International Journal of Physiology, Nutrition and Physical Education

Dr. Heera Singh Bisht
Physical Education Teacher,
A.U.G.I.C Cholosain
Uttarakhand, Pabau, Pauri,
Uttarakhand, India

Rachana Sirswal
Physical Education Teacher,
GIC Kewars, Pauri Garhwal,
Uttarakhand, India

Anthropometric, physiological and psychological characteristics of throwball and basketball women players with specific pertinence to positional roles: A review

Dr. Heera Singh Bisht and Rachana Sirswal

Abstract
The performance of the players is determined by various factors, specifically their physical configuration, and their technical, motor, physical and psychological attributes. The growth of the team players can be accomplished by physical development, visual and motor coordination enhancement accompanied with development of required motor competencies, taking into account the genetic and evolutionary aspect governing the rate of physical growth and maturation. Anthropometric attributes, for example, fat content of body, skinfold thickness, body stature, span of arm, and body dimensions, have been identified to be important constituents of players exhibiting high efficacy. The psychological attributes, which mainly incorporates personality characteristics and psychological competencies, have emerged as important indicators of performance of players. Numerous investigations carried along these lines have attempted to assess the psychological attributes of the players by the means of standard psychometric questionnaires in order to enhance the selection process of players.

Keywords: psychological attributes, anthropometric attributes, personality characteristics, psychometric questionnaires

1. Introduction
The procedure of an enduring increment in advancement of professional sports has prompted an enthusiasm for recognizing imminent best players as quickly as time permits. In view of this, clubs invest considerable amount of time span, energy and resources for enhancing the feasibility of recognizing and choosing young and talented sports persons. This article develops the current connection between anthropometric qualities, physical execution and distinguishing proof of talent in youthful male and female handball players (Matthys *et al.*, 2013; Mohamed, 2009) [37, 43].
The idea about real meaning of talent is still exceptionally complex to state, in spite of the fact that it has been recommended that it considers identification of talented players and determination of their probability of becoming expert players in future, which takes place in the very initial phases of career advancement (Abbott & Collins, 2004) [1]. However, this assumption about the potential of the players belonging to team sports is not applicable to those players involved with single-player games as they are primarily governed by the genetic factors, physiological factors, cognitive factors and the environmental conditions (Pearson, Naughton & Torode, 2006; Williams, 2000) [47, 62].
Along these lines, the model of talent recognition to a greater extent is impacted by the sport taken under consideration. These models make it hard to estimate the most ideal performance levels in various sports from an exceptionally young age and with sensible likelihood levels. In recent couple of years, the researchers have directed their attention towards talent recognition in team sports and have emphasized primarily on the major driving forces associated with talent recognition (Mohamed, 2009; Elferink-Gemser, 2007; Till *et al.*, 2011) [43, 12, 58].
Different qualities of players are determined and assessed with the objective of revealing a set of key factors that may aid in early recognition of talent. Past investigations have evaluated how anthropometric and physical execution attributes are essential to accomplish exceptional

Corresponding Author:
Dr. Heera Singh Bisht
Physical Education Teacher,
A.U.G.I.C Cholosain
Uttarakhand, Pabau, Pauri,
Uttarakhand, India

levels of execution in group sports, for instance, basketball (Karalejic, Jakovljevic & Macura, 2011) [29], soccer (Buchheit & Mendez-Villanueva, 2013; Huijgen *et al*., 2014) [7, 23], rugby (Till *et al*., 2013) [58] and handball (Mohamed, 2009; Ingebrigtsen, Jeffreys & Rodahl, 2013; Matthys *et al*., 2013) [43, 26, 37]. As indicated by these investigators, anthropometric, and physical performance attributes are viewed as major determinants affecting ability to recognize talent in an individual.

Akin to other sports, football requires an exceptional degree of physical performance as well as mental readiness and psychological competencies. There very limited number of investigations that have managed to examine the physiological aspects of football (Junge *et al*., 2000) [28] and relatively less importance has been given to the impact of physiological factors on the extent of performance ((Junge *et al*., 2000) [28]. It could be speculated that players allocated various level of roles while playing the sport may vary from each other not only in their football playing abilities but also in their playing qualities and in psychological competencies, for instance, attention span, response time, or their behaviour towards ethical play.

The talent recognition determinants that impact performance of players while playing football may prove to be a good source of knowledge for enhancing the training provided for the sport. Besides, such determinants may likewise impact the possibility of players getting wounded (Junge *et al*., 2000) [28] Several investigations carried in similar lines have exhibited the impact of psychosocial stressors, specifically events of life.

2. Literature Review
2.1 Anthropometric factors of female throwball and basketball players
The overall performance of the basketball players are governed by various variables, especially on their physical built up, their technical, motor, physical and psychological competencies. A coach of basketball sport should be responsible to look after the overall growth of the team members, which mainly includes physical development, visual and motor coordination enhancement accompanied with development of required motor competencies, taking into account the genetic and evolutionary aspect governing the rate of physical growth and maturation of the basketball players (Sánchez-Muñoz, Zabala & Williams, 2012; Šimonek, Horička & Hianik, 2016; Hu˚lka, Lehnert, Bˇelka, 2017) [54, 55, 24].

Basketball is a sport wherein adopting individual-specific methodology and determining anthropometric characteristics are essential components of the selection procedure and also for building long-term career goals. Anthropometric estimation, identification of physical characteristics have gained considerable attention from many researchers (Dežman, Trninić & Dizdar, 2001; Gryko *et al*., 2018) [10, 21]. The physiological profiles of basketball players have been generally perceived as a significant factor in the selection procedure and as a performance indicator (Ostojic, Mazic & Dikic, 2006; Berri, Brook & Fenn, 2011) [44, 45, 4].

Anthropometric attributes, for example, fat content of body, skinfold thickness, body stature, span of arm, and body dimensions, have been identified to be important constituents of basketball players exhibiting high efficacy; along these lines, they are frequently viewed as pointers of the degree of play (Vaquera, 2015) [59]. Past examinations considering substantial qualities in basketball players show that

determining body measurements is imperative for the selection process and allocating the appropriate roles and positions to the players (Abdelkrim *et al*., 2010) [2]. Besides, physical parameters affect the performance of players during the matches played under specific environmental conditions (Ribeiro *et al*., 2015) [51].

Investigations carried on young and experienced players have uncovered that people who possessing tall stature were likely to have mesomorphic body type and had longer limbs and also acquired higher score value with respect to productivity on the court and accomplished better physiological parameters (Sisodiya & Yadav, 2010) [56].

The essential factor taken into account while allocating particular playing positions is body stature (Dežman, Trninić & Dizdar, 2001) [10], in which the tallest players are chosen for central position, i.e., near the basket , and those of shorter stature for the position of guards, i.e., on the edge and little far from the basket (Ostojic, Mazic & Dikic, 2006; Sallet *et al*., 2005) [44, 45]. Furthermore, the contenders playing in various positions additionally stated about differences existing between them based on differences in body measurements, i.e., thigh, calf, arm, and forearm circumferences (Vučković & Mekić, 2009) [61].

Somatotype, characterized as the depiction of such morphological features as endomorph, mesomorph and ectomorph, is another useful tool to ascertain the physical factors essential for a specific sport (Purenović-Ivanović & Popović, 2014) [49]. Popovic *et al*. (2013) [48] had inferred from their observations that male basketball players are probably going to exhibit a mesomorph body type, however, there are likewise proficient players from top notch teams with blended and balanced body types. Additionally, the body type and other anthropometric factors may be particularly influenced by the topographical location, particularly amid body development and maturation (Malina & Kozieł, 2014) [32].

Taking into account the present level of available information in this domain, it may be helpful to ascertain breadth and circumference-based measurements of body parts. Besides, there is absence of past investigations conducting comparative analysis of the anthropometrics of young players and senior-level proficient basketball players.

Throwball is regarded as an exceptionally active sport which includes different types of actions such as intense running and jumping across the court. Fruitful execution of these actions relies significantly on anthropometric and physical execution factors (Milić, 2017) [42]. Contrasting physical capacities and anthropometric factors existing between sports persons portraying varied standard of performance, paying little heed to the position, both in throwball and in other sports activities have been researched extensively in past. However, the team sports comprise of players who execute their roles in accordance to their position and are trained accordingly. Therefore it can be inferred that while investigating on the anthropometric factors associated with a sport, the researcher must consider the position of the players in the team and the related roles (Boone *et al*., 2012; Duncan, Woodfield & Al-Nakeeb, 2006; Matthys, 2013) [6, 11, 37]. Similar investigations have already been carried on various types of sports (Boone *et al*., 2012; Matthys, 2013) [6, 37]. The players occupying varied positions in the team need to develop competencies accordingly so that they are able to handle intricate situations arising during the matches (Granatelli, 2014) [16].

Position-wise selection of players for throwball normally starts within the age range of 13–15 years. It is imperative to

ascertain what distinguishes female players belonging to this age range considering both anthropometric factors and physical capabilities. During physical growth, the anthropometric factors and the physical efficiency keep on altering and can be enhanced by subjecting the players to rigorous training; however, starting the training in accordance to the position of the players may probably influence the sense of competition among young players.

For determining the differences existing between players based on their positions, the samples can be categorised into smaller sub groups. Hence in order to obtain statistically significant outcomes, it is imperative to take into account a large sample size; however, this is not followed in all the instances (Duncan, Woodfield, Al-Nakeeb, 2006; Marques *et al*., 2009; Milanese *et al*., 2011) [11, 34, 38]. In view of this, it is of paramount importance to ascertain which anthropometric variables differentiate more efficient players from less efficient players in accordance to the position occupied by them in the team. In this manner, the general quality of player in competitive sports is at times characterized by contrasting the positioning of various groups taking part in a competition and at times by looking at individual quality player inside a group (e.g., starters versus non-starters; Hoffman, 2009) [22]. By consolidating these criteria, more prominent affectability and in this way a better assessment of the general quality of players involved in sports is accomplished (Gabbett, Georgieff & Domrow, 2007) [13].

This sort of assessment has just been effectively executed in studies exploring young female throwball players (Grgantov, Katić & Janković, 2006; 2007; Grgantov, Milić & Katić, 2013; Milic, Grgantov & Katic, 2013) [18, 19, 20]. It is likewise vital to focus on the choice of the factors that distinguish the playing positions, and the levels of the players belonging to particular positions. The commonly utilized anthropometric factors that meet these requirements are tallness, mass indexes, and somatotype (Malousaris *et al*., 2008; Martín-Matillas *et al*., 2014; Zhang, 2010) [33, 36, 64] and additionally the factors associated with physical performance, such as lower body strength, speed, readiness and upper body strength (Barnes *et al*., 2007; Gabbett & Georgieff, 2007, akubšová, Vaverka & Jandačka, 2011) [3, 13, 27]. For example, in one investigation carried in past (Milić, Grgantov, Katić, 2013) [19], trial of standing long bounce, 20-m run, steps and medicine ball supine throw were determined to be the best indicators of the physical performance related with adequacy in playing as a part of the team of throwball (Padulo *et al*., 2014) [46]

The present research endeavours to study the position-based differences in anthropometric factors, such as stature, weight, weight record and somatotype, and also physical performance, such as lower body strength, speed, deftness and upper body strength) in a comparatively huge sample comprising of young female throwball players. In this section, existing literature on the various anthropometric factors of female throwball and basketball players will be explored in this section. The impact of different anthropometric factors on the performance and competitiveness displayed by the female throwball and basketball players will be presented here.

2.2 Physiological and Morphological features affecting the positional roles of female players

Investigations carried on the impact of morphological qualities of performance of football players has been indirect, primarily because the individual attributes of players and their playing positions interfere with the study findings. Reilly *et*

al. (1990) [50] posited that body configuration plays an essential function in the wellness of football players. Nonetheless, the investigators should be careful enough while making direct correlations among male and female players as males have a tendency to have a higher proportion of lean body mass to muscle to fat than female players (Matković *et al*., 2003) may antagonistically influence the perseverance of female players. Martens (1996) [35] found that female expert football players had a tendency to be mesomorphic while non-players were more endomorph or ectomorph body type. Can *et al*. (2004) [1] found that female soccer players had essentially extraordinary muscle versus fat ratios and lean body mass than non-competitors, yet there were no distinctions in total body fat. Goalkeepers were the heaviest players with the most noteworthy level of muscle to fat ratio; however were the players of high stature in the group (Ingebrigtsen *et al*., 2011; Milanovic *et al*., 2012) [25].

Existing knowledge on morphological attributes of female football players (Can *et al*., 2004; Ingebrigtsen *et al*., 2011; Milanovic *et al*., 2012) [8, 25] state that world class female football players are of normal tallness (160-169 cm) and weight (52-65 kg), which did not vary from the non-selected health-wise fit female players. On an average the female players exhibited mesomorph and endomorph body attributes. Ingebrigtsen *et al*. (2011) [25] found no considerable contrasts in anthropometric factors between players divided into groups on the basis of playing position. In spite of the fact that not fundamentally extraordinary, defenders were averagely 5 cm taller than attackers and had higher body mass than players assigned different positions. Krustrup *et al*. (2005) [30] likewise observed defenders to be taller and heavier than the other playing positions. They likewise found that midfielders had the lowest level of muscle to fat ratio. As opposed to physiological factors, there no differences were observed in body stature, weight and the level of muscle to fat ratio between female soccer players belonging to different levels in team on the basis of their proficiency.

Strength of muscles, and anaerobic power, can be essential for female soccer players to expand running capability by the means of production of force creation, intramuscular glycogen content or expanded anaerobic activity of enzyme, enhancements in the stretch-shortening cycle or the force improvement rate (Sporiš *et al*., 2011) [57]. Strength and power enduring training sessions are utilized to expand force creation essential for the activities need to performed during matches. Additionally, high-intense strength training can be helpful since it improves activation of nerve cells and muscular adaptation (Sporiš *et al*., 2011) [57]. The execution of such training programs may help molding in female football players and additionally diminish the danger of anterior cruciate tendon wounds to which the female players are more prone to (Bien, 2011; Grandstrand *et al*., 2006) [5, 17].

Plyometric training incorporates hops and bounces to impact the stretch-shortening cycle of the muscle. Rubley *et al*. (2011) [52] examined the adequacy of low-effect and low-recurrence plyometric training in teenage female football players and found that the plyometric group demonstrated a huge increment in kicking distance from pretest to 7th week (11.5%) and an increment of 11.3% from 7th week to 14th week.

Strength of the muscle and power in female football players can be enhanced by incorporating resistance training (Oberacker *et al*., 2012; Sporiš *et al*., 2011) [57]. This kind of training, executed on shaky surfaces, enhanced balance, force generation and power in female football players (Oberacker *et*

al., 2012; Sporiš et al., 2011) [57] as it initiated neuromuscular strain and thus instigated better neural adaptations in contrast to resistance training executed on stable surface.

Through critical examination of the literature available on throwball players it has been inferred that the physiological features associated with the sport, for example, physical strength, speed and jumping capabilities rely primarily on the degree of competition (Lidor et al., 2005; Gorostiaga et al., 2006; Marques and Gonzalez-Badillo, 2006; Ziv and Lidor, 2009) [31, 34, 65]. This is indicative of the fact that identification of the physiological attributes of the players can be used as a major determinant of the success rate of the players. Several investigations have been carried to study the physiological attributes of the throwball players, which includes both fresh players and the senior players. Gathering information of this sort can be instrumental in conducting comparative analysis of the physiological characteristics of the players in accordance to the position held by them in the team and can also serve as a great source of help for formulating training modules in relevance to the physiological attributes possessed by them (Ingebrigtsen et al., 2012).

Moreover, past research has demonstrated that specific physical attributes are identified with good level of handball performance (Gorostiaga et al., 2005; Lidor et al., 2005; Ziv and Lidor, 2009) [14, 31, 65]. Specifically, a high body mass and height have been acknowledged as the preferable attributes among players (Ziv and Lidor, 2009) [65], and available literature indicates that junior and senior players of international level have majorly emphasized on enhancing their body mass and height in last few years (Ingebrigtsen et al., 2012). These inferences additionally suggest about the mixed physical attributes found among all player positions in a team (Lidor et al., 2005; Ziv and Lidor, 2009) [31, 65], albeit a few investigations have stated that wings were light-weighted and possessed small size when contrasted against players assigned different positions (Vila et al., 2011). However, directing broader examinations on physical attributes, such as muscle to fat ratio, fat free mass (FFM) and somatotype, and physiological attributes, e.g., ability to work at the most fundamental level of heart rate of 170 beats per minute, Wingate anaerobic test (WAnT) and 30 s Bosco test, have not been beforehand widely explored and further investigation on these attributes may aid in improving our comprehension about the top class throwball player.

2.3 Psychological attributes of women players that impact their performance and positional roles

The psychological attributes, which includes personality characteristics and psychological competencies, have emerged as important indicators of performance of football players. Various investigations along these lines have attempted to assess the psychological attributes of the football players by administering standard questionnaires, which have been instrumental in determining the psychological state of the players and have also helped in selecting proficient players. However, taking into consideration the evaluation of psychological attributes of skilled football players, an research work is recommended (Mills et al., 2012).

While football clubs frequently request that their mentors examine their players on self-outlined, unevaluated exploring sheets, investigations broadly disregard viewpoints of the expert mentors about the psychological attributes determining the performance level of the players. As we trust that the evaluations carried by the mentors could be a legitimate indicator of the performance level of a player and future

achievement, they need to emphasize more on the psychological attributes as major determinants of acknowledgement of proficient players (Lobinger, 2015).

As the enhancement of the quality of the psychometric examination of players is imperative for making the selection process more exhaustive, the norms for recognition of players should be improved to set a standard benchmark. To accomplish this, the psychometric evaluation tests should be worked upon such that they are highly objective, dependable, and legitimate for selection of proficient and talented players. Further, the assessment test used for determining psychological attributes of the players should incorporate self-appraisals of players and additional appraisals of mentors in talent acquisition. The help of sports psychologists should be sought for enhancing the diagnostics of psychological attributes and in addition in installing mental diagnostics and investigations in the talent acquisition procedure.

3. Discussions

The overall performance of the basketball players are driven by various determinants, primarily their physical built up, their technical, motor, physical and psychological attributes. The trainers of basketball should focus on the overall advancement of the team members, which mainly includes physical development, visual and motor coordination enhancement accompanied with development of required motor competencies, taking into account the genetic and evolutionary aspect governing the rate of physical growth and maturation of the basketball players. Anthropometric attributes, for example, fat content of body, skinfold thickness, body stature, span of arm, and body dimensions, have been identified to be important constituents of basketball players exhibiting high efficacy; along these lines, they are frequently viewed as pointers of the degree of play.

Research works carried on young and experienced players have explored that people who possessing tall stature were likely to have mesomorphic body type and had longer limbs and also acquired higher score value with respect to productivity on the court and accomplished better physiological parameters. During physical growth, the anthropometric factors and the physical efficiency keep on changing and can be made better by subjecting the players to rigorous training, however, starting the training in accordance to the position of the players may probably influence the sense of competition among young players

Diving deep into the literature available on throwball players it has been learned that the physiological attributes associated with the sport, for example, physical strength, speed and jumping capabilities rely primarily on the degree of competition. This is indicative of the fact that identification of the physiological attributes of the players can be used as a major determinant of the success rate of the players. Acknowledgement of the physiological attributes of the players can be leveraged as a major driving force for the enhancing the success rate of the players. Several investigations have been carried to study the physiological attributes of the throwball players, which includes both fresh players and the senior players. Gathering information of this sort can be instrumental in conducting comparative analysis of the physiological characteristics of the players in accordance to the position held by them in the team and can also serve as a great source of help for formulating training modules in relevance to the physiological attributes possessed by them.

4. Conclusion

Henceforth, to expand our insight into top performance of female throwball players, and to gather recent information associated with top level female players, extensive research work should be taken into account. This information could be utilized by sports mentors so as to improve their process of determination of proficient players and to formulate training programs as per the particular needs of every player.

Subsequently, the present paper will primarily focus on the anthropometric parameters, such as muscle versus fat, length parameters, sizes, circumferences, body types and breadth based estimations of the female players allocated different positions belonging to basketball sport. Moreover, this paper also aims to establish the relationship or specificity in choosing anthropometric qualities and basketball playing position

Consequently, the basic role of this review paper is to determine and analyze the probable distinguishing morphological and physiological attributes of the proficient female throwball players assigned different roles in the team. However, it is commonly assumed that players belonging to higher positions are likely to possess relatively better morphological and physiological attributes. Thus, ideal morphological attributes and useful capacities helpful to female soccer players ought to incorporate high degree of speed, deftness, quality, control, perseverance, exactness, adaptability, parity and coordination. Particular training programs are utilized to enhance each of these distinctive attribute which can likewise incorporate the improvement of motor capacities.

References

1. Abbott A, Collins D. Eliminating the dichotomy between theory and practice in talent identification and development: considering the role of psychology. Journal of sports sciences 2004;22(5):395-408.
2. Abdelkrim NB, Chaouachi A, Chamari K, Chtara M, Castagna C. Positional role and competitive-level differences in elite-level men's basketball players. The Journal of Strength & Conditioning Research 2010;24(5):1346-1355.
3. Barnes JL, Schilling BK, Falvo MJ, Weiss LW, Creasy AK, Fry AC. Relationship of jumping and agility performance in female volleyball athletes. Journal of Strength and Conditioning Research 2007;21(4):1192.
4. Berri DJ, Brook SL, Fenn AJ. From college to the pros: Predicting the NBA amateur player draft. Journal of Productivity Analysis 2011;35(1):25-35.
5. Bien DP. Rationale and implementation of anterior cruciate ligament injury prevention warm-up programs in female athletes. The Journal of Strength & Conditioning Research 2011;25(1):271-285.
6. Boone J, Vaeyens R, Steyaert A, Bossche LV, Bourgois J. Physical fitness of elite Belgian soccer players by player position. The Journal of Strength & Conditioning Research 2012;26(8):2051-2057.
7. Buchheit M, Mendez-Villanueva A. Reliability and stability of anthropometric and performance measures in highly-trained young soccer players: effect of age and maturation. Journal of Sports Sciences 2013;31(12):1332-1343.
8. Can F, Yilmaz I, Erden Z. Morphological characteristics and performance variables of women soccer players. Journal of Strength and Conditioning Research 2004; 18(3):480-485.
9. Dežman B, Trninić S, Dizdar D. Expert model of decision-making system for efficient orientation of basketball players to positions and roles in the game–Empirical verification. Collegium antropologicum 2001;25(1):141-152.
10. Dežman B, Trninić S, Dizdar D. Expert model of decision-making system for efficient orientation of basketball players to positions and roles in the game–Empirical verification. Collegium antropologicu 2001;25(1):141-152.
11. Duncan MJ, Woodfield L, Al-Nakeeb Y. Anthropometric and physiological characteristics of junior elite volleyball players. British Journal of Sports Medicine 2006;40(7):649-651.
12. Elferink-Gemser MT, Visscher C, Lemmink KA, Mulder T. Multidimensional performance characteristics and standard of performance in talented youth field hockey players: A longitudinal study. Journal of sports sciences 2007;25(4):481-489.
13. Gabbett T, Georgieff B. Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. Journal of strength and Conditioning Research 2007;21(3):902.
14. Gorostiaga EM, Granados C, Ibanez J, Izquierdo M. Differences in physical fitness and throwing velocity among elite and amateur male handball players. International journal of sports medicine 2005;26(03):225-232.
15. Granados C, Izquierdo M, Ibanez J, Ruesta M, Gorostiaga EM. Effects of an entire season on physical fitness in elite female handball players. Medicine & Science in Sports & Exercise 2008;40(2):351-361.
16. Granatelli G, Gabbett TJ, Briotti G, Padulo J, Buglione A, D'ottavio S *et al*. Match analysis and temporal patterns of fatigue in rugby sevens. The Journal of Strength & Conditioning Research 2014;28(3):728-734.
17. Grandstrand SL, Pfeiffer RP, Sabick MB, DeBeliso M, Shea KG. The effects of a commercially available warm-up program on landing mechanics in female youth soccer players. Journal of Strength and Conditioning Research, 2006;20(2):331.
18. Grgantov Z, Katić R, Janković V. Morphological characteristics, technical and situation efficacy of young female volleyball players. Collegium antropologicum 2006;30(1):87-96.
19. Grgantov Z, Milić M, Katić R. Identification af explosive power factors as predictors of player quality in young female volleyball players. Collegium antropologicum 2013;37(2):61-68.
20. Grgantov Z, Nedović D, Katić R. Integration of technical and situation efficacy into the morphological system in young female volleyball players. Collegium antropologicum 2007;31(1):267-273.
21. Gryko K, Kopiczko A, Mikołajec K, Stasny P, Musalek M. Anthropometric Variables and Somatotype of Young and Professional Male Basketball Players. Sports 2018;6(1):9.
22. Hoffman JR, Ratamess NA, Neese KL, Ross RE, Kang J, Magrelli JF, *et al*. Physical performance characteristics in National Collegiate Athletic Association Division III champion female lacrosse athletes. The Journal of Strength & Conditioning Research 2009;*23*(5):1524-1529.
23. Huijgen BC, Elferink-Gemser MT, Lemmink KA, Visscher C. Multidimensional performance

characteristics in selected and deselected talented soccer players. European journal of sport science 2014;14(1):2-10.

24. Hůlka K, Lehnert M, Bělka J. Reliability and validity of a basketball-specific fatigue protocol simulating match load. *Acta Gymnica* 2017;*47*(2):92-98.

25. Ingebrigtsen J, Dillern T, Shalfawi SA. Aerobic capacities and anthropometric characteristics of elite female soccer players. The Journal of Strength & Conditioning Research 2011;25(12):3352-3357.

26. Ingebrigtsen J, Jeffreys I, Rodahl S. Physical characteristics and abilities of junior elite male and female handball players. The Journal of Strength & Conditioning Research 2013;27(2):302-309.

27. Jakubšová Z, Vaverka F, Jandačka D. Comparison of the lower extremities' explosive muscular strength via jumping tests in different performance level and age groups of women volleyball players. Acta Gymnica 2011;41(4):7-15.

28. Junge A, Dvorak J, Rosch D, Graf-Baumann T, Chomiak J, Peterson L. Psychological and sport-specific characteristics of football players. The American Journal of Sports Medicine 2000;28(5_suppl):22-28.

29. Karalejic M, Jakovljevic S, Macura M. Anthropometric characteristics and technical skills of 12 and 14 year old basketball players. The Journal of sports medicine and physical fitness 2011;51(1):103-110.

30. Krustrup P, Mohr M, Ellingsgaard HELGA, Bangsbo J. Physical demands during an elite female soccer game: importance of training status. Medicine & Science in Sports & Exercise 2005;37(7):1242-1248.

31. Lidor R, Falk B, Arnon M, Cohen Y. Measurement of talent in team handball: the questionable use of motor and physical tests. Journal of Strength and Conditioning Research 2005;19(2):318.

32. Malina RM, Kozieł SM. Validation of maturity offset in a longitudinal sample of Polish boys. Journal of Sports Sciences 2014;32(5):424-437.

33. Malousaris GG, Bergeles NK, Barzouka KG, Bayios IA, Nassis GP, Koskolou MD. Somatotype, size and body composition of competitive female volleyball players. Journal of science and medicine in sport 2008;11(3):337-344.

34. Marques MAC, González-Badillo JJ. In-season resistance training and detraining in professional team handball players. Journal of strength and conditioning research, 2006;20(3):563.

35. Martens R. Successful coaching 4th edition. Human Kinetics 1996.

36. Martín-Matillas M, Valadés D, Hernández-Hernández E, Olea-Serrano F, Sjöström M, Delgado-FERNáNDEZ M, et al. Anthropometric, body composition and somatotype characteristics of elite female volleyball players from the highest Spanish league. Journal of sports sciences 2014; 32(2):137-148.

37. Matthys SP, Fransen J, Vaeyens R, Lenoir M, Philippaerts R. Differences in biological maturation, anthropometry and physical performance between playing positions in youth team handball. Journal of sports sciences 2013;31(12):1344-1352.

38. Milanese C, Piscitelli F, Lampis C, Zancanaro C. Anthropometry and body composition of female handball players according to competitive level or the playing position. Journal of Sports Sciences 2011;29(12):1301-1309.

39. Milanović Z, Sporiš G, Trajković N. Differences in body composite and physical match performance in female soccer players according to team position. Journal of human sport and exercise 2012;7(1):s67-s72.

40. Milanović Z, Sporiš G, James N, Trajković N. Motor Abilities of Female Soccer Players. In International Conference on Sport and Disability, University of Neaples" Parthenope" Italy 2014.

41. Milic M, Grgantov Z, Katic R. Impact of biomotor dimensions on player quality in young female volleyball players. Collegium antropologicum 2013;*37*(1):93-99.

42. Milić M, Grgantov Z, Chamari K, Ardigò LP, Bianco A, Padulo J. Anthropometric and physical characteristics allow differentiation of young female volleyball players according to playing position and level of expertise. Biology of sport 2017;34(1):19.

43. Mohamed H, Vaeyens R, Matthys S, Multael M, Lefevre, J, Lenoir M, Philippaerts R. Anthropometric and performance measures for the development of a talent detection and identification model in youth handball. Journal of Sports Sciences 2009;27(3):257-266.

44. Ostojic SM, Mazic S, Dikic N. Profiling in basketball: Physical and physiological characteristics of elite players. Journal of strength and Conditioning Research 2006;20(4):740.

45. Ostojic SM, Mazic S, Dikic N. Profiling in basketball: Physical and physiological characteristics of elite players. Journal of strength and Conditioning Research 2006;20(4):740.

46. Padulo J, Chamari K, Chaabène H, Ruscello B, Maurino L, Sylos PL, Migliaccio GM. The effects of one-week training camp on motor skills in Karate kids. The Journal of sports medicine and physical fitness 2014;54(6):715-724.

47. Pearson DT, Naughton GA, Torode M. Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. Journal of science and medicine in sport 2006;9(4):277-287.

48. Popovic S, Akpinar S, Jaksic D, Matic R, Bjelica D, Popovic S et al. Comparative study of anthropometric measurement and body composition between elite soccer and basketball players. Int. J. Morphol 2013;31(2):461-7.

49. Purenović-Ivanović T, Popović R. Somatotype of top-level Serbian rhythmic gymnasts. Journal of human kinetics 2014;40(1):181-187.

50. Reilly T, Secher N, Snell P, Williams C. Physiology of sports: An overview. Physiology of sports 1990;465-485.

51. Ribeiro BG, Mota HR, Sampaio-Jorge F, Morales AP, Leite TC. Correlation between body composition and the performance of vertical jumps in basketball players. J. Exerc. Physiol. Online 2015;18:69-79.

52. Rubley MD, Haase AC, Holcomb WR, Girouard TJ, Tandy RD. The effect of plyometric training on power and kicking distance in female adolescent soccer players. The Journal of Strength & Conditioning Research, 2011; 25(1):129-134.

53. Sallet P, Perrier D, Ferret JM, Vitelli V, Baverel G. Physiological differences in professional basketball players as a function of playing position and level of play. Journal of sports medicine and physical fitness, 2005;45(3):291.

54. Sánchez-Muñoz C, Zabala M, Williams K. Anthropometric variables and its usage to characterise elite youth athletes. In Handbook of anthropometry Springer, New York, NY 2012, 1865-1888.

55. Šimonek J, Horička P, Hianik J. Differences in pre-planned agility and reactive agility performance in sport games. Acta Gymnica 2016;46(2):68-73.
56. Sisodiy AS, Yadav M. Relationship of anthropometric variables to basketball playing ability. Journal of Advances in Developmental Research 2010;1(2):191-194.
57. Sporiš G, Jovanovic M, Krakan I, Fiorentini F. Effects of strength training on aerobic and anaerobic power in female soccer players. Sport science 2011;4(2):32.
58. Till K, Cobley S, O'Hara J, Brightmore A, Cooke C, Chapman C. Using anthropometric and performance characteristics to predict selection in junior UK Rugby League players. Journal of Science and Medicine in Sport 2011;14(3):264-269.
59. Vaquera A, Santos S, Villa JG, Morante JC, García-Tormo V. Anthropometric characteristics of Spanish professional basketball players. Journal of human kinetics 2015;46(1):99-106.
60. Vila H, Manchado C, Rodriguez N, Abraldes JA, Alcaraz PE, Ferragut C. Anthropometric profile, vertical jump, and throwing velocity in elite female handball players by playing positions. The Journal of Strength & Conditioning Research 2012;26(8):2146-2155.
61. Vučković I, Mekić M. Morphological characteristics of basketball players from playing position aspect 2009.
62. Williams AM. Perceptual skill in soccer: Implications for talent identification and development. Journal of sports sciences 2000;18(9):737-750.
63. Witmer CA, Oberacker LM, Moir GL, Davis SE, Haff GG. The Effects of Stable versus Unstable Surface Resistance Training on Performance of Female Soccer Players. Medicine & Science in Sports & Exercise, 2011;43(5):839.
64. Zhang Y. An investigation on the anthropometry profile and its relationship with physical performance of elite Chinese women volleyball players 2010.
65. Ziv G, Lidor R. Physical attributes, physiological characteristics, on-court performances and nutritional strategies of female and male basketball players. Sports Medicine 2009;39(7):547-568.