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Original Article

The relationship between fundamental motor skills and game specific skills in elite young soccer players

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Abstract:
Game specific motor skills develop the foundation of the game of football. The importance of fundamental motor skills as a substantial basis of sport-specific motor skills is generally accepted. However, up until now, research on the relationship between fundamental and specific motor skills in soccer players has been missing. The aim of this study, therefore, was to investigate the relationship between fundamental motor skills and game specific motor skills in elite young football players (N = 24; mean age 11.6 ± 0.4 years). Football specific dribbling and shooting test as a game-specific motor skills and The Test of Gross Motor Skills – 2nd edition (TGMD-2) as a set of fundamental motor skills were used. We found a strong relationship between TGMD-2 and game-specific motor skills (r = 0.62 - 0.70). The horizontal jump and catch were found to be the best predictors of game-specific motor skills ($F_{(2, 21)} = 21.13$, $p < 0.001$, $R^2 = 0.64$). The players reported the poorest performance in several subtests: striking a stationary ball, overhand throw, underhand roll, and horizontal jump. These results demonstrate the need for a certain level of both fine and gross fundamental motor skills in order to acquire game-specific motor skills. Youth coaches should emphasize adequate development of FMS, particularly during early and middle childhood. Coaches should especially develop and improve a wide range of fundamental motor skills as building blocks of more complex and difficult, football-specific, motor skills during the long-term training process.
Key Words: *soccer, motor skills, performance, test, elite youth*

Introduction

A player's performance in a football match depends on their cognitive, perceptive and motor skills (Ali, 2011), all of which are influenced by technical, tactical, physiological, physical and mental factors (Reilly, Williams, Nevill, & Franks, 2000; Stolen, Chamari, Castagna, & Wisloff, 2005). It is well established that game-specific motor skills (GSMS) like receiving, passing, shooting, and dribbling are fundamental elements of the football game (Ali, 2011). GSMS measurement is often used to distinguish between elite and non-elite players, and thus, often serves as predictors of elite football performance (Waldron & Worsfold, 2010). Skills testing is also used to identify and develop strategies to improve acquisition and maintenance of performance-related skills during match play (Ali, 2011). Given the importance of GSMS in the football game, the dribbling test has been found to be the best indicator of relative performance levels of football players, allowing easier identification of elite players (Reilly et al., 2000; Rösch et al., 2000; Vaeyens et al., 2006).

Recently, the role of non-specific motor coordination has been highlighted as an important predictor of talent in young football players (Vandendriessche et al., 2012; Deprez, Fransen, Lenoir, Philippaerts, & Vaeyens, 2015b). There seems, however, to be a deficit in studies focused on the relationship between GSMS and non-specific motor coordination which is particulary related to performance in fundamental motor skills (FMS). This relationship has been verified by Božanić and Bešlija (2010), who found high correlations between specific karate skills and FMS (r = 0.74) in five- to seven-year-old members of karate clubs. The authors suggest that children with a higher level of FMS demonstrate a higher level of karate technique, while other children clearly have difficulties in acquiring the same karate-specific techniques.

FMS are commonly grouped into the functional skill categories of locomotor, balance and manipulative skills (Galahue, Ozmun, & Goodway, 2011). According to Galahue's theoretical Triangulated Hourglass Model of motor development, mastering FMS leads to easier learning of sport-specific skills (Clark & Metcalfe, 2002). Given the fundamental nature of this relationship, it follows that mastery in FMS predicts a higher level of physical activity in players (Barnett, Morgan, van Beurden, & Beard, 2008; Bryant, James, Birch, & Duncan, 2014) which, in turn, predicts a significantly higher investment of time in practice. Thus, both the quality and quantity of sport-specific motor skills acquired is also increased.

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According to Gallahue, Ozmun and Goodway (2011), children have the developmental potential to master most FMS by the age of six. Moreover, research data from a Victoria, Australia, Department of Education (1996) suggest that all FMS can be mastered by 10-11 years. Therefore, it is reasonable to expect that older children who have participated in organized sport should demonstrate FMS competency. Yet, recent research has highlighted that children and adolescent youth are not performing FMS to their expected developmental capability (Hardy, King, Farrell, Macniven, & Howlett, 2010; Booth et al., 1999; Mitchel et al., 2013; Pang & Fong, 2009). Therefore, the aim of this study was to investigate the relationship between FMS and GSMS in young elite football players (11-12 years).

Material & methods

Participants

The research sample consisted of 24 (mean ± SD; age 11.6 ± 0.4 years) highly trained U12 football players that participated in the highest Czech youth league. The players narmally have three soccer-specific training sessions per week (average time of the lesson 90 minutes) and one competitive match per weekend. The average player's had 6.3 ± 0.6 years of experience with organized football. Each parent provided full informed consent and ethical approval for the study was obtained from the Ethics Committee of the Faculty of Physical Education and Sport, Charles University.

Procedures

Fundamental motor skills. FMS were examined using the Test of Gross Motor Development-2 (TGMD-2) (Ulrich, 2000) protocol, which is designed for children aged three to ten years. The TGMD-2 measures the competency of twelve FMS, six locomotor skills (run, broad jump, leap, hop, gallop, and slide) and six object-control skills (overarm throw, stationary strike, kick, catch, underhand roll and stationary dribble). The TGMD-2 was administered by one trained field tester, via in situ observation before the start of data collection. Assessments of FMS took place on playground with a taraflex surface. The field tester was responsible for providing a verbal description and a single demonstration of the skill required, while his assistant recorded each trial using a tripod mounted video camera (Sony, Japan). A small group of players (3-4) performed each skill twice. Video records were used for subsequent analysis, with components of each skill assessed as performance criteria. The examiner marked correctly-performed criterion as '1' and incorrectly-performed criterion as '0'. Then, all points for the six locomotor and the six object control skills were totaled, resulting in a composite score for twelve skills on the TGMD-2 test. Generally, a higher number of points equals to higher FMS performance. For the purpose of this study, we used only row scores of the OC skills subtest, LOC skills subtest and TGMD-2 (sum of row scores of all 12 skills).

Game specific motor skills. We used two technical tests ('dribbling' and 'shooting') from the test manual of the German Football Association (Weber, n.d.) for GSMS assessment. The task in the 'speed dribbling' test (fig. 1) was to complete the track as fast as possible. In the 'shooting' test (fig. 2) the player had eight shots (two shots with each foot to each side of the goal). The tasks in this test were to complete the test as quickly as possible, and to be, as many times as possible, accurate in shooting. The best out of two trials was selected for further analysis in both technical tests. Both tests were evaluated in the next training lesson after FMS execution.

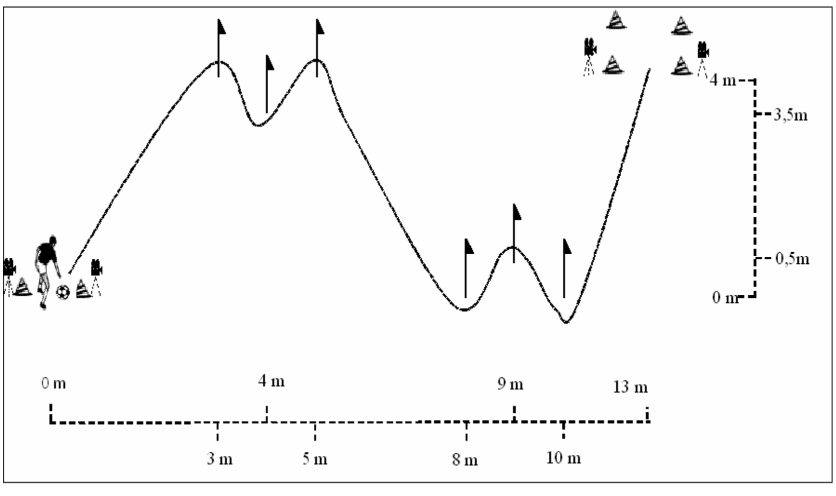

Figure 1. Dribbling.

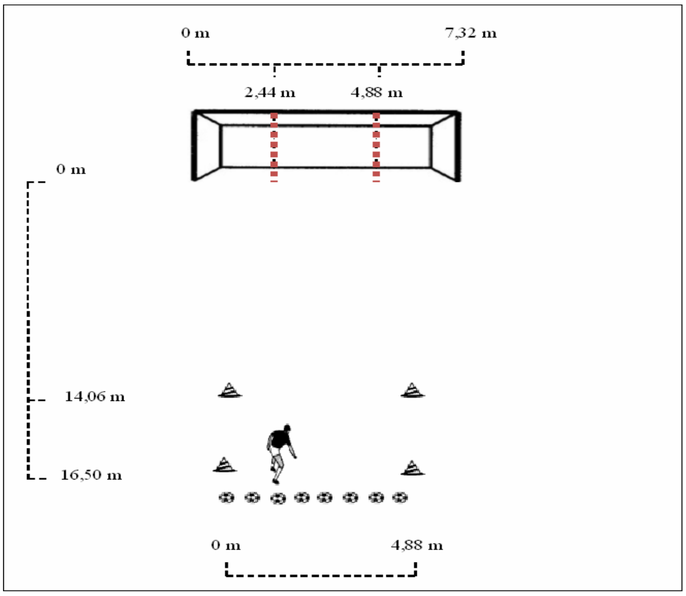

Figure 2. Shooting on time/accuracy.

Statistical analysis

The results of all measured variables were reported as mean ± standard deviation (mean ± SD), and minimal and maximal values. Mastery in FMS was expressed using percentage scoring. All data sets were assessed using the Shapiro-Wilk test for normal distributions. To express the total result of GSMS (speed dribbling, shooting on time, and shooting accurately) we used a z score. The Pearson Correlation Coefficient test was used to investigate the relationships between actual FMS proficiency and GSMS levels. Correlations were considered strong if $r > 0.60$, moderate if $r = 0.30$ to 0.60, and weak if $r < 0.30$ (Pagano & Gauvreau, 2000). A multilevel linear regression model, adopting the stepwise method procedure, was used to assess the association between GSMS (as outcome dependent variable) and FMS test items (as independent predictor variables). The significance level for all tests performed was set at p-value < 0.05. As a sufficient level of FMS in our study, we determined at least 80 % of success in all criteria for each subtest. All statistical analyses were performed using SPSS version 24 (SPSS Inc., Chicago, IL).

Results

The basic statistical characteristics of all measured variables are shown in table 1. Table 2 displays the Pearson correlations between GSMS items and FMS subtests, and total test scores for young soccer players. Statistically significant correlations ranged in strength from moderate-to-strong ($r = 0.50 – 0.77$). When the TGMD-2 total test score took into account performance on GSMS, we found a strong relationship ($r = 0.62$). Similarly, strong correlations were found between the OC subtest and GSMS ($r = 0.70$), and between the LOC subtest and GSMS ($r = 0.67$). Based on multiple linear regression, 'horizontal jump' and 'catch' were found to be significant ($F_{(2, 21)} = 21.13$, $p < 0.001$) and strong ($R^2 = 0.64$) predictors of performance in GSMS (tab. 3). None of the other ten FMS test items were significantly associated with performance on GSMS. In table 4 the percentages of players who reached at least 80% success in FMS mastery are shown. The highest success was found in the 'run', 'slide', and 'catch' skills. On the other side, we found the lowest success to be in 'striking', 'overhand throw', 'underhand roll', and 'horizontal jump'.

Table 1. Results of the tests of FMS and GSMS.

	Mean	SD	Minimum	Maximum
Shooting-accuracy (succesfull attemps)	7.4	2.2	3.0	11.0
Shooting-time (seconds)	46.5	4.8	40.6	57.3
Dribbling (seconds)	10.5	0.8	9.0	12.3
GSMS (z score)	0.0	2.6	-4.8	3.8
OC Subtest (row score)	40.3	4.3	31.0	48.0
LOC Subtest (row score)	48.0	4.2	33.0	48.0
TGMD-2 (row score)	91.4	20.1	67.0	160.0

Notes: GSMS – Game Specific Motor Skills; OC – object control; LOC – Locomotor; TGMD-2 – Test of gross motor development-2nd editon.

Table 2. Correlation relationships between FMS and GSS.

	Shooting-time	Shooting – accuracy	Dribbling	GSMS
TGMD-2	-0.60**	0.31	-0.70**	0.62**
OC Subtest	-0.53**	0.50*	-0.77**	0.70**
LOC Subtest	-0.67**	0.38	-0.67**	0.67**

Notes: GSMS – Game Specific Motor Skills; OC – object control; LOC – Locomotor; TGMD-2 – Test of gross motor development-2nd editon.

Table 3. Multiple regression analysis for relationship between GSMS and significant TGMD-2 test items.

Dependent variables	Predictors	B	SEβ	β	R^2
GSMS	Horizontal jump	1.17	0.28	0.67**	0.42
	Catch	2.71	0.72	0.47**	0.64

Notes: GSMS – Game Specific Motor Skills; B – unstandardized coefficient; SEβ – coefficients standard error; β – standardized coefficient; ** - p<0.001; R^2 – coefficient of determination .

Table 4. Number of players with at least 80% success in mastering FMS.

LOC Subtest	N (≥ 80%)	OC Subtest	N (≥ 80%)
Run	20(83%)	Striking	10(42%)
Gallop	16(67%)	Dribbling	18(75%)
Hop	15(62%)	Catch	23(96%)
Leap	14(58%)	Kick	16(67%)
Horizontal Jump	12(50%)	Overhand Throw	10(42%)
Slide	23(96%)	Underhand Roll	12(50%)

Notes: OC – object control; LOC – Locomotor.

Dicussion

The present study investigated the possible relationship between non-specific motor coordination (FMS) and game-specific motor skills (GSMS) in young adolescent football players. We assumed that higher FMS performance would result in higher performance, at a higher level of GSMS, in players. Generally, we found a strong relationship between FMS and GSMS (r = 0.62). This strong relationship was revealed between FMS subtests and individual GSMS ('dribbling' and 'shooting') ranging between 0.50 – 0.77. Moreover, we found very poor performance in 50 per cent or more of players in each of the 'horizontal jump', 'striking', 'overhand throw' and 'underhand roll' TGMD-2 subtests.

The results suggest that young football players should have an adequate level of non-specific motor coordination in the areas of locomotor and object control skills to serve as essential building blocks for more difficult and complex sport specific skills later. Importantly, the motor patterns developed during early childhood provide the basis for subsequent motor skillfulness in football where running, jumping, catching, throwing, and many other FMS are important (Clark & MetCalfe, 2002). However, it is important to note that these basic motor patterns are not acquired naturally during the process of maturation (Hardy et al. 2010). Movement practitioners (especially sport coaches and physical education teachers) need to structure and implement developmentally appropriate activities specifically teaching and learning (with feedback) during the training process, with continuous provision for opportunities of practice available (Logan, Robinson, Wilson, & Lucas, 2011). Since tests of technical skills like shooting or dribbling have been proven as valid discriminative factors between elite and non-elite youth football players (Honer, Votteler, Schmid, Schultz, & Roth, 2015; Huijgen, Elferink-Gemser, Post, & Visscher, 2010; Huijgen, Elferink-Gemser, Lemmink, & Visscher, 2014; Rebelo et al., 2013), precise development of FMS during childhood should be insured. We assume that a higher level of FMS may contribute to better performance in GSMS, and in cooperation with other factors (physical fitness, tactical skills, and psyche) to better performance during the football game. Young players may acquire adequate FMS performance during the sampling years (from 6 to 12 years) through participation in deliberate practice and exercises that help to achieve gains in their motor abilities, rather than those exercises involving an early specialization in a given sport (Côté, Lidor, & Hackfort, 2009). Players with marked motor coordination, balance, and strength are likely to perform complex movements (e.g. agility tasks) with a high degree of postural control and intensity (Bobbio, Gabbard, & Cacola, 2009; Cordo & Gurfinkel, 2004). The importance of the role of FMS in long-term sport training is supported by the findings reported by Deprez et al. for professional Belgian clubs (2015), where higher levels of FMS and game-specific skills were found in selected players than in "dropout" players. These findings suggest the importance of non-specific FMS in the identification of gifted players and their likelihood of remaining in high-level talent development programmes.

The importance of non-specific FMS has been also highlighted in relation to physical fitness. Deprez et al. (2015a) found that non-specific FMS were a long-term predictor of explosive power in football players from childhood to young adulthood. The authors pointed out that well-coordinated players benefit in late adolescence from the well-developed FMS they acquired during childhood. Similarly, Deprez et al. (2014) found that non-specific FMS were an important long-term predictor of football-specific aerobic performance in elite pubertal football players. Therefore, the authors emphasized the importance of non-specific FMS in the talent-identification and -development process, and recommend youth soccer coaches should implement motor-coordination exercises in their regular training program, especially in the years around peak height velocity. Moreover, a relationship between FMS and aerobic performance was found in children (Hands, 2008) and adolescents (Okely, Booth, & Patterson, 2001), which suggests the importance of FMS not only to GSMS but also to separate components of PF, such as explosive power and aerobic endurance, during long-term motor training. When TGMD-2 was separated by test items of OC skills (striking, dribbling, catch, kick, overhand throw, underhand roll) and LOC skills (run, gallop, hop, leap, horizontal jump, slide), horizontal jump and catch were the only significant predictors for GSMS performance, where dribbling and shooting skills were presented. To our surprise, the 'kick' subtest was not found to be a strong predictor of GSMS, where this skill is contained in both football technical tests. We feel the need to emphasize that the TGMD-2 is a process-oriented test which means that quality of movement is assessed instead of quantity (i.e. length of the jump or number of correct catching). We think that quality of movement in both test items – correct movements and their subsequent timing in horizontal jump, and correct eye-hand coordination in catch, may play a substantial role in the acquisition of specific football techniques in speed dribbling the ball through a slalom, and shooting with timing and accuracy. Moreover, we found that 50 percent or more of the players had poor performance for several TGMD-2 items (horizontal jump, striking, overhand throw and underhand roll), achieving less then 80 percent of success in the given skills. Also, O´Brien, Belton and Issartel (2016) found that poor FMS performance in children 12-14 years old was especially related to a high rate of failure in the performance, or process, component of the movement pattern (knees bent, arms extended, etc.). These motor patterns often overlap between skills, and therefore movement practitioners (sport coaches, P.E. teachers) should be concerned with the proper development of these behavioural components, which a large proportion of participants were unable to successfully complete. A natural result of these motor interventions should be better and faster learning and acquisiton of GSMS.

Conclusions

The study highlighted the importance of FMS as a substantial foundation of GSMS in young football players. Horizontal jump and catch were found to be especially significant predictors of GSMS. Based on these results, the coaches of youth players should emphasize sufficient development of FMS, particularly during early and middle childhood. Future researchers should determine if this relationship holds true in a larger sample size, and if differences in FMS exist between elite and sub-elite football players.

Conflicts of interest - No potential conflict of interest was reported by the authors.

References:

Ali, A. (2011). Measuring soccer skill performance: a review. *Scandinavian journal of medicine & science in sports, 21*(2), 170-183.

Barnett, L. M., Morgan, P. J., van Beurden, E., & Beard, J. R. (2008). Perceived sports competence mediates the relationship between childhood motor skill proficiency and adolescent physical activity and fitness: a longitudinal assessment. *International journal of behavioral nutrition and physical activity, 5*(1), 1-12.

Bobbio, T., Gabbard, C., & Caçola, P. (2009). Interlimb coordination: an important facet of gross-motor ability. *Early Childhood Re-search & Practice, 11*, 2.

Booth, M. L., Okely, T., McLellan, L., Phongsavan, P., Macaskill, P., Patterson, J., ... & Holland, B. (1999). Mastery of fundamental motor skills among New South Wales school students: prevalence and sociodemographic distribution. *Journal of Science and Medicine in Sport, 2*(2), 93-105.

Božanić, A., & Bešlija, T. (2010). Relations between fundamental motor skills and specific karate technique in 5-7 year old begginers. *Sport science, 3*(1), 79-83.

Bryant, E. S., James, R. S., Birch, S. L., & Duncan, M. (2014). Prediction of habitual physical activity level and weight status from fundamental movement skill level. *Journal of sports sciences, 32*(19), 1775-1782.

Clark, J. E., & Metcalfe, J. S. (2002). The mountain of motor development: A metaphor. *Motor development: Research and reviews, 2,* 163-190.

Cordo, P. J., & Gurfinkel, V. S. (2004). Motor coordination can be fully understood only by studying complex movements. *Progress in brain research, 143,* 29-38.

CôTé, J. E. A. N., Lidor, R., & Hackfort, D. (2009). ISSP position stand: To sample or to specialize? Seven postulates about youth sport activities that lead to continued participation and elite performance. *International journal of sport and exercise psychology, 7*(1), 7-17.

Department of Education Victoria. (1996). *Fundamental Motor Skills: A Manual for Classroom Teachers.* Melbourne: Education Department of Victoria.

Deprez, D., Valente-dos-Santos, J., e Silva, M. C., Lenoir, M., Philippaerts, R. M., & Vaeyens, R. (2014). Modeling developmental changes in the yo-yo intermittent recovery test level 1 in elite pubertal soccer players. *International journal of sports physiology and performance, 9*(6), 1006-1012.

Deprez, D., Valente-Dos-Santos, J., Coelho-e-Silva, M. J., Lenoir, M., Philippaerts, R., & Vaeyens, R. (2015a). Longitudinal development of explosive leg power from childhood to adulthood in soccer players. *International journal of sports medicine, 36*(08), 672-679.

Deprez, D., Fransen, J., Lenoir, M., Philippaerts, R. M., & Vaeyens, R. (2015b). A retrospective study on anthropometrical, physical fitness and motor coordination characteristics that influence drop out, contract status and first-team playing time in high-level soccer players, aged 8 to 18 years. *Journal of Strength and Conditioning Research, 29*(6), 1692-1704.

Hands, B. (2008). Changes in motor skill and fitness measures among children with high and low motor competence: A five-year longitudinal study. *Journal of Science and Medicine in Sport, 11*(2), 155-162.

Hardy, L. L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport, 13*(5), 503-508.

Höner, O., Votteler, A., Schmid, M., Schultz, F., & Roth, K. (2015). Psychometric properties of the motor diagnostics in the German football talent identification and development programme. *Journal of Sports Sciences, 33*(2), 145-159.

Huijgen, B. C., Elferink-Gemser, M. T., Lemmink, K. A., & Visscher, C. (2014). Multidimensional performance characteristics in selected and deselected talented soccer players. *European journal of sport science, 14*(1), 2

Huijgen, B. C., Elferink-Gemser, M. T., Post, W., & Visscher, C. (2010). Development of dribbling in talented youth soccer players aged 12–19 years: A longitudinal study. *Journal of sports sciences, 28*(7), 689-698.

Gallahue, D. L., Ozmun, J. C., & Goodway, J. (2011). *Understanding motor development: Infants, children, adolescents, adults.* (7th ed.). New York, NY: McGraw-Hil.

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2011). Getting the fundamentals of movement: a meta□analysis of the effectiveness of motor skill interventions in children. *Child: care, health and development, 38*(3), 305-315.

Mitchell, B., McLennan, S., Latimer, K., Graham, D., Gilmore, J., & Rush, E. (2013). Improvement of fundamental movement skills through support and mentorship of class room teachers. *Obesity Research & Clinical Practice, 7*(3), e230-e234.

O'Brien, W., Belton, S., & Issartel, J. (2016). Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy, 21*(6), 557-571.

Okely, A. D., Booth, M. L., & Patterson, J. W. (2001). Relationship of cardiorespiratory endurance to fundamental movement skill proficiency among adolescents. *Pediatric exercise science, 13*(4), 380-391.

Pagano, M., & Gauvreau, K. (2000). Principles of biostatistics (2nd ed.). Belmont, CA: Brooks/Cole, Cengage Learning.

Pang, A. W. Y., & Fong, D. T. P. (2009). Fundamental motor skill proficiency of Hong Kong children aged 6–9 years. *Research in Sports Medicine, 17*(3), 125-144.

Rebelo, A., Brito, J., Maia, J., Coelho-e-Silva, M. J., Figueiredo, A. J., Bangsbo, J., ... & Seabra, A. (2013). Anthropometric characteristics, physical fitness and technical performance of under-19 soccer players by competitive level and field position. *Internaional Journal of Sports Medicine, 34*(4), 312-317.

Reilly, T., Williams, A. M., Nevill, A., & Franks, A. (2000). A multidisciplinary approach to talent identification in soccer. *Journal of Sports Sciences,* 18, 695-702.

Rösch, D., Hodgson, R., Peterson, L., Graf- Baumann, T., Junge, A., Chomiak, J., & Dvorak, J. (2000). Assessment and evaluation of football performance. *American Journal of Sports Medicine, 28,* 29-39.

Stolen, T., Chamari, K., Castagna, C., & Wisloff, U. (2005). Physiology of soccer: an update. *Sports Medicine, 35*(6), 501-536.

Ulrich, D. A. (2000). TGMD-2. Test of Gross Motor Development Examiner's Manual.

Waldron, M., & Worsfold, P. (2010). Differences in the Game Specific Skills of Elite and Sub-Elite Youth Football Players: Implications for Talent Identification. *International Journal of Performance Analysis in Sport, 10*(1), 9-24.

Weber, K. (n.d.). Testmanual für die technomotorische: Leistungsdiagnostik. Retrieved from https://www.bfv.de/cms/docs/dfb_manual_leistungsdiagnostik_low.pdf

Vaeyens, R., Malina, R. M., Janssens, M., Van Renterghem, B., Bourgois, J., Vrijens, J., & Philippaerts, R. M. (2006). A multidisciplinary selection model for youth soccer: The Ghent Youth Soccer Project. *British Journal of Sports Medicine, 40*(11), 928-934.

Vandendriessche, J. B., Vaeyens, R., Vandorpe, B., Lenoir, M., Lefevre, J., & Philippaerts, R. M. (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). *Journal of Sports Sciences, 30*(15), 1695-1703.