection methods in regression: ignorable problem, outing notable solution. J Targeting Meas Anal Market. 18:65–75. doi:10.1057/jt.2009.26.

Rommers N, Mostaert M, Goossens L, Vaeyens R, Witvrouw E, Lenoir M, D'Hondt E. 2018. Age and maturity related differences in motor coordination among male elite youth soccer players. J Sports Sci. 37:196–203. doi:10.1080/02640414.2018.1488454.

Rosch D, Hodgson R, Peterson L, Graf- Baumann T, Junge A, Chomiak J, Dvorak J. 2000. Assessment and evaluation of football performance. Am J Sports Med. 28:S29–S39. doi:10.1177/28.suppl_5.s-29.

Serrano JS, Pizarro AP, García-González L, Domínguez AM, Álvarez FV. 2017. Evolution of tactical behavior of soccer players across their development. Int J Perform Anal Sport. 17:885–901. doi:10.1080/24748668.2017.1406781.

Song M-K, Lin F-C, Ward SE, Fine J. 2013. Composite variables: when and how. Nurs Res. 62:45–49. doi:10.1097/NNR.0b013e3182741948.

Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C, Garcia LE. 2008. A developmental perspective on the role of motor skill competence in physical activity: an emergent relationship. Quest. 60:290–306. doi:10.1080/00336297.2008.10483582.

The FA. 2016. Fundamental movements in the foundation stage. Staffordshire: The FA. http://www.thefa.com/learning/coaching/fundamental-movements-in-the-foundation-phase

Ulrich DA. 2001. Test of gross motor development. 2nd ed. Austin (TX): PRO-ED.

Unnithan V, White J, Georgiou A, Iga J, Drust B. 2012. Talent identification in youth soccer. J Sports Sci. 30:1719–1726. doi:10.1080/02640414.2012.731515.

Vaeyens, R., Lenoir, M., Williams, A.M., Philippaerts, R.M. (2008). Talent identification and development programmes in sport: current models and future directions. *Sports Medicine*. 38:703–714

Valento-dos-santos J, Coelho-e-silva MJ, Simoes F, Figueiredo AJ, Leite N, Elferink-Gemser MT, … Sherar L. 2012. Modeling developmental changes in functional capacities and soccer-specific skills in male players aged 11–17 years. Pediatr Exerc Sci. 24:603–621. doi:10.1123/pes.24.4.603.

Vandendriessche JB, Vaeyens R, Vandorpe B, Lenoir M, Lefevre J, Philippaerts RM. 2012. Biological maturation, morphology, fitness, and motor coordination as part of a selection strategy in the search for international youth soccer players (age 15–16 years). J Sports Sci. 30:1695–1703. doi:10.1080/02640414.2011.652654.

Warner M, Robinson J, Heal B, Lloyd J, Mandingo J, Lennox B, Davenport Huyer L. 2020. Increasing physical literacy in youth: a two-week sport for development programme for children aged 610. Prospects. e-pub ahead of print.

Wormhoudt R, Savelsbergh G, Teunissen J, Davids K. 2017. The athletic skills model. London: Routledge.