Analysis of Association of the Anthropometric, Motor and Functional Parameters on Competitive Efficiency in Youth Football Players

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ANALYSIS OF ASSOCIATION OF THE ANTHROPOMETRIC, MOTOR AND FUNCTIONAL PARAMETERS ON COMPETITIVE EFFICIENCY IN YOUTH FOOTBALL PLAYERS

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ANALIZA UTJECAJA ANTROPOMETRIJSKIH, MOTORIČKIH I FUNKCIONALNIH PARAMETARA NA NATJECATELJSKU USPJEŠNOST KOD MLADIH NOGOMETAŠA

SAŽETAK

U kompleksnim momčadskim sportovima, kao što je nogomet, krajnji ishod određen je brojnim faktorima poput tehničkog, taktičkog, fizičkog i psihološkog stanja pripremljenosti svih igrača koji moraju djelovati kao cjelina. Cilj ovoga rada bilo je utvrditi koje antopometrijske karakteristike te motoričke i funkcionalne sposobnosti utječu na natjecateljsku uspješnost nogometaša U-15 kategorije. 20 nogometaša podijeljenih u dvije grupe – starteri (N=10) i pričuve (N=10), prošli su morfološka mjerenja visine i mase tijela, testiranje funkcionalnih kapaciteta i procjenu razine motoričkih sposobnosti: sprint na 5 metara, sprint na 10 metara, sprint na 20 metara, skok u dalj, bacanje medicinke te troskok lijevom i desnom nogom. Također, za procjenu biološke dobi izračunata je dob najvećeg prirasta u visinu. Provedena je statistička analiza koja je uključila T-test i binomnu logističku regresiju. Rezultati studije pokazali su da su tjelesna masa (OR:0.86; 95%CI:0.75-0.99) i bacanje medicinke (t=2,24; p=0,02) značajni prediktori natjecateljske uspješnosti u promatranom uzorku mladih nogometaša. Budući da antropometrijske karakteristike uvelike utječu na snagu gornjeg dijela tijela u toj dobi, starteri će vjerojatno biti superiorniji i provesti više vremena u igri u odnosu na ostale vršnjake zbog spomenutih morfoloških prednosti. Ovaj rad još je jednom potvrdio da su rano sazrijevajući igrači u prednosti nad ostalima zbog većeg stasa, koji se čini kao značajan faktor uspjeha u toj dobi.

Ključne riječi: pubertetska dob, natjecateljska uspješnost, motoričke sposobnosti, morfologija, sazrijevanje

ANALYSIS OF ASSOCIATION OF THE ANTHROPOMETRIC, MOTOR AND FUNCTIONAL PARAMETERS ON COMPETITIVE EFFICIENCY IN YOUTH FOOTBALL PLAYERS

ABSTRACT

In a complex team sport setting, such as in football, match outcome is determined by numerous factors such as technical, tactical, physical and psychological preparedness of all players who have to act like a unit. The aim of this study was to identify anthropometric characteristics and motor and functional abilities that affect competitive efficiency of the U-15 football players. 20 football players, classified either as starters (N=10) or non-starters (N=10) underwent morphologic measurements comprised of body height and body weight, testing of functional capacity and motoric assessments: 5-meter sprint, 10-meter sprint, 20-meter sprint, broad jump, medicine ball throw and triple jump on left and right leg. Also, age of peak height velocity (APHV) was calculated for each participant. Statistical analysis included T-test and binomial logistic regression. Results showed that body weight (OR:0.86; 95%CI:0.75-0.99) and medicine ball throw ($t=2,24$; $p=0,02$) were significant predictors of the competitive efficiency in observed sample of young football players. Since upper body power is highly influenced by anthropometric characteristics in this age, starters will most likely receive more playing time and have superiority over their peers due to morphologic advantages. This study once again confirmed that early maturing players are in precedence over others because of their body size that seems to be significant determinant of success in that age.

Keywords: puberty age, competitive efficiency, motor abilities, morphology, maturation

Introduction

In a complex team sport setting, such is in football, match outcome is determined by numerous factors such as technical, tactical, physical and psychological preparedness of all players in a team who have to act like a unit (Rowat, Fenner, & Unnithan, 2016). The game of football is physically highly demanding and is characterized by the combination of sprint bouts, high-intensity running, tackles, jumps and turns that can be performed in any direction or plane of motion (Alexandre et al., 2012; Mohr, Krustrup, Nybo, Nielsen, & Bangsbo, 2004). Physiological stress of the match-play, that usually lasts up around 90 minutes, can be observed through increase in cardiovascular and metabolic output, rise in core temperature, glycogen depletion and high energy expenditure (Reilly & Gilbourne, 2003). It is well known that elite level football players can cover up to 12 km per match, and that high-speed running accounts for 1.5-3.3 km of total distance (Rebelo, Brito, Seabra, Oliveira, & Krustrup, 2014). During the match, average and peak heart rate values are around 85% and 98% of maximal values, respectively, corresponding to the average oxygen uptake to approximately 70% of VO2max (Bangsbo, 2014). Also, on average every 2 to 4 seconds during the match, footballers perform changes of direction, jumps, accelerations and decelerations which results in total of 1200-1400 of these intensive actions (Sporis, Jukic, Ostojic, & Milanovic, 2009). Over the past years, technical and tactical demands of the game have also increased substantially, likely due to the tactical modifications, and as a result there is significant increase in the sprint distance and distance covered in high-speed running (Collins et al., 2021). Due to the outlined specificities of the sport, it is of utmost importance to train and develop players' abilities accordingly so that they could perform these intense actions and to recover quickly from these periods of high-intensity exercise (Bangsbo, Mohr, & Krustrup, 2006).

Young football players usually cover 5-7 km during the match, with approximately 15% of total distance (0.4-1.5 km) performed with high intensity activities (Di Giminiani & Visca, 2017). Average heart rate frequency varies between 165 and 171 heart beats per minute which corresponds to 85% of maximal heart rate value (Di Giminiani & Visca, 2017; Rebelo et al., 2014). Studies have shown that U-15 players have similar relative VO2max, but poorer running mechanics compared to senior players, and that higher aerobic capacity resulted in increased total distance and high-speed running (HSR) (Lovell, Bocking, Fransen, Kempton, & Coutts, 2018; Stølen, Chamari, Castagna, & Wisløff, 2005). Activity pattern of elite youth and senior football players does not differ much, suggesting that aerobic capacity and game load of aforementioned categories are comparable (Strøyer, Hansen, & Klausen, 2004). Anaerobic energy system is crucial when performing explosive activities such as sprint, jump or change of direction, i.e. actions that define key moments of the match (Stølen et al., 2005). Exponential increase in muscle size and power occurs during pubertal phase, which, in combination with carefully planned strength and power training, results in enhanced power-speed abilities manifested through sprints and jumps (Di Giminiani & Visca, 2017). Paul, Gabbett, and Nassis (2016) stated that power, speed and agility training is necessary for comprehensive/complete growth and development of the young football players. Player's conditional characteristics like endurance, strength and agility, as well as technical and tactical aspects, should be developed for a team prosperity (Mouloud, 2019).

Previous studies investigating predictors of situational efficiency in youth football showed that young elite players are taller, heavier, are more mature and achieve better results in power, flexibility and specific football skill parameters (A. J. Figueiredo, Gonçalves, Coelho E Silva, & Malina, 2009; Malina et al., 2005; Williams & Reilly, 2000). Ré, Cattuzzo, Santos, and Monteiro (2014) highlight that anthropometric indices, such as body height and body mass, as they have large influence on selection of the adolescent players, favour biologically advanced individuals. Rowat et al. (2016) indicated that functional capacities and specific football skills, are also under certain influence of maturity status and morphologic components.

Elite players usually perform better in tests of sprint, vertical jump and endurance shuttle run in contrast to players of average and below-average quality (Malina, Ribeiro, Aroso, & Cumming, 2007). This leads to the phenomenon where more mature players, characterised as elite-ones, receive higher quality coaching and are exposed to increased football-specific loads. Disproportion of these physical and technical loads will eventually aggravate or even cease developmental path of the late-maturing players (Lovell et al., 2018). However, the problem with such sport-selection system that is oriented on physical characteristics, emerges at the senior level when these biological distinctions gradually disappear and players are differentiated via specific technical and tactical competencies (Ré et al., 2014).

Given the fact that this phenomenon is still evident in the world of sports in general, and particularly in football, the main aim of this study was to identify which anthropometric characteristics and motor and functional abilities affect situational and competitive efficiency of the elite U-15 football players.

Methods

The sample included 20 young male football players aged 14.06 years on average. Participants were members of a team that competed in the first division of Croatian national championship, and were categorised by the coaching staff either as starters (N=10) or non-starters (N=10). The study was conducted at the beginning of the summer preparation period for the 2021/2022. season. All players were healthy at the time of testing, without evident injury or illness.

Variables in this study included anthropometric indices, indirect estimation of the biological age (peak height velocity), and a set of motor and functional variables (sprinting on 5, 10 and 20 meters, broad jump, medicine ball throw, unilateral triple jump on both legs and 30-15 intermittent fitness test).

Anthropometric measures consisting of body height (BH) and body mass (BM) were recorded. Body mass was measured in 0.1 kg, and body height in cm (encompassed at nearest 0.5 cm). Mirwald, Baxter-Jones, Bailey, and Beunen (2002) algorithm, which calculates age of the peak height velocity (APHV) and maturity offset (DIFF), was used for assessment of biological age.

Acceleration and sprinting abilities were evaluated with the sprint test on 5 meters (5m), 10 meters (10m) and 20 meters (20m) using photoelectric timing gates (Powertimer, New test, Finland). Placed 1 meter behind the starting line, the participant assumed the flying start position and was instructed to start when feeling ready, run as fast as possible and to decelerate after passing the gates. One pair of the gates was installed on the starting line, and the second pair was placed 5, 10 and 20 meters away from the starting line, respectively. Lower body power was assessed with the broad jump (BJ), triple jump on the left leg (TJL) and the triple jump on the right leg (TJR). Broad jump test was used to assess the coordination and (horizontal) explosive power of the lower extremities. Participant performed two-legged broad jump, without falling forward or moving the feet during landing, and the distance between the starting line and the heel of the back foot was measured. In the triple jump on the left (TJL) and the right leg (TJR) participant executed 3 maximal consecutive (unilateral) jumps, without pushing off the floor with the other leg, and the distance between the rear heel and the marked line was recorded. Medicine ball throw was used as an indicator of the trunk and upper body power. Holding the 2 kg medicine ball in hands and with feet positioned in parallel stance, athletes performed maximal extension of the body followed by powerful ejection of the medicine ball. 30-15 Intermittent Fitness Test was carried out to estimate aerobic fitness of the players (Buchheit, 2008). The test is performed on the 40-meter-long turf, comprising of two alternating periods – 30 seconds shuttle run and 15 second passive rest. 30-15 IFT starts at 10 km/h, and the speed gradually increases by 0.5 km/h per level. All tests, excluding 30-15 IFT, were performed twice with the best result being taken into statistical analysis.

After assessing normality of the distributions by Kolmogorov Smirnov test, descriptive statistic parameters (arithmetic means and standard deviations) were calculated for all variables. To compare the groups (starter vs. non-starters) Student t-test was used. The differences between starters and non-starters were evaluated by magnitude-based Cohen’s effect size (ES) statistics with the following criteria: <0.2 = small; <0.5 = medium and >0,8 = large. Additionally, to establish associations between predictors (anthropometrics, biological age, motor-functional status) and quality-level (starters vs. non-starters), binary logistic regression was used. Statistica 13.0 (TIBCO Software Inc, USA) was used for all calculation with a p-level of 95%.

Results

Results of the descriptive statistics (arithmetic means and standard deviations) and student T-test (t and p values) are presented in Table 1. Significant difference between starters and non-starters are found in the BM and MT variables. Although the difference is not statistically significant, it can be seen from Table 1 that starters are biologically more mature, they entered the APHV period earlier, and they have a larger difference between the actual chronological age of APHV.

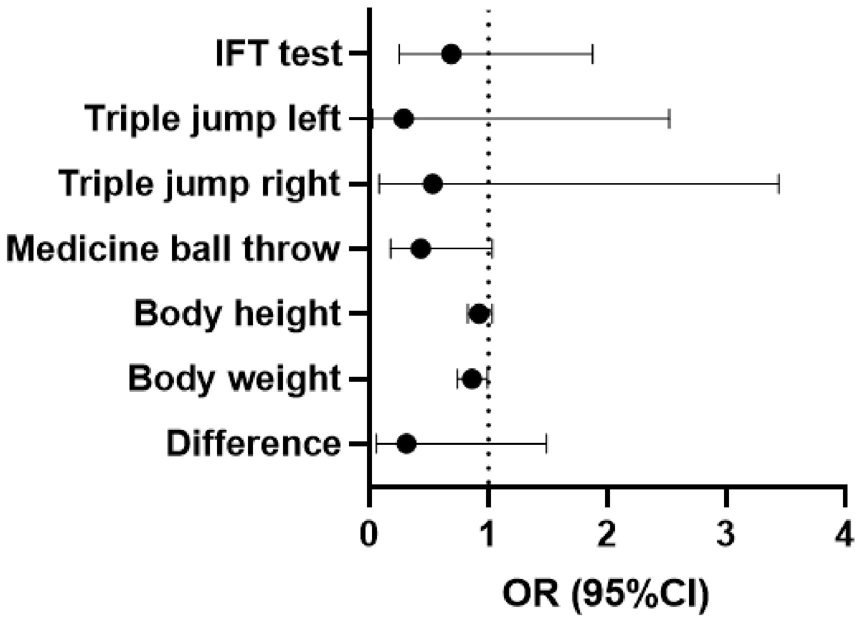
Table 1. *Descriptive statistics and Student t-test*

	Group 1		Group 2			
Variable	AM	SD	AM	SD	t-value	p
AGE (years)	14.12	0.33	14.00	0.46	0.67	0.51
APHV (years)	13.30	0.49	13.66	0.56	-1.53	0.14
DIFF (years)	0.82	0.63	0.34	0.72	1.59	0.13
BM (kg)	61.62	7.99	53.67	6.30	2.47	0.02*
BH (cm)	176.25	9.35	170.40	8.28	1.48	0.16
5 m (sec)	1.09	0.06	1.08	0.05	0.19	0.85
10 m (sec)	1.85	0.07	1.82	0.07	1.01	0.33
20 m (sec)	3.21	0.09	3.19	0.09	0.51	0.62
BJ (cm)	2.09	0.11	2.02	0.13	1.26	0.22
MT (cm)	8.91	1.53	7.59	1.06	2.24	0.04*
TJR (m)	6.01	0.38	5.87	0.60	0.65	0.52
TJL (m)	6.03	0.31	5.80	0.55	1.14	0.27
IFT (level)	19.22	1.09	18.88	0.92	0.70	0.49

Legend: AGE – chronological age, **APHV –** age at peak height velocity, **DIFF –** difference between AGE and APHV, **BM –** body mass, **BH –** body height, **5 m –** 5 meters sprint, **10 m –** 10 meters sprint, **20 m –** 20 meters sprint, **BJ –** broad jump, **MT –** medicine ball throw, **TJR –** triple jump on right leg, **TJL –** triple jump on left lef, **IFT –** 30-15 intermittent fitness test

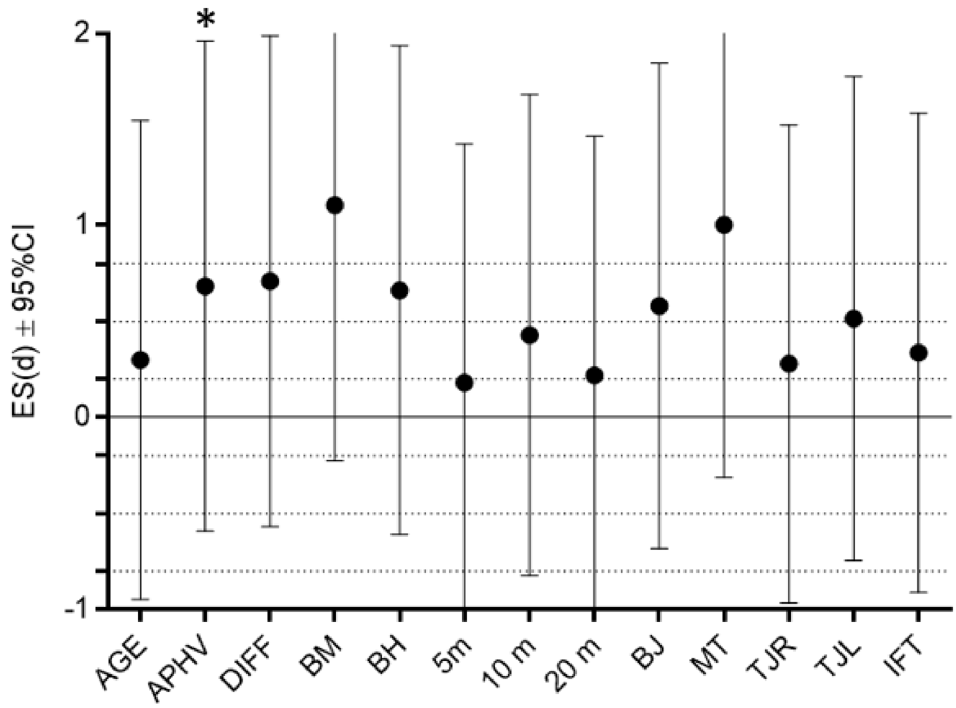
Results of binary logistic regression are graphically presented on the Figure 1. It can be seen that only significant predictor of competitive efficiency was BM variable.

Figure 1. *Logistic regression results (OR – Odds Ratio, CI – Confidence Interval)*



ES values indicated large magnitude of difference between starters and non-starters in the BM (Cohen's d= 1.105) and MT (Cohen's d= 1.003) variables.

Figure 2. *Effect Size (ES) differences between observed groups*



*APHV variable shows higher values for group 2

Discussion

The results of this study suggest several important findings. First, anthropometric indices (primary body mass) were the factor that differentiates starters and non-starters. Second, there are significant differences in the power of the upper body between the groups.

Results of our analyses suggest that body mass is the most significant factor which contributes to quality of the players, with starters being heavier than non-starters. To explain such findings, it is important to note that due to higher concentrations of testosterone and growth hormone, boys aged 13-18 experience major weight and height gain, thus enlarging their stature and physical size (Pearson, Naughton, & Torode, 2006). Previous investigations, dealing with body dimensions of the youth football players, showed that players of higher performance level are usually biologically more advanced, i.e., they are taller and have greater body mass in contrast to players of lower performance level (Malina et al., 2005; Malina et al., 2007; Rosch et al., 2000). These findings are not specific for football, only. For example, Gabbett, Kelly, Ralph, and Driscoll (2009) observed the elite junior rugby sample and concluded that starters are heavier and taller than non-starters. Given the fact that our sample is composed of the elite young football players, it can be expected that heavier players will most likely possess greater amount of lean body mass (muscle mass) also. It is well documented that muscle volume directly affects the force production ability, so it seems that players with greater muscle mass are capable of higher force/power production (Sekulic & Metikos, 2007). Although no significant differences in motor variables were observed (except in MT), we can assume that players will exploit this produced force in football-specific activities, such as aerial or ground duels. Therefore, it is reasonable to speculate that coaches will perceive these players as more efficient or successful and will give them more playing time.

Furthermore, our results suggest that upper body power (MT) is a significant predictor of the performance level in youth football players. Although intuitively upper body power does not seem to be significant factor of football efficiency, this finding can be linked with the already explained difference in the body mass. Studies have confirmed that body size and maturity influence the performance of the strength and power tests significantly (Mala, Maly, Zahalka, & Hrasky, 2015;

Malina et al., 2005). Force production has regional character and depends on the neuromuscular control, length and arrangement of the fibres and the muscle cross-section area (Pearson et al., 2006). In the study carried out on the elite sample of the Australian football players, Bilsborough et al. (2015) also indicated high correlation between lean body mass and the manifestations of the upper body power. Also, for our study it is important to note that the most significant strength increment in males happens in the adolescent period, between the age of 14 and 16, when gains in muscle size occur due to higher concentration of androgens (Pearson et al., 2006). Simultaneous development of the nervous system, biochemical properties and (theoretical) fibre type differentiation happens during the pubertal stage, highlighting the need to improve ballistic movements, such as the one evidenced throughout MT in our study (Kraemer, Fry, Frykman, Conroy, & Hoffman, 1989; Newton, Kraemer, Häkkinen, Humphries, & Murphy, 1996).

It is anecdotally known that coaches and scouts very often select the players according to their anthropometric-morphological attributes, while neglecting smaller players of the same quality. This approach to talent identification can lead to premature drop-out of the late maturing boys, who are not included in the training process because of the (relatively) weak stature and (consequently) less developed motor abilities (A. Figueiredo, Coelho e Silva, & Malina, 2011; Malina et al., 2007; Ré et al., 2014). Likewise, players labelled as the most talented ones in the puberty usually don't live up to expectations in the senior level, when persistent late-maturing individuals catch up their body size and strength and power levels (Malina et al., 2007). Some authors propose the idea that physical inferiority of the late maturing boys can be compensated with improvements in technical and tactical skills that will eventually provide their perseverance and competitiveness in the game (Vandendriessche et al., 2012). When assembling the team for an important match, majority of football coaches will most certainly choose the best individuals at that particular moment, because of the strive to win. However, such approach ignores, even obstructs the development path of a talented, but physically unmatured individuals (Strøyer et al., 2004). Therefore, although players should be selected based on their skills and abilities rather than physical size, in the team that is composed of the players of similar football skills, it can be expected that physically larger players will ultimately be chosen to participate more (Williams & Reilly, 2000).

Conclusion

The present study revealed the differences in some anthropometric/morphologic attributes and motor abilities between performance levels among U-15 football players. Namely, starters are shown to be heavier and superior in upper body power than non-starters. One of the major strengths of this study was the sample of elite youth football players, as HNK Hajduk is ranked in Top 20 football academies in Europe (CIES, 2021).

Although the sample was relatively homogenous, i.e. composed of the players that are equally skilled, results indicate that physically advanced players will most likely be selected for the starting squad more frequently, hence receiving more playing time.

In the process of selection, football scouts and coaches usually favour larger players over their weaker teammates because of their perceived robustness, but this is the paradigm that has to be shifted in future in order to enable the most talented ones to express their football potential, no matter of the stature. Football coaches, especially those working in high-level academies, are constantly pressured to achieve competitive success and that is the main reason why they rely more on the larger, physically more dominant players. This is in a disagreement with the main goal of the football academy – production and development of the high-quality players.

Future studies should include more objective measures of player's competitive efficiency, like technical and tactical components of the match that will precisely distinguish between performance levels in high-level football.

References

Alexandre, D., da Silva, C. D., Hill-Haas, S., Wong, d. P., Natali, A. J., De Lima, J. R., . . . Karim, C. (2012). Heart rate monitoring in soccer: interest and limits during competitive match play and training, practical application. *The Journal of Strength & Conditioning Research, 26*(10), 2890-2906.

Bangsbo, J. (2014). Physiological demands of football. *Sports Science Exchange, 27*(125), 1-6.

Bangsbo, J., Mohr, M., & Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football player. *Journal of sports sciences, 24*(07), 665-674.

Bilsborough, J. C., Greenway, K. G., Opar, D. A., Livingstone, S. G., Cordy, J. T., Bird, S. R., & Coutts, A. J. (2015). Comparison of anthropometry, upper-body strength, and lower-body power characteristics in different levels of Australian football players. *The Journal of Strength & Conditioning Research, 29*(3), 826-834.

Buchheit, M. (2008). 30-15 Intermittent Fitness Test et répétition de sprints. *Science & Sports, 23*(1), 26-28.

CIES Football Observatory. (2021). Ajax crowned best training club in Europe. Retrieved 2/17, 2022, from https://football-observatory.com/IMG/sites/b5wp/2021/wp353/en/

Collins, J., Maughan, R. J., Gleeson, M., Bilsborough, J., Jeukendrup, A., Morton, J. P., . . . Close, G. L. (2021). UEFA expert group statement on nutrition in elite football. Current evidence to inform practical recommendations and guide future research. *British journal of sports medicine, 55*(8), 416-416.

Di Giminiani, R., & Visca, C. (2017). Explosive strength and endurance adaptations in young elite soccer players during two soccer seasons. *PLoS One, 12*(2), e0171734.

Figueiredo, A., Coelho e Silva, M., & Malina, R. (2011). Predictors of functional capacity and skill in youth soccer players. *Scandinavian journal of medicine & science in sports, 21*(3), 446-454.

Figueiredo, A. J., Gonçalves, C. E., Coelho E Silva, M. J., & Malina, R. M. (2009). Youth soccer players, 11–14 years: maturity, size, function, skill and goal orientation. *Annals of human biology, 36*(1), 60-73.

Gabbett, T., Kelly, J., Ralph, S., & Driscoll, D. (2009). Physiological and anthropometric characteristics of junior elite and sub-elite rugby league players, with special reference to starters and non-starters. *Journal of science and medicine in sport, 12*(1), 215-222.

Kraemer, W. J., Fry, A. C., Frykman, P. N., Conroy, B., & Hoffman, J. (1989). Resistance training and youth. *Pediatric Exercise Science, 1*(4), 336-350.

Lovell, T., Bocking, C., Fransen, J., Kempton, T., & Coutts, A. (2018). Factors affecting physical match activity and skill involvement in youth soccer. *Science and Medicine in Football, 2*(1), 58-65.

Mala, L., Maly, T., Zahalka, F., & Hrasky, P. (2015). Body composition of elite youth soccer players with respect to field position. *Journal of Physical Education and Sport, 15*(4), 678.

Malina, R. M., Cumming, S. P., Kontos, A. P., Eisenmann, J. C., Ribeiro, B., & Aroso, J. (2005). Maturity-associated variation in sport-specific skills of youth soccer players aged 13–15 years. *Journal of sports sciences, 23*(5), 515-522.

Malina, R. M., Ribeiro, B., Aroso, J., & Cumming, S. P. (2007). Characteristics of youth soccer players aged 13–15 years classified by skill level. *British journal of sports medicine, 41*(5), 290-295.

Mirwald, R. L., Baxter-Jones, A. D., Bailey, D. A., & Beunen, G. P. (2002). An assessment of maturity from anthropometric measurements. *Medicine and Science in Sports and Exercise, 34*(4), 689-694.

Mohr, M., Krustrup, P., Nybo, L., Nielsen, J. J., & Bangsbo, J. (2004). Muscle temperature and sprint performance during soccer matches–beneficial effect of re- warm- up at half- time. *Scandinavian journal of medicine & science in sports, 14*(3), 156-162.

Mouloud, K. (2019). Level of state anxiety among youth football players according different playing positions. *Sport Mont, 17*(1), 33-37.

Newton, R. U., Kraemer, W. J., Häkkinen, K., Humphries, B. J., & Murphy, A. J. (1996). Kinematics, kinetics, and muscle activation during explosive upper body movements. *Journal of applied biomechanics, 12*(1), 31-43.

Paul, D. J., Gabbett, T. J., & Nassis, G. P. (2016). Agility in team sports: Testing, training and factors affecting performance. *Sports medicine, 46*(3), 421-442.

Pearson, D., Naughton, G. A., & Torode, M. (2006). Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. *Journal of science and medicine in sport*, *9*(4), 277-287.

Ré, A. H., Cattuzzo, T. M., Santos, F. M., & Monteiro, C. B. (2014). Anthropometric characteristics, field test scores and match-related technical performance in youth indoor soccer players with different playing status. *International Journal of Performance Analysis in Sport, 14*(2), 482-492.

Rebelo, A., Brito, J., Seabra, A., Oliveira, J., & Krustrup, P. (2014). Physical match performance of youth football players in relation to physical capacity. *European Journal of Sport Science, 14*(sup1), S148-S156.

Reilly, T., & Gilbourne, D. (2003). Science and football: a review of applied research in the football codes. *Journal of sports sciences, 21*(9), 693-705.

Rosch, D., Hodgson, R., Peterson, L., Graf-Baumann, T., Junge, A., Chomiak, J., & Dvorak, J. (2000). Assessment and evaluation of football performance. *The American journal of sports medicine*, *28*(5_suppl), 29-39.

Rowat, O., Fenner, J., & Unnithan, V. (2016). Technical and physical determinants of soccer match-play performance in elite youth soccer players. *The Journal of sports medicine and physical fitness, 57*(4), 369-379.

Sekulic, D., & Metikos, D. (2007). Fundamentals of transformational procedures in kinesiology. *Split: Faculty of natural and mathematical sciences and kinesiology*.

Sporis, G., Jukic, I., Ostojic, S. M., & Milanovic, D. (2009). Fitness profiling in soccer: physical and physiologic characteristics of elite players. *The Journal of Strength & Conditioning Research, 23*(7), 1947-1953.

Stølen, T., Chamari, K., Castagna, C., & Wisløff, U. (2005). Physiology of soccer. *Sports medicine, 35*(6), 501-536.

Strøyer, J., Hansen, L., & Klausen, K. (2004). Physiological profile and activity pattern of young soccer players during match play. *Medicine and Science in Sports and Exercise, 36*(1), 168-174.

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.

Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of sports sciences, 18*(9), 657-667.