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Pol. J. Sport Tourism **2020**, *27(3), 15-19*
DOI: 10.2478/pjst-2020-0015

CARDIORESPIRATORY FITNESS IN UNIVERSITY LEVEL VOLLEYBALL PLAYERS AND ITS CORRELATION WITH BODY FAT

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Abstract

Introduction. The present study was aimed to compare the cardiorespiratory fitness levels (VO_2max) between university level male and female volleyball players and to find its correlation with percentage body fat. ***Material and Methods.*** In the present cross-sectional study, male and female volleyball players (n = 15 each) aged 18-25 years were randomly selected from Teerthanker Mahaveer University, Moradabad, India. An equal number of sedentary individuals were also selected who did not indulge in any vigorous physical activity or training. Body height, body weight, body mass index (BMI), % lean body mass of players and sedentary individuals were recorded using standard methods. Percentage body fat was calculated using the sum of four skinfolds and VO_2max was recorded using Queen's college step test. Data were analysed using SPSS software version 20.0. Unpaired t-test was used for comparison between players and sedentary individuals and two-way ANOVA was used to examine interaction of status (active players and sedentary individuals) and gender on VO_2max. ***Results.*** Players had higher mean values for % lean body mass and VO_2max. Statistically, highly significant differences ($p < 0.05$) were observed between male and female players for all variables except BMI. Players had better cardiorespiratory fitness (VO_2max) as compared to their sedentary counterparts. ***Conclusions.*** Significant differences exist between players and sedentary individuals for percentage body fat and percentage lean body mass. Cardiorespiratory fitness of players is negatively correlated with percentage body fat. Players have higher VO_2max as compared to their sedentary counterparts.

Key words: aerobic capacity, sedentary, body composition, fitness

Introduction

The overall capacity of cardiovascular and respiratory system and the ability to carry out prolonged strenuous exercise is termed as cardiorespiratory fitness or maximal aerobic power. It serves as an important marker of health in young people [1]. The maximal oxygen consumption or VO_2max is an internally accepted parameter to evaluate cardiorespiratory fitness [2]. It is measured as ml/kg/min. It has emerged as a strong predictor of adverse health outcomes [3, 4]. VO_2max is dependent upon many factors, such as gender, age or level of fitness and varies from individual to individual. Multiple factors can affect aerobic performance including body mass and body composition [5]. Due to this, body composition and cardiorespiratory fitness are frequently used in association with each other. Goran *et.al.* [6] suggested that with better cardiovascular fitness, a person is at a lower and reduced risk of factors affecting individual's health. Aerobic fitness serves as an important factor in predicting the cardiovascular risk factors for an individual in future. It may also help to prevent morbidity and mortality in higher age group.

Aerobic capacity of athletes plays an important role in successful sports achievement. Its evaluation provides the information about the players' health status and also helps in evaluating the effects of training and early selection of athletes [6]. Many direct and indirect methods are available to measure the aerobic capacity. Out of many methods available, Queen's college step test (QCT) is one of the simplest indirect methods to evaluate cardiorespiratory fitness in young Indian individuals [7]. It does not require any calibration or elaborate and expensive equipment. This test can be applied for estimation of maximum oxygen uptake in large numbers of participants, in absence of a well-equipped laboratory [2].

Volleyball is a popular game requiring power, agility and high speed. It is a high skill game requiring adequate levels of physical fitness since the competitive load involves substantial energy expenditure. A high level of maximal oxygen uptake is critical for achievement of high physical capacity of human body. The amount of oxygen that an athlete requires depends, in particular, on an athlete's level and exercise intensity. Trained individuals have better exercise economy and more efficient oxygen use. Therefore, the present study was undertaken to compare cardiorespiratory fitness (VO_2max) between university level volleyball players as well as sedentary individuals and to find the correlation of anthropometric characteristics with VO_2max in players.

Material and Methods

Study Design: Cross-sectional

Participants

Thirty male (n = 15) and female (n = 15) volleyball players, aged 18-25 years (Mean age: 21.33 and 21.06 years, respectively)

and with playing experience of more than one year were randomly selected from Teerthanker Mahaveer University, Moradabad (UP). An equal number of sedentary individuals without any athletic background were also selected for comparison. The study was conducted at the Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad (UP).

Inclusion criteria

Subjects with the following inclusion criteria were selected for the study:

1. Both male and female university level volleyball players between the age group of 18-25 years.
2. Playing experience of 1 or more years.
3. Apparently healthy players not suffering from any medical or musculoskeletal conditions.

Exclusion criteria

History of any medical or musculoskeletal conditions, smoking, any recent surgery, presence of implants, history of cardiorespiratory disease.

Written informed consent was obtained from the participants. Data were collected under natural environmental conditions in the morning (between 9 am - 1 pm) during the months of March-April, when the average temperature and humidity was 70° F and 71%, respectively. The participants did not perform any vigorous exercise 48 h prior to the test. They were instructed to wear comfortable clothing. The study was approved by the institutional ethics committee and was undertaken in compliance with the Helsinki Declaration. Age of the subjects was recorded from the institutional records.

Method

For all the participants, height, weight, BMI, % body fat, % lean body mass and VO_2max were measured. Height was measured in metre during inspiration using a stadiometer (Holtain Dyfed, UK) and body weight was measured in kilogram (kg) by digital standing scales (Model DS-410, Seiko, Tokyo, Japan). Percentage body fat was assessed using skinfold measurements taken from four sites i.e. biceps, triceps, subscapular and suprailiac using Harpenden skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) to the nearest 0.2 mm and using the Durnin and Womersley's and Siri's equation [8, 9]. Harpenden skinfold caliper is considered a gold standard method for skinfold measurement with 99% accuracy, hence chosen for the present study [10]. For Queen's college step test [7], each participant was instructed to step up and down on a step of height 41.3 cm for 3 minutes at a rate of 24 cycles/minute for males and 22 cycles/minute for females. The cycle rate was set up using a metronome. The participant maintained the required minute pace. After completion of the test, the participant kept standing and the carotid pulse rate was measured from 15 – 20 seconds of the recovery period. The 15 seconds pulse rate was converted into beats per minute and the following equations were used to predict VO_2max:

- VO_2max for males: VO_2max (ml/kg/min) = 111.33 – (0.42 x heart rate in beats per minute)
- VO_2max for females: VO_2max (ml/kg/min) = 65.81 – (0.1847 x heart rate in beats per minute)
- Percentage lean body mass was calculated using the following formula:
  Percentage lean body mass = 100 – percentage body fat

Statistical analysis

Data were analysed using SPSS version 20.0 for Windows. Unpaired t-test was used to compare the variables between players and sedentary individuals. Two-way ANOVA was used to examine the effect of gender (male/female) and status (active players/inactive sedentary individuals) on VO_2max. Pearson's coefficient test was done to find correlation between variables. Statistical significance was indicated using a 5% level of probability.

Results

Table 1 shows the descriptive statistics of anthropometric characteristics and VO_2max of male players and their sedentary counterparts. Players recorded a higher mean value for all variables except body weight, BMI, and % body fat. Highly significant differences ($p < 0.05$-0.001) were observed in VO_2max, % body fat, % lean body mass between players and sedentary males.

Table 2 shows the descriptive statistics of various anthropometric characteristics and VO_2max of female players and their

Table 1. Descriptive statistics of anthropometric characteristics and VO_2max between male players and sedentary males.

Variables	Male players (n = 15)		Sedentary males (n = 15)		t value	p value
	Mean	SD	Mean	SD		
Height (m)	1.67	0.07	1.65	0.08	0.89	0.381
Body weight (kg)	60.95	7.30	65.08	7.57	1.51	0.140
BMI (kg/m²)	22.49	3.27	23.11	1.92	0.62	0.535
VO_2max (ml/kg/min)	53.27	4.97	47.33	6.49	2.45	0.021
% Body fat	18.48	1.03	19.88	1.55	2.89	0.007
% Lean body mass	81.51	1.03	80.11	1.55	2.89	0.007

Table 2. Descriptive statistics of anthropometric characteristics and VO_2max between female players and sedentary females.

Variables	Female players (n = 15)		Sedentary females (n = 15)		t value	p value
	Mean	SD	Mean	SD		
Height (m)	1.56	0.56	1.56	0.04	3.36	0.002
Body weight (kg)	52.59	7.97	51.98	6.45	0.23	0.819
BMI (kg/m²)	21.46	2.97	22.86	2.15	1.47	0.153
VO_2max (ml/kg/min)	48.91	2.00	46.13	5.08	1.97	0.059
% Body fat	21.33	1.75	23.57	1.36	3.90	0.001
% Lean body mass	78.66	1.75	76.42	1.36	6.50	0.001

Table 3. Descriptive statistics of anthropometric characteristics and VO_2max between male and female players.

Variables	Male players (n = 15)		Female players (n = 15)		t value	p value
	Mean	SD	Mean	SD		
Height (m)	1.67	0.07	1.56	0.05	4.69	0.000
Body weight (kg)	60.95	7.30	52.59	7.97	4.39	0.000
BMI (kg/m²)	22.49	3.27	21.46	2.97	1.92	0.064
VO_2max (ml/kg/min)	53.27	4.97	48.91	2.00	7.58	0.000
% Body fat	18.48	1.03	21.33	1.75	11.17	0.000
% Lean body mass	81.51	1.03	78.66	1.75	11.17	0.000

Table 4. Two-way ANOVA showing the effect of status (active players and sedentary individuals) and gender on VO_2max.

	Sum of squares	df	Mean square	F	Sig	Partial eta square
Status	336.550	1	336.550	21.633	0.000	0.279
Gender	391.598	1	391.598	25.172	0.000	0.310
Status*Gender	35.356	1	35.356	2.273	0.137	0.039

Table 5. Correlation of VO_2max with various anthropometric characteristics in volleyball players.

Variables	Male players (n = 15)		Female players (n = 15)	
	r	p	r	p
Height (m)	-0.184	0.512	-0.544	0.036
Weight (kg)	0.040	0.888	-0.460	0.085
BMI (kg/m²)	0.216	0.440	-0.181	0.518
% Body fat	-0.294	0.288	-0.260	0.348
% Lean body mass	0.294	0.288	0.260	0.348

sedentary counterparts. Female players recorded a higher mean value for VO_2max and % lean body mass. Highly significant differences ($p < 0.05$-0.001) were observed in VO_2max, % body fat, % lean body mass between players and sedentary females.

Table 3 shows the descriptive statistics of various anthropometric characteristics and VO_2max between male and female players. Male players recorded a higher mean value for all variables except % body fat. Highly significant differences ($p < 0.05$-0.001) were observed for all variables between male and female players.

Table 4 shows the interaction of status (active players and sedentary individuals) and gender on VO_2max. There was a statistically significant difference in VO_2max between males and females and active/inactive individuals. However, the interaction between status and gender did not result in significant effects on VO_2max.

Table 5 shows correlation of VO_2max with various anthropometric characteristics in male and female players. Both positive and negative correlation of VO_2max was observed with different variables among male and female players.

Discussion

The aim of the present study was to estimate the maximum oxygen uptake and find its correlation with % body fat and % lean body mass of volleyball players. Thirty randomly selected male and female volleyball players (n = 15 each), aged 18-25 years, were involved in the study. An equal number of sedentary individuals were also selected. The results showed that male volleyball players had higher value of VO_2max (53.27 ml/kg/min) than female players. The highest rate of oxygen consumption attainable during maximal exercise is referred to as VO_2max [11]. Aerobic capacity plays an important role in the success for athletes. With regular physical activity, there is a decreased risk of heart disease, obesity and stress [12]. Body composition factors such as BMI, % body fat and body muscle mass get affected with a reduction in physical activity levels. Hence, close associations are found between body composition factors and aerobic fitness. A decrease in aerobic fitness is attained with an increase in body fatness [13].

The present study showed that significant differences exist for VO_2max and anthropometric characteristics between male and female players as well as between players and their sedentary counterparts. The findings of the present study are in line with the previously reported studies, where males recorded better VO_2max values than females [14]. With training, an increase in VO_2max is found due to an increase in the cardiac output, secondary to high stroke volume and an increase in arterio-venous oxygen difference [15]. Increased VO_2max in athletes may also result from enlargement of cardiac chambers, increased capillary density, increased number of mitochondria as well as hypertrophy of muscle fibers [16].

In the present study, highly significant differences in % body fat, % lean body mass were observed between male and female players as well as between sedentary individuals and players. Players had higher % lean body mass and VO_2max as compared to sedentary subjects. These findings are consistent with the results of Milenkovic et al. and Taware et al. [17, 18], who reported higher values of VO_2max in volleyball players as compared to sedentary subjects (45.50 ml/kg/min and 44.55ml/kg/min, respectively). On comparing the VO_2max values of the present study with university volleyball players of Marathwada region [19], it was found that players of Marathwada had higher values of VO_2max than controls (52.99 ± 5.13ml/kg/min), which is consistent with our findings. Similar results were also observed by Milenkovic et al. and Mishra et al., who reported higher VO_2max values (45.50ml/kg/min and 60.266 ml/kg/min) [17, 20]. Excessive amount of body fat imposes unnecessary burden over cardiac system especially during exhaustive exercise. Also, an excessive amount of adipose tissue is considered as unused mass because the athlete's body has to separately cope up with gravitational forces during locomotion and jumps, which results in a lowering of performance and an increase in demands on energy during the performance of a particular action [21].

The lack of physical activity may be an attributing factor towards higher % of body fat and a lesser value of VO_2max amongst sedentary individuals. Among players, negative correlations of weight, height, BMI, % body fat with VO_2max were

found. This indicates the effect of increasing BMI and % body fat on cardiorespiratory fitness. This is in line with the findings of previously reported studies [2]. A higher percentage of fat among sedentary individuals demonstrates the importance of low cardiorespiratory fitness in young adults, which could be a factor for developing cardiovascular comorbidities later in middle age.

Clear links have been established between the levels of fitness and coronary heart disease risk factors in adolescents and young children [22]. Improvements in cardiorespiratory fitness have positive effects on depression, anxiety, mood states and self-esteem. So, it is suggested that young adults should indulge in regular physical activity because studies have found that achieving 60 min or more of moderate or vigorous physical activity daily is associated with healthier cardiorespiratory fitness levels in adolescents, independent of their adiposity status [23].

Studies have shown that high levels of cardiorespiratory fitness in young adults are associated with a lower risk of having calcification in the coronary arteries and prevent the development of early atherosclerotic vascular disease [24]. Physical inactivity and sedentary behaviour lead to accumulation of excess adipose tissue and a state of chronic inflammation which is a major factor in the development of non-communicable diseases. Hence, it becomes important to assess cardiorespiratory fitness in young adults. The findings of the present study will be helpful in designing an exercise program for sedentary individuals to improve their aerobic capacity, which may help to prevent morbidity and mortality in older age groups. Also, it will help coaches to develop some selection criteria prior to formation of a team.

Conclusion

The findings of the present study show that both male and female volleyball players had better cardiorespiratory fitness as compared to their sedentary counterparts. Also, significant differences existed between players and sedentary individuals for percentage body fat and percentage lean body mass. In players, VO_2max had a negative correlation with percentage body fat and a positive correlation with percentage lean body mass. It can be concluded that higher body fat leads to lesser VO_2max which is an integral component of cardiorespiratory fitness and one should indulge in aerobic exercises or games requiring bursts of energy expenditure like volleyball to maintain good cardiorespiratory fitness.

Acknowledgements

The authors would like to thank all the study participants for their valuable time and Dr. Shashank Mehra, Sharda University, for his guidance in statistical analysis.

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Submitted: July 3, 2020
Accepted: August 12, 2020