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Measurement of Physical, Anthropometric and Physiological Characteristics in Junior Volleyball Saudi Arabia Players: Cross Sectional Study

Mohamed Salama Younis[1], Anwar Abdelgayed Ebid[2], Ashraf Abdelaal Mohamed[2], Mohamed Nasim Jain[3]

[1]Physical Education Department, Al-Qunfudhah College, Umm al Qura University, **Kingdom of Saudi Arabia**
[2]Physical Therapy Department, College of Applied Medical Sciences, Umm Al-Qura University, **Kingdom of Saudi Arabia**
[3]Physical Education Department, Makkah, Umm al Qura University, **Kingdom of Saudi Arabia**

***Correspondence:** aaebeed@uqu.edu.sa **Received 05-04-2020, Revised: 04-05-2020, Accepted: 05-05-2020 e-Published: 10-05-2020**

The aim of this study was to evaluate the anthropometric, physical and physiological (ventilatory) characteristics in Junior Volleyball Saudi Arabia Players. Ninety-Seven Junior volleyball players were included from three regions (western, central and eastern) in different clubs in Saudi Arabia. The primary measures were anthropometric, physical and physiological characteristics according to designed protocol for measurements. The result of this study demonstrated that, there were statistically significant differences in mean values of selected anthropometric measures in one region in relation to other regions. In addition, there were statistically significant differences in mean values of physiological (ventilatory) measures in favor of the western area. In conclusion, these results demonstrated the importance of measuring the anthropometric, physical and physiological parameters of junior volleyball players and presented normative data for anthropometric, physical and physiological parameters and could be useful in selection and profiling of junior volleyball players.

Keywords: Anthropometric, Physical, Physiological, Volleyball, Saudi Arabia

INTRODUCTION

Volleyball is a competitive global sport with high physical and technical performance, and it has many unique characteristics in itself and the coach must dive into the nature of the game in order to better adapt to the strategies and tactics of successful play (FIVB. 2011)

Physical fitness is not the main goal in volleyball, but it is the basis upon which other capabilities are built. Volleyball requires the physical ability to repeat high-energy movements with short recovery times. An explosive force is required to jump and land when attacking and blocking, as well as in the trunk, shoulders, and upper limbs at Move the lever to the height in attack, so Technical and physical strength are key factors in winning or losing a volleyball match (FIVB. 2011; Volleyball Australia. 2018).

Anthropometric characteristics are one of the determinants of the relative stability in a player's training age; in volleyball, Remember that Performance requires ‘height above the net’. Relatively long arms add to the height that a player is able to compete above the net and therefore reach is important. Long arms also give players a mechanical advantage in spiking, due to longer lever lengths. The key measure is that the normal arm span is approximately equal the standing height without shoes. If the player’s arm span is greater than height, then the player has a relatively good reach and is suited to volleyball. (Pittera et al. 2009; Volleyball Australia, 2018).

The high level of physiological and physical fitness levels and the well-developed anaerobic as well as aerobic energy production systems (Hakkinen.1993) are among the essential demands for involvement in the volleyball sport since the player is required to compete in alternating short bouts of high intensity playing and relatively long bouts low intensity playing (Gabbett and Georgieff. 2007). Evaluation of the respiratory functions is essential in assessing the player's physiological fitness level and health status, judging the ability of the athlete to successfully perform the required activities (Cular et al. 2017). The pulmonary function testing (PFT) provides qualitative as well as quantitative details about the pulmonary system health and adaptation to the type of sport training (Hagberg et al. 1988; Robinson and Kjeldqard. 1982).

The importance of respiratory system health appears not only during rest; but also, during physical activities where delivery of large volumes of gases is required for proper diffusion process (Khurana. 2005), so the PFT is essential to determine the physical capacity level of any subject (Singh and Sunderesh. 1979). Furthermore, monitoring the functional status of the respiratory system and its response to specified training can be evaluated through the assessment of the lung volumes and capacities (Vedala et al. 2013) that can provide clear clues about the level of response and adaptation to specified training or exercise type (American Thoracic Society. 1991).

The PFT variables are important determinants of the aerobic endurance gained in response to sport training (Prakash et al. 2007; Schoene et al. 1997), especially in type of sports that require long-term training (Patlar et al. 2000).

Spirometery is the most commonly objective evaluation test of the respiratory system function (Laszlo. 2006) and is a widely accepted evaluation method in sport field because its ease of application and accuracy of outcomes. The most commonly used PFT are the forced vital capacity (FVC) test and the maximum voluntary ventilation test (MVV) (Cular et al. 2017; Vitaić et al. 2015).

Assessment of physiological variables in athletes provides a unique chance to know the training- dependent adaptations to a specified type of training (Coyle et al. 1991). Detailed evaluation of the pulmonary functions in the volleyball players is important to reach a conclusive judgment about the players; fitness level and monitoring the training–induced functional improvements (Basu et al. 2018).

Although the importance of the PFT as a diagnostic as well as prognostic tool in sport field; no sufficient literatures are provided in this concern. This can be due to the belief that no need to perform the PFT in athletes since they already have greater volumes and capacities compared with sedentary counter partners (Jeličić. 2000).

Understanding the anthropometric, physical and physiological features of junior athletes is important in identifying talents in sports and the accurate distribution of resources within a team, so far there has been little information about the physical, anthropometric, and physiological characteristics of junior volleyball players across the Kingdom of Saudi Arabia (KSA).Therefore, our cross-sectional study was designed to assess the physical, anthropometric and physiological parameters in three regions of the Kingdom of Saudi Arabia.

MATERIALS AND METHODS

Study design

For this cross-sectional study; multiple on-sites evaluations of the anthropometric, physical and physiological parameters were performed. Familiarization with the tests procedure and instrument were done through detailed explanation of each test procedure, steps, guidelines and demonstration before involvement, all participants' inquiries and questions regarding potential risks and benefits were fully answered before starting the test batteries. Each participant signed written informed consent for participation in this study at the beginning of the study. This study focused on the Saudi junior volleyball players. This study was conducted in accordance with the principles of the World Medical Association Declaration of Helsinki 1975, revised in Hong Kong 1989 and was done in accordance with the Umm Al-Qura university Ethics Committee’s rules and regulations and approval of the Saudi Volleyball Federation.

Subjects:

The sample consisted of (N = 97) junior volleyball players in Saudi Arabia from three regions. All of the participants were team players in the (Central, Western and Eastern) regions involved in volleyball training for the season 2018/2019, and all materials received a clear explanation of the study, all study tests were conducted by the research team with the assistance of the team's coaches. Inclusion criteria included that all participants were on regular athletic volleyball training had close socio-economic circumstances. Exclusion criteria included irregular training schedule, training break for more than 2 months and previous training injuries that can significantly interferer with the of the accuracy study outputs and participant's performance during evaluation

Test protocols

In the 24-hour period prior to the test, the players were shown the tests used and the method of performance, and the need to adhere to the method and instructions for performance, All participants were requested to have at least two hours gab between the breakfast and the evaluations battery of tests, and not to be involved in any strenuous physical activity before the time of evaluation to avoid the acute/ immediate training effects. All measures were conducted on the same day. Each participant had half an hour rest time before being involved in the evaluation process. Participant's evaluations were conducted at the same time of the day (between 4-8 pm) to avoid any diurnal variation's effect on the evaluated parameters. All utilized instruments were calibrated prior to use.

Anthropometric parameters

Body height was measured to the nearest 0.1 cm using a stadiometer (Charder HM-200P Ports tad). Body mass was measured to the nearest 0.1 kg by a scale (body composition monitor BF508, China), the body mass index (BMI) was calculated by dividing body mass by the square of body height. Percentiles for body height and the BMI were calculated as previously described (Flegal and Cole. 2013). The anthropometric parameters included also Standing reach dominant hand (SRH), width hand (WH), Hand length (HL), biceps circumference, lateral arm span (LAS)(Pittera et al. 2009)

Physiological parameters:

Ventilatory functions including Forced vital capacity (FVC), forced expiratory volume in the first minute (FEV1), FEV1/FVC and maximum voluntary ventilation (MVV) were all evaluated by the same evaluator to avoid the inter-rater variability, following documented standards (Durmic et al. 2017) using computerized portable spirometer (LTSA99 Portable Spirometer, Beijing M&B Electronic Instruments Co., Ltd, China). Instrument preparation and calibration was done according the manufacturer's instructions before beginning of the test where all measurements were done at body temperature and pressure saturated with water vapor (BSTP). Participants were encouraged to do their best and perform maximum efforts during the test that was conducted from standing position to eliminate body position-related influences. (Padulo et al. 2012). The trial with the highest values of the three consecutive trials (with 5-minutes rest interval in between trials) was used and considered for statistical analysis. Five minutes rest was allowed between each trial. After recording of participant's name, height, weight and age, the FVC and FEV1 assessment were conducted through encouraging the participant to perform forceful, single maximum prolonged expiration after deep inspiration. The MVV was evaluated through directing the participant to perform maximum effort during the consecutive rapid, beep inspirations and expirations over 12-seconds (Durmic et al. 2017).

Physical parameters:

All athletes had been previously evaluated with these tests and had been using most of them as part of their training and testing routines with their local teams. All performance tests took place between 16:00 and 21:00 hours following a standardized warm-up. The warm-up consisted of 10 minutes of light jogging on the court and 10 minutes of dynamic stretching of the lower and upper body muscles (Tsoukos et al. 2016).

Handgrip strength test (HST).

The participants were asked to stand with their elbow bent at 90^o and instructed to squeeze the handle of the handgrip dynamometer (Takei, Tokyo, Japan) as hard as possible for 5 s.Two trials were given for dominant hand and the best trial was recorded. HST was calculated as the sum of the best efforts for each in absolute values (kg)

Leg strength dynamometer Test

Participants should stand with both feet on base, adjust chain to accommodate test protocol, Perform the test, Subject should lift in a gradual vertical motion, and the pointer on the dial indicates the force exerted, each test should consist of three trial measurements, and the result is the average.

Vertical Jump Test (Sargent Jump)

Players were asked to stand with flat feet on the ground, extend their arm and hand, extend their arm and hand, put a sign of standing position standing, then bend the knees, swing arms and jump to touch the highest point, record the distance the jump height for the three attempts and then calculate the average.

Lying Medicine Ball Throw 3kg

From lying on the back, shoulders on the line, the player throws a 3 kg medical ball as far as possible, score average of two attempts.

10 m sprint.

Participants performed two trials with 5 min break and the best was recorded.

Statistical Analysis:

All statistical analysis was performed using SPSS software package (version 16.0, Inc, Chicago, IL, USA). Descriptive data were presented as Mean ± Standard Deviation. Kolmogorov-Smirnov test was used to test the normal data distribution. Between groups differences hypothesis in evaluated variables were tested using one-way ANOVA. The chi-square test of independence was used to test for equality of proportions between populations. The level of significance was set at <0.05 for all the analyses.

RESULTS

Study results revealed that there were non-significant differences in age, height, weight, and body mass index between the three groups (p > 0.05), (Table 1).

Physical parameters:

Between-groups comparison revealed that there were statistically significant differences in mean values of Lateral Arm Span (P=0.03); but in favor of Central area (P<0.05). There were statistically significant differences in mean values of Standing reach dominant hand (P=0.0001); but in favor of Western area (P<0.05). There were statistically significant differences in mean values of Hand Length (P= 0.00); but in favor of Eastern area (P<0.05).

Table 1: The demographic characteristics of participants for all groups (Mean ± SD)

Variables	Western Area (N=29)	Eastern Area (N=37)	Central Area (N= 31)	F value	P value☼
Age (year)	17.48 ± 1.122	17.57 ± 1.48	17.9 ± 2.02	0.61	0.55 **
Height (cm)	182.345 ± 6.74	183.14 ± 7.78	180.52 ± 5.99	1.24	0.3 **
Weight (kg)	71.38 ± 11.04	72.97 ± 13	73.47 ± 4.96	0.33	0.72 **
BMI (Kg/m^2)	21.43 ± 2.91	21.7 ± 3.16	22.61 ± 2.01	1.53	0.22 **

Level of significance at P<0.05. * = significant, ** = non-significant, BMI: Body mass index.

Table 2: Between-group's comparison of anthropometric physical parameters.

Variables	Western Area (N=29)	Eastern Area (N=37)	Central Area (N= 31)	F value	P value☼
Lateral Arm Span (cm)	185.21 ± 7.1 172-199	185.22 ± 7.65 (173-196)	189.71 ± 7.51 (176-200)	3.85	0.03 *
Biceps Circumference (cm)	28.19 ± 2.59 (23-34)	27.76 ± 3.2 (22-34)	28.42 ± 2.36 (26-33)	0.5	0.61 **
Standing reach dominant hand (cm)	229.55 ± 11.44 (209-251)	239.87 ± 9.17 (227-259)	242.32 ± 14.68 (214-261)	9.86	0.0001 *
Hand Length (cm)	19.36 ± 1.89 (17-25)	22.38 ± 1.16 (20-25)	20.68 ± 2.06 (17-26)	25.75	0.00 *
Hand Grip (kg)	45.97 ± 7.95 (25-57)	50.65 ± 6.83 (38-65)	51.94 ± 13.15 (40-73)	3.22	0.04 *
10 meter Sprint (sec)	1.85 ± 0.09 (1.65-2)	1.87 ± 0.08 (1.76-2)	1.73 ± 0.15 (1.5-1.94)	14.94	0.00002 *
Medicine Ball (meter)	5.76 ± 0.63 (4.4-7)	5.64 ± 0.43 (5-6.8)	5.83 ± 0.36 (5.2-6.4)	1.26	0.29 **
Leg Strength (kg)	137.28 ± 26.48 (91-185)	152.43 ± 16.53 (120-175)	149.03 ± 18.9 (110-170)	4.63	0.01 *
Vertical Jump (cm)	284.38 ± 15.45 (245-318)	298 ± 10.8 (275-320)	299.26 ± 18.84 (260-320)	9	0.0003 *

Table 3: Between-group's comparison of physiological parameters (ventilatory functions).

Variables	Western Area (N=29)	Eastern Area (N=37)	Central Area (N= 31)	F value	P value☼
Predicted FVC (Liter)	5.55 ± 0.49 (4.57-6.63)	5.62 ± 0.61 (4.48-6.86)	5.43 ± 0.48 (4.74-6.55)	1.02	0.37 **
Measured "observed" FVC (Liter)	5.81 ± 0.66 (4.1-6.88)	5.69 ± 0.41 (4.65-6.48)	5.45 ± 0.36 (4.77-5.99)	4.4	0.02 *
Predicted FEV1 (Liter)	4.62 ± 0.4 (3.9-5.5)	4.69 ± 0.49 (3.78-5.63)	4.53 ± 0.38 (3.99-5.43)	1.04	0.36 **
Measured "observed" FEV1 (Liter)	4.86 ± 0.5 (3.73-5.79)	4.68 ± 0.37 (3.95-5.61)	4.54 ± 0.35 (3.89-4.95)	4.85	0.01 *
Predicted FEV1/FVC (%)	83.22 ± 2.08 (74.43-86.19)	84.94 ± 0.4 (83.87-85.6)	84.9 ± 0.54 (83.73-85.7)	20.37	0.00 *
Measured "observed" FEV1/FVC	83.97 ± 5.31 (76.13-93.9)	82.44 ± 3.67 (73.24-90.19)	83.4 ± 3.57 (76.73-91.74)	1.14	0.33 **
Predicted MVV (Liter/minute)	186.52 ± 16.03 (155.96-216.2)	187.41 ± 19.46 (151.2-225.2)	181.46 ± 14.01 (155.6-198.0)	1.17	0.32 **
Measured "observed" MVV (Liter/minute)	251.74 ± 38.96 (180-319.44)	187.12 ± 14.65 (158-224.4)	181.35 ± 15.21 (159.6-217.2)	76.04	0.00 *

Level of significance at P<0.05. * = significant و ** = non-significant, FVC: Forced Vital Capacity, FEV1: Forced Expiratory Volume in One Second, MVV: Maximum voluntary ventilation

Table 4: Post-hoc multiple comparisons of mean values of evaluated variables between groups (P value).

Variables	groups	Western Area	Eastern Area
Lateral Arm Span (cm)	Western Area		
	Eastern Area	0.996 **	
	Central Area	0.02 *	0.015 *
Standing reach dominant hand (cm)	Western Area		
	Eastern Area	0.001 *	
	Central Area	0.0001 *	0.396 **
Hand Length (cm)	Western Area		
	Eastern Area	0.00 *	
	Central Area	0.004 *	0.0001 *
Hand Grip (kg)	Western Area		
	Eastern Area	0.052 **	
	Central Area	0.02 *	0.583 **
Ten-meter Sprint (sec)	Western Area		
	Eastern Area	0.3 **	
	Central Area	0.0002 *	0.000001 *
Leg Strength (kg)	Western Area		
	Eastern Area	0.004 *	
	Central Area	0.03 *	0.501 **
Vertical Jump (cm)	Western Area		
	Eastern Area	0.001 *	
	Central Area	0.0003 *	0.734 **
Measured "observed" FVC (Liter)	Western Area		
	Eastern Area	0.31 **	
	Central Area	0.005 *	0.045 *
Measured "observed" FEV1 (Liter)	Western Area		
	Eastern Area	0.071 **	
	Central Area	0.002 *	0.16 **
Measured "observed" MVV (Liter/minute)	Western Area		
	Eastern Area	0.00 *	
	Central Area	0.00 *	0.34 **

Level of significance at P<0.05. * = significant, ** = non-significant, FVC: Forced Vital Capacity, FEV1: Forced Expiratory Volume in One Second, MVV: Maximum Voluntary Ventilation.

There were statistically significant differences in mean values of Hand Grip (P= 0.04); but in favor of Western area (P<0.05). There were statistically significant differences in mean values of Ten-meter Sprint (P= 0.00002); but in favor of Central area (P<0.05). There were statistically significant differences in mean values of Leg Strength (P= 0.01); but in favor of Western area (P<0.05). There were statistically significant differences in mean values of Vertical Jump (P= 0.0003); but in favor of Western area (P<0.05). (Table 2, 4).

Physiological parameters (Ventilatory functions):

Between-groups comparison revealed that there were statistically significant differences in mean values of measured "observed" FVC (P=0.02), FEV1 (P=0.01), MVV (P= 0.00). Furthermore, results of testing the equality of proportions between groups revealed that there were significant differences in the FVC, FEV1, and MVV; but in favor of Western Area. (P<0.05) (Table 3, 4).

DISCUSSION

The main finding of this study indicates that, the volleyball players in different regions significantly differed in selected anthropometric, physical and ventilatory parameters when compared according to the age and BMI and this play a vital role in game performance in junior volleyball players. Anthropometric properties as well as appropriate physical fitness are important prerequisites for outstanding performance of sports skills and play a distinguished role in sports' successful achievements (Stamm et al. 2003).

Long arms give players a mechanical advantage in spiking, due to longer lever lengths. The key measure is that the normal arm span is approximately equal the standing height without shoes. If the player's arm span is greater than height, then the player has a relatively good reach and is suited to volleyball (Volleyball Australia. 2018).

These findings suggest that physiological and anthropometric monitoring should be included in any testing of junior volleyball players to provide coaches with objective feedback on the individual strengths and weaknesses of players (Tim et al. 2007).

The information about the anthropometric characteristics of the players (body height, weight, and body mass index) and the reach capacities of the spike and block serve as reference values in the selection and training process of the players. When players reach a performance age in volleyball, these values orient the coach in team management. Age also allows one to have a temporal reference of the approximate time until optimal performance may be achieved. Difference in the physiological and anthropometric characteristics of players contribute significantly in the competitive performances of junior volleyball players (Volleyball Australia. 2018).

The overall volleyball players FVC, FEV1 and MVV mean values in all regions included in this study were higher than predicted normal value (matched for age and height). Adaptive changes in form of elevated ventilatory variables are expected in athletes compared with normal predicted values or sedentary matched populations **(**Cheng et al. 2003). Regular training positively impacts the respiratory system, and even each physical training and sport branch has its own specific impact on the athlete's pulmonary capacity (Atan et al. 2012).

Volleyball is an interval sport that depends on both aerobic and anaerobic energy production systems within the body, with the latter type predominates during training and competition and can significantly increase the ventilatory functions of the Volleyball player (Smith et al. 1992). Endurance training generally produces general respiratory adaptations as well as increases in the FVC, FEV1 and the MVV values among the volleyball players (Durmic et al. 2017). These adaptations are secondary to reduction in the airway's resistance, improved alveolar expansion, increased the respiratory muscles strength and increased total lung elasticity in response to regular physical activities and training (Leischik and Dworrak. 2014; Park et al. 2012).

The observed increase in the mean values of the spirometric indices among the Junior Saudi volleyball players can be explained on the basis that regularly conducted -even mild- exercise training favorably affects the ventilatory functions and ends in obviously increased FVC, FEV1 and MVV especially after long-term physical training (Myrianthefs et al. 2014). Regular participation in specific training has a facilitating effect on the lungs resulting in improving maximum inflation and deflation of the lungs that in turn stimulates the release of the surfactants inside the alveoli as well as release of prostaglandins that reduce the bronchial smooth muscles tone; resulting in improving lung compliance and elasticity (Smith. 1976; Hildebran et al. 1981). In addition to the regular training; higher body mass, increased arm span (Silva et al. 2013), and increased height (Goswami et al. 2014) values are among the main contributors to increased ventilatory functions in the Volleyball players. High level of muscular strength and aerobic fitness that are essential requirements in the volleyball player (Gabbett et al. 2008) can further explain the enhanced respiratory parameters among them, so the variability among different volleyball players groups in these parameters can be attributed to the level of training among groups (Atan et al. 2012).

CONCLUSION

Measuring the anthropometric, physical and physiological parameters of junior volleyball players is an important aspect in selecting volleyball junior players and presented normative data for anthropometric, physical and physiological parameters and could be useful in selection and profiling of junior Saudi Arabia volleyball players.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

MSY, AAE, AAM, and MNJ were responsible for the design, conduct the study and wrote the manuscript. MSY, AAE, AAM conducted the participant selection, measurements and statistical analysis of data. MSY, AAE, AAM, and MNJ reviewed the manuscript. All authors read and approved the final version.

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