RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND TEAM PERFORMANCE IN ETHIOPIAN MEN VOLLEYBALL PREMIER LEAGUE CLUBS

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ABSTRACT

The purpose of this study was to investigate the relationship between anthropometric measurements in relation to the player's performance in Ethiopian Men Volleyball Premier League Clubs. The study used a cross-sectional research design which is descriptive and correlational in nature. The target population comprised 84 players derived from 7 teams. The anthropometric variables such as Height, Leg length, Upper leg length, Lower leg length, Arm Length, Forearm length, and Upper arm length were selected as independent variables and volleyball playing performance was selected as dependent variable for this study. The selected variables were measured by using standardized measurements, like height measured by stadiometer, weight measured by weighing machine, volleyball playing performance of the subjects was assessed by the rank of the tournament season. A point biserial correlation coefficient was calculated to establish the relationship between the anthropometric variables and performance. The results of this study indicate that those who are good in anthropometrical variables included Height, Leg length and Arm Length (p<0.05) were playing an important role for successes full volleyball teams than the non-successive teams. Based on our findings, we conclude that anthropometric characteristics are among the essentials in volleyball success.
Keywords: Anthropometric, Arm length, Performance, Premier League, Volleyball

INTRODUCTION

Volleyball is a dynamic, fast-paced sport that calls for a blend of athleticism, skill, and strategy.

One of the most incredible sports, volleyball requires a lot of power and strength to play at its best because it involves quick movements, jumps, landings, and abrupt shifts (De Almeida & Soares, 2003). Studies using anthropometric measurements to assess elite volleyball players' height, body type, jumping ability, and other physiological and physical traits have been published (Gualdi-Russo & Zaccagni, 2001). Accordingly, the height above the net is one of the factors that determine superiority. A crucial element influencing efficacy is the player's capacity to rise above the net. A volleyball player's primary goal in a match is to outperform the opposing team on the net, and players who can jump higher than the others have an advantage (Ciccarone et al., 2007). Studies have indicated that the significance of height, body shape, strength, and lower limb strength varies amongst elite volleyball players in various technical scenarios (Marques etal, 2009). Although agility, power, and technique are important components of a player's game, arm length is another factor that can have a big impact on a player's ability to play on the court (Bursaria JR, 1989). The two main factors influencing volleyball performance are anthropometric profiles and motor skills (Nasuka et al., 2020).

A body's capacity or support, such as height, weight, sitting height, and arm span, is referred to as body anthropometry (Mu'afillah, & Yuliastrid, 2021). According to (Fadhli et al., 2021), anthropometric measurement results demonstrate that volleyball players need to have a proportionate body posture. This quality can affect a player's attacking, blocking, serving, and digging strategies in volleyball (Bursaria, 1989). Let's examine more closely how player performance is impacted by anthropometry in these domains. Spiking or attacking the ball is one of the fundamental volleyball skills. Players with longer arms can hit the ball higher above the net because they have a wider range of motion. According to Ajay et al. (2016) volleyball players' abilities and performance were significantly correlated with their body anthropometry, height, and leg length. Because of this advantage, attacks can be launched with greater force and effectiveness, making it more difficult for adversaries to block or repel the spike.

Anthropometric parameters like standing height, body mass index, and a few other physical characteristics linked to performance skills like jumping ability, agility, strength, and endurance are the main ways that volleyball players' physical structures are evaluated (Bayios et al, 2006; Duncan et al., 2006; Gualdi-Russo & Zaccagni, 2001; Ibrahim., 2010; Palao et al, 2008; Zhang, 2010). Blocking is a crucial defensive tactic used to stop the attack of the other team from getting past the net. A player with longer arms can block a ball at a greater distance, which facilitates changing the ball's trajectory. One of the main goals of a volleyball match is for one team to outscore the other on the net, and players who can jump higher than the others have an advantage (Ciccarone et al., 2007). Furthermore, attackers may be intimidated by their extended reach and be forced to change their shots or aim from less favorable angles. According to Stamm et al. (2003), anthropometric parameters significantly affect how well all tactical and technical elements, particularly block and spike, are performed.

Anthropometric measurements are not the only factors that affect a player's performance; other factors include their general skills, coordination, and teamwork abilities. When assessing players, coaches and scouts frequently take Anthropometry into account, especially for specialized

positions like middle blockers and outside hitters (Milanse et al., 2001; Reilly et al., 2000). But it's crucial to keep in mind that a player's skill, court awareness, and mental toughness all play a significant role in how successful they are in volleyball. In summary, an anthropometric measure has a big impact on how well a volleyball player performs. It has an impact on all aspects of the game, such as digging, serving, attacking, and blocking. Players can launch stronger attacks, make more efficient blocks, serve with accuracy, and dig more successfully when they have good anthropometric because they can reach farther. It is imperative to bear in mind, though, that anthropometric testing is only one component of the myriad factors that go into a player's total skill set on the court. Therefore, this study aimed to compare the anthropometric characteristics of volleyball players who competed at different levels of success.

The current status of male premier league volleyball players is unknown due to the lack of scientific evidence regarding their anthropometric traits and performance, despite a few studies on Ethiopian volleyball players. As a result the researchers aimed to examine the relationship between anthropometric traits and team performance of male premier league volleyball teams in Ethiopia.

METHODS AND MATERIALS

Study Design
To examine the relationship between anthropometric traits of Ethiopian male volleyball premier league clubs in relative to their performance, the researchers used a cross-sectional research design which is descriptive and correlational in nature.

Subjects
Male volleyball players from seven Ethiopian premier league teams were participated in the study. Accordingly, Addis Ababa Police, Bahir Dar City, Ethiopian Defense Medawolabo University, Muger Cement, National Alcohol, and Wolayta Dicha were included in the study. A total of 84 male volleyball players were participated across all teams, the participants' average age was 24.9 ($\pm$5) years old.

Procedures
After being made aware of the study's purpose and methodology, each participant engaged a written up-to-date consent form demonstrating their voluntary participation. The players were between the end of the preseason and the start of the season when the measurement were asked in 2020/2021.

Players were asked to complete personal profiles that included information on their age, project experience, and club level playing experience, weekly training schedules, and playing positions. These profiles were then cross-checked with the club roster. Professionals with expertise in sport science and volleyball coaching carried out all operations.

Instrument
To achieve the proposed outcome of the research, anthropometric sizes were composed from players done practical tests. Height and body length were measured using a digital scale, body masses were measured using weighing machine. Body mass index (BMI) was calculated as body mass (kg)/ height (m) ^{2}. The measurements were taken using the correct testing procedure to get

that well versed with the technique of conducting tests or not, using the test and re-test methods, the tester's reliability was established. All measurements were taken following the guidelines outlined by the ISAK (International Society for the Advancement of Kinanthropometry) by capable, qualified, and knowledgeable sport science professionals and volleyball coaches.

To assess team performance at the end of the premier league season, the teams were divided into two based on their point (game result). The first three teams who scored higher points (Medawolabo University, Wolayta Dicha and Muger Cement) were considered as successful, and the remaining four teams (Ethiopian Defense, National Alcohol, Addis Ababa Police, and Bahir Dar City) were considered as unsuccessful teams.

Statistical Analysis

Both descriptive and inferential statistics techniques were applied to analyze the collected data. The researchers used SPSS (Statistical Package for Social Science, version 26) to generate the output of data analysis, adopting at a significance level of $p < 0.05$. Descriptive statistics is used to have a clear picture about the study and to compare the magnitude and characteristics of the Anthropometric parameters among the volley ball teams in the tournament season.

In addition to this, the data were also analyzed by using correlation coefficient analysis method. In order to examine the relationship between Anthropometric variables and the performance of volley ball teams, a point biserial correlation coefficient was also used in this study. Thus, correlation coefficient is applied to see whether these independent variables are factors for the improvement of the performance of the volley ball teams in Ethiopia or not.

RESULT

The main objective of the study was to explore the relationship between anthropometric traits (Length measurement) of Ethiopian male volleyball premier league clubs in relation to their performance. The result is presented in the following tables.

Table 1:- Base measurements of men Volleyball Players in Ethiopian premier league (Mean + SD) (N-84)

Anthropometric Variables	Minimum	Maximum	Mean $\pm$ SD
standing height (cm)	165	205	187.89$\pm$7.99
sitting height (cm)	59	100	90.82$\pm$6.01
standing reach height (cm)	203	272	242.11$\pm$11.02
weight (kg)	53.20	104.00	76.95$\pm$8.98
Body mass index (kg/m^2)	17.093	29.425	21.80$\pm$2.23
Valid N (list wise)			

Based on statistical analyses on table 1, the mean heights were as follows: 187.89$\pm$7.99 cm for standing height, 90.82$\pm$6.01 cm for sitting height, 242.11$\pm$11.02 cm for standing reach height, 76.95$\pm$8.98kg for weight of the players. With the exception of BMI, the other indices have revealed comparatively greater variation in the fundamental anthropometric measurements of men's

volleyball players from Ethiopia's premier league. Every volley ball player on the teams falls between the 19 and 25 body mass index (BMI) range. All of the teams' players have average body mass indices that fall between 21.80±2.23, which indicates that they are in good health based on their height and weight measurements. Players are found in a healthy condition in their weight measure with regard to their stature.

Table 2:- Body lengths measurements of men Volleyball Players in Ethiopian premier league (Mean ± SD) (N-84)

Anthropometric Variables	Minimum	Maximum	Mean ± SD
Arm length (cm)	54	76	64.92±4.15
Lower arm length (cm)	28	64	33.06±4.61
Upper arm length (cm)	32	48	39.36±2.66
Leg length (cm)	41	115	101.08±8.97
Upper leg length (cm)	51	99	59.85±5.79
Lower leg length (cm)	46	65	55.76±3.63
Valid N (list wise)			

Men volleyball players' average arm length is 64.92±4.15 cm, forearm length is 33.06±4.61 cm, upper arm length is 39.36±2.66 cm, leg length is 101.08±8.97 cm, upper leg length is 59.85±5.79 cm, and lower leg length is 55.76±3.63 cm, according to Table 2's results.

Table 3. Descriptive statistics of basic measurements in Ethiopian men volley ball premier league clubs (mean ± SD) (N-7)

	Standing height (cm)	Sitting height (cm)	Standing reach height (cm)	Weight (kg)	BMI
Volley ball Teams	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Addis Ababa Police	185 + 0.10	91.25±4.85	238±0.15	73.08±12.24	21.13±2.12
Bahir Dar City	189 + 0.08	92.58±3.68	240±0.13	79.25±9.40	22.31±2.38
Ethiopian Defense	191 + 0.09	92.41±3.23	245±0.11	73.17±7.91	20.17±1.91
Medawolabo University	187 + 0.08	91.58±3.03	240±0.10	79.00±6.70	22.69±2.38
Muger Cement	188 + 0.08	90.50±2.907	247±0.13	78.42±8.56	22.08±1.00
National Alcohol	188 + 0.06	91.50±2.393	241±0.09	78.43±10.81	22.21±3.16

Wolayta Dicha	188 + 0.07	85.91±12.97	244±0.09	77.33±5.03	21.97±1.49

With regard to standing height, most of clubs' players have similar standards with an average height of less than 188cm except players in Ethiopian defense which is 191cm in average. The result revealed that most of the players have above 87.95cm sitting height and similar standing reach height of more than 245cm in average. Players in the teams have similar weight records of more than 79.29kg in average.

With regard to the body mass index (BMI), all of the volley ball players in the teams are found between 19 and 25. The average body mass index of players in all of the teams is found within the normal weight range 22.40 and thus players are found in a healthy condition in their weight measure with regard to their height.

Table 4:- Descriptive statistics of body length measurements in Ethiopian men volley ball premier league clubs (mean + SD) (N-7)

	Leg length (cm)	Upper leg length (cm)	Lower leg length (cm)	Arm length (cm)	Upper arm length(cm)	Lower arm length (cm)
Teams	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Addis Ababa Police	101.58±7.68	60.08±4.68	56.83± 4.39	62.92±4.46	37.67±2.35	33.42±6.64
Bahir Dar City	95.75±18.6	62.42±11.85	55.00±3.81	64.67±4.71	39.08±3.679	35.00±9.29
Ethiopian Defense	100.75±5.27	58.75±4.48	54.50±2.939	65.75±5.27	40.33±3.28	31.58±1.98
Medawolabo University	101.42±6.40	61.33±3.822	56.50±3.000	64.33±3.17	39.33±2.39	33.25±1.82
Muger cement	102.75±5.27	58.33±4.250	54.75±3.60	66.08±3.89	39.92±2.50	32.67±2.06
National Alcohol	103.92±5.10	60.00±3.104	58.17±3.35	64.92±3.31	39.58±1.56	33.00±1.65
Wolayta Dicha	101.42±5.66	58.00±3.28	54.58±3.29	65.75±4.30	39.58±2.12	32.50±2.94

The result provided in the above table describes the descriptive statistics of anthropometric length measurements of players in the 7 volley ball teams. The leg length result revealed that most of the clubs have similar leg length with the exception of Ethiopian defense and National alcohol that have the shortest and the highest leg length of 100.75 cm and 103.92 cm. As the result indicated, there is no significant difference in the mean value of upper leg length, lower leg length, upper arm length and lower arm length among the players of the volley ball teams. Thus, players in the respective teams do have quite similar upper and lower mean value of leg and arm length measurements. A similar output is found in arm and leg length. Most of the clubs have similar average of arm and leg length.

Table 5**:** Point biserial correlation coefficient between body length measurements and the performance of the volley ball teams

		Successful teams			Unsuccessful teams	
Anthropometric measurements	**Categories**	**correlation coefficient with performance**	**P - Value (r)**		**correlation coefficient (r) with performance**	**P - Value**
Length measurement	Arm length	0.71	0.04		0.50	0.37
	Upper arm length	0. 89	0.03		0.51	0.64
	Lower arm length	0.69	0.04		0.47	0.15
	Leg length	0.78	0.03		0.28	0.54
	Upper leg length	0.69	0.04		0.44	0.46
	Lower leg length	0.48	0.55		0.35	0.35

The result revealed that the correlation coefficient of anthropometric measurements between successful and unsuccessful volley ball teams in Ethiopia in 2020/2021 tournament season. As can be understood from the output presented above, the correlation coefficient between upper and lower arm length and the total arm length and team performance of successful teams is 0.71, 0.69, 0.68 and the p-value of 0.04, 0.03, 0.04 respectively, which is significant. This shows that the positive and strong correlation is significant. Therefore, the result revealed that there is a strong positive effect (relationship) between the length measurement and the performance of successful volley ball teams.

But there is no substantial relationship among arm length, and leg length measurement and performance of unsuccessful volley ball teams. The correlation coefficient is weak (0.37 and 0.54) r < 0.5 and the p-value is not significant (> 0.05).

DISCUSSION ON FINDINGS

This study goals to regulate the correlation coefficient of anthropometric measurements between successful and unsuccessful volley ball teams in Ethiopia in 2020/2021 tournament season. In volleyball, teams compete by using high-altitude spiking and blocking maneuvers. As can be gotten from the output above, the correlation coefficient between arm length and team performance of successful teams is 0.71 with a p-value of 0.04, which is significant. The correlation coefficient of arm length between successful and unsuccessful volley ball teams was also found. Thus, the outcome showed that the arm length measurement and the performance of winning volley ball teams have a strong positive effect (relationship). Tall, arm-length players are essential for a team to succeed, according to Gaurav et al. (2010) findings. According to scholars, our analysis of Table 3 reveals a noteworthy distinction in arm length between teams that were successful and those that weren't.

Anthropometric measurements and morphological characteristics have a major impact on an athlete's success (Wilmore & Costill, 1999). One of the sports where a player's anthropometrics affects their level of performance is volleyball. Research has demonstrated that the anthropo-morphological characteristics of volleyball players are different from those of most athletes (Ercolessi, 1999; Jankovic V, 1995; Ugarkovic D., 2004). The anthropometric profile of volleyball players was evaluated in a number of other studies (Bandyopadhya, 2007; Bayios et al., 2006; Duncan et al., 2006; Gabbett, T., & Georgieff, 2007; Gaurav et al., 2010; Gaurav & Singh, 2014; Hadzic et al., 2012; Petroski et al., 2013);.

The output above shows that there is a significant correlation (p-value of 0.03) between leg length and the team performance of successful teams, with a correlation coefficient of 0.78. According to Nasuka et al. (2020), when it comes to volleyball players who are blocker and spikers, there is a significant relationship between leg length and maximum vertical jump results. The majority of players have long appendages that can support them when playing volleyball, according to the study's findings. It was also discovered that there was a correlation between successful and performance of volley ball teams' leg lengths. This is corroborated by the fact that Prasetya & Sulistyorini, (2019) state that ideal weight and height are supportive factors for volleyball players because they affect the athlete's bio motor abilities when it comes to execution volleyball technique movements. According to Masanovic et al. (2019), body mass and stature are crucial components of attack and defense tactics. Taller players are more adept at blocking and spiking baskets fast. According to Milić et al. (2017), athletes with a high body mass index move more slowly. In volleyball clubs, the primary criterion for assigning playing positions is height and maximum jump height.

But there is no significant relationship among arm length, and leg length measurement and performance of unsuccessful volley ball teams. The correlation coefficient is weak (0.37 and 0.54) r < 0.5 and the p-value is not significant (> 0.05).

The results show a positive and significant association between arm length and leg length and performance among successful volleyball teams. This is because anthropometric characteristics

are almost exclusively genetically determined, meaning that length and breadth measurements cannot be changed through training (Norton, 2001). Anthropometry is used to measure body dimensions. Measurements include height, bone widths and lengths, skin fold thickness, body weight, and circumference (Heyward, 2006). An athlete needs specific anthropometric characteristics in order to succeed in any given sport (Gualdi-Russo & Zaccagni, 2001). Genetics plays a major role in determining body height, the most distinctive characteristic of volleyball players (Milicerowa., 1973).

CONCLUSIONS

This study's arm length issue highlights the significance of arm length among elite league club teams by showing that successful teams had longer arms than unsuccessful teams. The importance of game performance among the top volleyball teams from league clubs is that successful teams perform better than unsuccessful teams in games.

There was a substantial connection between volleyball playing ability and selected anthropometric variables, that is, arm length have a strong association with volleyball playing skill. The successes-full teams have shown a significant difference in the selected anthropometric variables Arm Length, upper arm, for arm and leg length, upper leg and lower leg when compared to the unsuccessful teams among Ethiopian Men Volleyball Premier League Clubs.

Author Contributions:
- [1]Dawit Teferi is a major investigator and involved in the process of conceptualization, study design, data collection, statistical analysis, and manuscript preparation.
- [2]Dr. Alemmebrat Kiflu is a major supervisor of the research and he was involved in statistical analysis, manuscript preparation and over all supervision, review & editing.
- [3]Dr. Tesfaye Dessalegn is an internal supervisor of the research and he was involved in statistical analysis, manuscript preparation, processing of fund and over all supervision, review & editing.

Competing Interests
We authors of this research declare that no conflict of interest regarding this paper.

Patient and Public involvement

Participants of this study were Ethiopian premier league club male volleyball players.

Ethical Approval and Consent to Participate:

- This research was approved by Bahir Dar University Sport Academy Research Approval committee. **Ref. No- GRCS –ERC02/2022**

- All subjects involved in the study were signed informed consent.

Availability of Data and Materials:

All the data and materials supporting the study's findings are available upon request from the corresponding author.

References

Ajay K. P, Meena, T. R., Kerketta, I., & Bisht, S. (2016). Relationship between selected anthropometric variables and performance of volleyball players. *International Journal of Physical Education, Sports and Health IJPESH*, *3*(5), 217–219. www.kheljournal.com

Bandyopadhya A, . (2007). Anthropometry and body composition in soccer and volleyball players in West Bengal, India. *J Physiological Anthropology*, *26*(4), 501–505.

Bayios IA, Bergeles NK, Apostolidis NG, Noutsos KS, K. M. (2006). Anthropometric, body composition and somatotype differences of Greek elite female basketball, volleyball and handball players. *J Sport Med & Physical Fitness*, *46*(2), 271–280.

Bursaria JR. (1989). Anthropometrical Profiles of Volleyball players. In *EPU* (pp. 3–4).

Ciccarone G, Croisier Jl, Fontani G, Martelli G, Albert A, Zhang L, et al. (2007). Comparison between player specialization, anthropometric characteristics and jumping ability in top-level volleyball players. *J Sport Med & Physical Fitness.*, *61*(1), 29–43.

De Almeida, T. A. & E. A. S. (2003). Nutritional and anthropometric profile of adolescent volleyball athletes. *Revista Brasileira de Medicina Do Esporte*, *9*, 198–203.

Duncan, M. J., Woodfield, L., & Al-Nakeeb, Y. (2006). Anthropometric and physiological characteristics of junior elite volleyball players. *British Journal of Sports Medicine*, *40*(7), 649–651. https://doi.org/10.1136/bjsm.2005.021998

Ercolessi D. (1999). La caduta dal salto. *Super Volley*, *1*, 79–82.

Fadhli, N. R., Wulandari, A. M., Rifa'i, I. P., Assidiqqi, M. G., & Wijaya, K. B. P. (2021). Performa Smash Bola Voli dalam Event Liga Mahasiswa Ditinjau dari Antropometri Dan Pengalaman Bertanding. JSES. : *: Journal of Sport and Exercise Science*, *4*(1), 1–10. https://journal.unesa.ac.id/index.php/jses

Gabbett, T., & Georgieff, B. (2007). Physiological and anthropometric characteristics of Australian junior national, state, and novice volleyball players. *J Strength Cond Res*, *21*, 902–908.

Gaurav V, Singh M, S. S. (2010). Anthropometric characteristics, somatotyping and body composition of volleyball and basketball players. *Journal of Physical Education and Sports Management*, *1*(3), 28–32.

Gaurav, V., & Singh, A. (2014). Anthropometric characteristics of Indian volleyball players in relation to their performance level. *Turkish Journal of Sport and Exercise*, *16*(1), 86–86. https://doi.org/10.15314/tjse.201416168

Gualdi-Russo, E., & Zaccagni, L. (2001). Somatotype, role and performance in elite volleyball

players. *The Journal of Sports Medicine and Physical Fitness*, *41*(2), 256–262.

Hadzic R, Belica D, P. S. (2012). Comparative study of anthropometric measurement and body composition between elite basketball and volleyball players. *PESH, 2012*, *1*, 103–108.

Heyward, V. H. (2006). *Advanced fitness assessment and exercise prescription.* (5th ed.). Champaign, IL: Human Kinetics.

Ibrahim MA. (2010). Anthropometric measurements as a significant for choosing Juniors both in Volleyball and Handball Sports. *World J Sports Sci.*, *3*(4), 227–289.

Jankovic V, M. N. (1995). *Odbojka (Volleyball). Fakultetzafizičkukulturu (Faculty of Physical Education Zagreb),* (pp. 7–9).

Marques MC, van den Tillaar R, Gabbett TJ, Reis VM, G.-B. J. (2009). Physical fitness qualities of professional volleyball players: determination of positional differences. *J Strength Cond Res*, *23*(4), 1106–1111. https://doi.org/doi: 10.1519/JSC.0b013e31819b78c4.

Masanovic, B., Bjelica, D., & Corluka, M. (2019). Differences in Anthropometric Characteristics among Junior Soccer and Volleyball Players. *Journal of Anthropology of Sport and Physical Education*, *3*(2), 9–13. https://doi.org/10.26773/jaspe.190402

Milanse C, Piscitelli F, Lampis C, Z. C. (2001). Anthropometry and body composition of female handball players according to competitive level. *J Sports Sci*, *29*(12), 1301–1309.

Milić, M., Grgantov, Z., Chamari, K., Ardigò, L. P., Bianco, A., & Padulo, J. (2017). Anthropometric and physical characteristics allow differentiation of young female volleyball players according to playing position and level of expertise. *Biology of Sport*, *34*(1), 19–26. https://doi.org/10.5114/biolsport.2017.63382

Milicerowa H. (1973). Somatic Traits as a Main Criterion in the Process of Sport Selection. *AWF Warszawa*, *5*, 51–109.

Mu'afillah, M., & Yuliastrid, D. (2021). Analisis Tingkat Antropometri dan Kondisi Fisik Atlet Bola Voli Akademi Indomaret. *Jurnal Kesehatan Olahraga*, *9*(1), 319–326.

Nasuka, N., Setiowati, A., & Indrawati, F. (2020). Power , Strength and Endurance of Volleyball Athlete Among Different Competition Levels. *Utopía y Praxis Latinoamericana*, *25*, 15–23.

Norton K, O. T. (2001). Morphological evolution of athletes over the 20th century. *Sports Medicine*, *31*, 763–783.

Palao JM, Gutierrez D, F. J. (2008). Height, weight, body mass index and age in beach volleyball players in relation to level and position. *J Sport Med & Physical Fitness.*, *48*(4), 466–471.

Petroski EL, Fraro JD, Fidelix YL, Silva DAS, Pires-neto CS, Dourado AC, Rocha MA, Stanganelli LCR, Oncken P, V. F. (2013). Anthropometric, morphological and somatotype characteristics of athletes of the Brazilian Men's volleyball team: an 11-year descriptive study. *Rev Bras CineantropomDesempenho Hum*, *15*(2), 184–192.

Prasetya, D. D., & S. (2019). Analisis Antropometri dan Daya Tahan VO2 Max Peserta Ekstrakulikuler Bola Voli Putri SMAN 1 Talun Blitar. *Indonesian Performance Journal*, *3*(2), 54–57.

Reilly T, Williams AM, Nevill A, Framks A. (2000). A Multidisciplinary approach to talent identification in soccer. *J Sports Sci*, *18*(9), 695–702.

Stamm, R., Veldre, G., Stamm, M., Thomson, K., Kaarma, H., Loko, J., & Koskel, S. (2003). Dependence of young female volleyballers' performance on their body build, physical abilities, and psycho-physiological properties. *The Journal of Sports Medicine and Physical Fitness*, *43*(3), 291–299.

Ugarkovic D. (2004). *Biomedicinskeosnovesportske medicine (Biomedical foundations of sports medicine).* Novi Sad,.

Wilmore, J.H., and Costill, D. L. (1999). *Physiology of Sports and Exercise* (2nd ed.). Champaign, Human Kinetics.

Zhang, Y. (2010). An investigation on the anthropometry profile and its relationship with physical performance of elite Chinese women volleyball players. MSc thesis. Southern Cross University, Lismore, NSW. *EPublications@SCU*, 2–189.