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Research Study

Medical research

To evaluate the physical fitness of female medical students involved in sports in terms of VO₂ max, handgrip strength, handgrip endurance and compare it with those not involved in physical activities - A cross sectional study

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ABSTRACT

Background

Physical activity increases oxygen supply to various organ thus increases VO₂ max and increase muscular strength.

Purpose of the study

The purpose of the present study was to understand the influence of regular physical activity on VO₂max, handgrip strength and handgrip endurance and to compare it with non exercising female.

Methodology

The subjects consisted of 30 control (not involved in any physical activity), 15 runners and 15 volleyball player without any history of respiratory disease, cardiac disease or any other chronic disease. VO₂max was calculated by queen college step test whereas handgrip strength and handgrip endurance was measured by using handgrip dynamometer.

Results

Runners showed superior aerobic capacity (VO₂max). Handgrip strength found to be higher in volleyball players as compared to runners and control. When comparing all groups there is no significant difference (p>0.5) in Handgrip endurance.

Keywords: VO₂max, handgrip strength, handgrip endurance

INTRODUCTION

Regular exercise in the form of sports, aerobics, or workouts has beneficial effects on various systems of the body. These systems are benefited by exercise because the blood flow is increased to

various organs thus increasing nutrition and functioning of organs¹.

Regular exercise reduces the risk of cardiovascular diseases, brain stroke and kidney

diseases. Exercise reduces the risk for several chronic metabolic disorders associated with obesity; such as insulin resistance and type II diabetes. Various studies have been shown that exercise results in better health related fitness that keeps the individual away from the diseases and prolongs the life².

Health-related fitness is generally known as physical fitness. Physical fitness is defined as “the ability to carry out daily tasks with vigor and alertness, without undue fatigue, and with ample energy to enjoy leisure-time pursuits and to meet unforeseen emergencies³. Components of physical fitness include cardio-respiratory fitness, strength, muscular endurance, flexibility, body composition.

Presently, maximal oxygen uptake (VO₂max) has been recognized as the best index of cardio-respiratory fitness^{4,5}.

Common determinant of success in athletic event is ‘muscle’ for the athlete. Muscle strength refers to the maximum force that can be produced by a muscle or muscle group in a single contraction, while muscle endurance refers to the ability of the muscles to contract repeatedly or maintains a sub maximal force for an extended period of time⁶.

Various research studies have been conducted exclusively in sportsmen^{7, 8} however, very few research studies are available in sportswomen, especially in India. With this background, the present study is conducted in women medical students who are exclusively runners and exclusively volleyball players.

AIM & OBJECTIVES

Aim

To evaluate and compare physical fitness in female medical students who are exclusively runners and volleyball players; and compare it with control group.

Objectives

1. To determine and compare the maximum oxygen uptake (VO₂max) in control group, runners and volleyball players.
2. To assess and compare handgrip strength (HGS) and handgrip endurance (HGE) in control group, runners and volleyball players.

Methodology

The present study was aimed at finding out VO₂max, handgrip strength and handgrip endurance. These parameters were compared in control group, runners and volleyball players.

Study setting & Study design

This cross sectional study was conducted in the department of Physiology BPS GMC (W), Khanpur

Kalan, a rural medical college in Haryana after taking approval from Institutional Ethical Committee.

Study duration

Data were collected from August to September.

Distribution of study population

A total of randomly selected MBBS students studying in any professional who were exclusively runners or volleyball players were taken as subjects and the students not involved in any physical activity were taken as control.

Group 1 = Control group of age and BMI matched females (n=30)

Group 2 = Runners (n=15)

Group 3 =Volleyball players (n=15)

Inclusion criteria

1. Sports women in the age group of 18-25 years.
2. Sports women those were indulged in running and volleyball playing
3. Minimum experience of 2 years of sports and participated in various sports competitions.
4. Minimum of 1 hour of practice daily.
5. Females who were not involved in regular sports activity were selected as control group.

Exclusion criteria

1. Subjects with history of (H/O) acute and chronic lung disease, cardiac disease, neuromuscular disorder, metabolic disorders and obstetric disease.
2. H/O cardiothoracic surgery and any major surgery.
3. H/O trauma.
4. Control female subjects doing regular exercise.
5. The students who refused to give consent for the study.

Data collection

The study protocol was explained in detail to the subjects. Subjects were asked to fill the consent form. All subjects who gave their consent for the study and fulfilled selection criteria were included. The study was conducted in the morning session i.e. between 8 a.m. to 11 a.m. They were asked not to indulge in any vigorous exercise prior to test and to take light breakfast and wear comfortable clothing.

A Performa was designed to obtain information on demography including weight, height, pulse, blood pressure, respiratory rate, basic information on sports activity and medical history.

The following measurements were recorded:

- Body weight (in Kg): measured by standard weighing machine.

- Standard height (in cm): taken by measuring tap
- Body Mass index (BMI)= weight in kg / (height in meter²)
- Pulse (in beats/min): radial pulse taken for full one minute.
- Blood pressure (in mm of Hg): taken on left hand in supine position.

Determination of Maximal oxygen consumption (VO₂max)

Queen College Step test (QCT) ⁹ was used to predict maximal oxygen uptake. It is a standard method to measure one’s maximal oxygen uptake using sub maximal exercise in the form of bench stepping, suitable for adults.

Procedure

1. A wooden stepping bench of 16.25 inch was used along with metronome and stopwatch.
2. Step test began after a brief demonstration and practice period.
3. The subjects were asked to perform each stepping cycle to four-step condense, Up – up – down-down continuously for 3 minute.
4. Frequency of stepping was 22 stepping cycle per minute so metronome was set at 88 beats per minute.
5. After completion of test, subject remained standing while recovery pulse rate (Radial pulse) was measured for 15 seconds, starting from 5th to 20th second of recovery period. 15 seconds recovery heart rate was converted to be expressed as beats per minute (15-second heart rate x 4).

Following equation was used to calculate VO₂max:

$$VO_2max \text{ (ml/min/kg)} = 65.81 - (0.1847 \times HR)$$

(Where, HR is full one minute recovery heart rate)
VO₂max was expressed as milliliter per kilogram of body weight per minute (ml/kg/min)

Determination of Handgrip Strength and Handgrip Endurance

The handgrip strength and handgrip endurance were measured by using handgrip dynamometer. Tests were demonstrated to the subjects before performing the test.

Procedure

A] Handgrip strength (HGS):

- 1) The handgrip dynamometer was held in the dominant hand, in standing position, with arm by their side, not touching the body.
- 2) The subject was instructed to hold the dynamometer in such a way that second phalanx was against the inner stirrup.
- 3) The subject was then be asked to grip the dynamometer handle with as much force as possible.
- 4) The reading was taken in kilograms as indicated by the pointer on the dynamometer. Three readings were taken with a gap of 10-20 seconds between two readings. Best amongst the 3 measurements were considered as subject’s handgrip strength.

B] Handgrip endurance (HGE):

- 1) Handgrip endurance was measured by asking the subjects to maintain their grip on the handgrip dynamometer to 1/3rd of maximum handgrip strength for as long as possible, until the subject was fatigued.
- 2) The time for which the subject was able to maintain the grip at 1/3rd of maximum handgrip strength was recorded using a digital stopwatch. This time in seconds was recorded as handgrip endurance.

Statistical analysis

The data of the observation for all parameters were statistically analyzed by calculating mean and standard deviation. The data were analyzed using Graph pad prism5 software. Statistical difference between the date obtained in various groups were evaluated by students’ t test and p value <0.05 was considered as statistically significant.

OBSERVATIONS AND RESULTS

TABLE 1: Mean values of different parameters in Control and Runners

S.No	Parameters	Control (n =30) Mean± SD	Runner (n =15) Mean ±SD	P Value	Significance
1.	Age (years)	21.1(0.995)	21(0.845)	.741	NS
2.	Height (cm)	159.5(5.05)	160.33(5.106)	.635	NS
3.	Weight (kg)	54.23(7.122)	57.81(7.401)	.109	NS
4.	BMI (kg/m ²)	21.57(2.737)	22.41(2.384)	.341	NS
5.	Pulse (/min)	80.83(6.889)	72.33(9.021)	.001	S**
6.	Systolic BP (mmHg)	116.53(6.786)	114.73(7.015)	.411	NS

7.	Diastolic BP (mmHg)	76.4(7.190)	79.43(9.456)	.232	NS
8.	VO ₂ max (ml/kg/min)	41.47(2.528)	45.73(2.400)	.000	S***
9.	HGS (Kg)	13.06(4.906)	14.13(4.422)	.482	NS
10.	HGE (Seconds)	34.7(21.541)	33.93(19.587)	.908	NS

HGS= Handgrip strength, HGE= Handgrip endurance, S***= highly significant, NS= Non significant

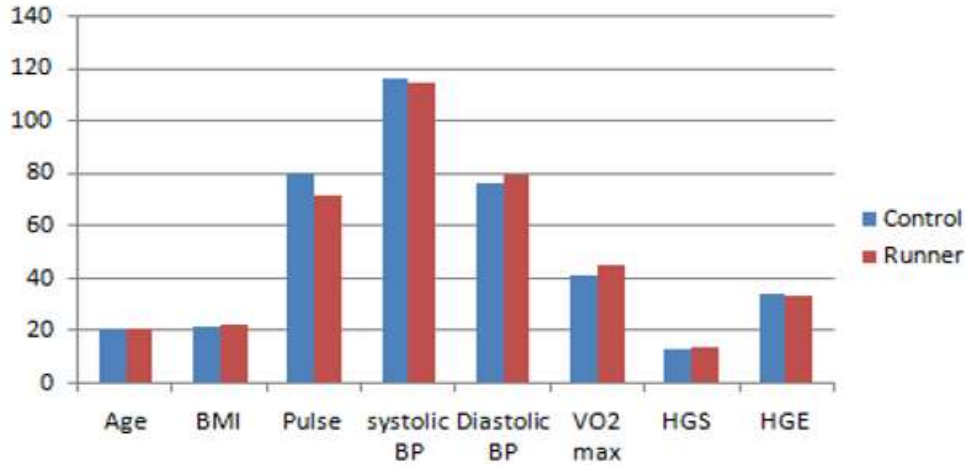


Figure 1: Comparison of mean values of different parameters in Control and Runners

Table 1 & Figure 1 shows statistically no significant difference in mean values of age, height, weight, BMI. Therefore three groups were comparable with respect to these parameters.

On comparison of mean values of Pulse, Blood pressure (systolic and diastolic), VO₂ max, HGS & HGE in controls and runners, we found pulse and VO₂ max significantly higher (p< .05) in runners.

TABLE 2: Mean values of different parameters in Control versus Volleyball players

S.No	Parameters	Control(n =30) Mean ±SD	Volley ball players (n =15) Mean± SD	P Value	Significance
1.	Age (years)	21.1(0.995)	20.73(0.884)	.234	NS
2.	Height (cm)	159.5(5.050)	161.16(4.367)	.255	NS
3.	Weight (kg)	54.23(7.122)	54.52(5.422)	.924	NS
4.	BMI (kg/m ²)	21.57(2.737)	20.97(2.052)	.410	NS
5.	Pulse (/min)	80.83(6.889)	81.26(11.793)	.877	NS
6.	Systolic BP (mmHg)	116.53(6.786)	114.80(6.961)	.428	NS
7.	Diastolic BP (mmHg)	76.4(7.190)	81.6(7.899)	.032	S*
8.	Vo ₂ max (ml/kg/min)	41.47(2.528)	42.83(3.121)	.121	NS
9.	HGS (Kg)	13.06(4.906)	20.93(5.230)	.000	S***
10.	HGE (Seconds)	34.7(21.541)	32.13(26.090)	.727	NS

S***= highly significant, S*= significant

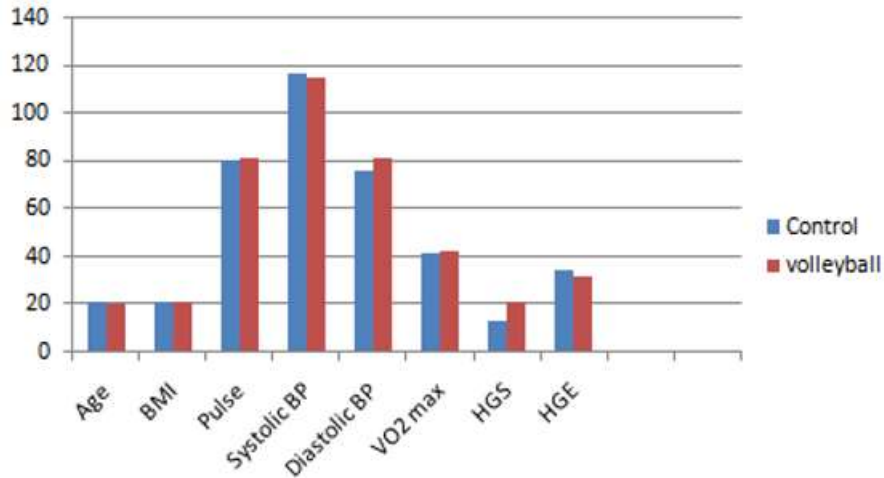


Figure 2: Showing comparison of mean value of parameters between control and volleyball players

Table 2 & Figure 2 shows statically no significant difference in mean values of age, height, weight, BMI. Therefore three groups were comparable with respect to these parameters.

On comparison of mean values of Pulse, Blood pressure (systolic and diastolic), VO₂ max, HGS & HGE in controls and volleyball players, we found HGS significantly higher (p< .05) in Volleyball players.

TABLE 3: Comparison of mean values of different parameters recorded between runners and volleyball players

S.No	Parameters	Runners (n =15) mean± SD	Volleyball players (n =15) mean± SD	P Value	Significance
1.	Pulse (/min)	72.33(9.021)	81.26(11.793)	.027	S*
2.	Systolic BP (mmHg)	114.73(7.015)	114.80(6.961)	.979	NS
3.	Diastolic BP (mmHg)	79.43(9.456)	81.6(7.899)	.508	NS
4.	Vo2 max (ml/kg/min)	45.73(2.440)	42.83(3.121)	.009	S**
5.	HGS (Kg)	14.13(4.422)	20.93(5.230)	.001	S**
6.	HGE (Seconds)	33.93(19.587)	32.13(26.090)	.832	NS

S **= highly significant, S*= Significant

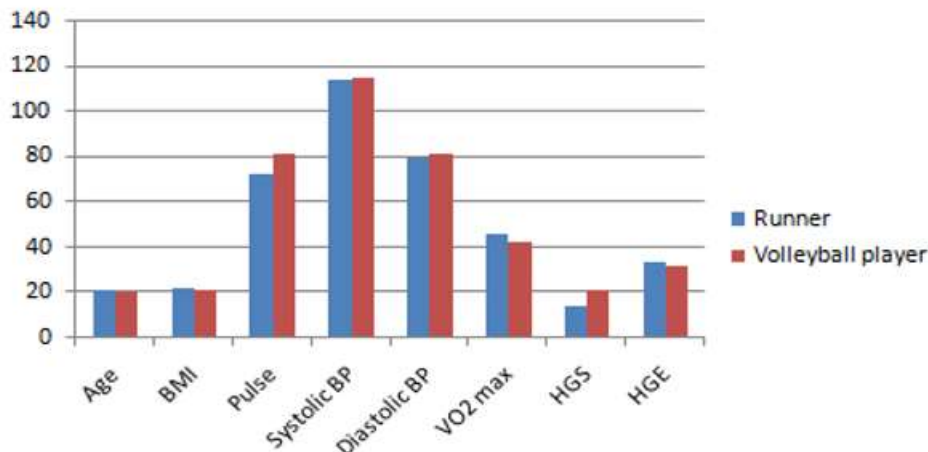


Figure 3: Comparison of mean values of different parameters recorded between runners and volleyball players

Table 3 & Figure 3 show the comparison of mean values of pulse, blood pressure (systolic & diastolic), VO₂ max, HGS & HGE in runners and

DISCUSSION

Physical exercise in form of sports, workouts has beneficial effects on various systems of body. It increases oxygen supply to various organs thus increases VO₂ max and increase muscular strength.

In present study, the response of different kind of sport activity such as running and playing volleyball on some of the components of physical fitness was studied. We studied pulse, blood pressure and VO₂ max in sports women and control subjects for cardiovascular fitness and hand grip strength (HGS) and hand grip endurance (HGE) were recorded to assess muscular fitness.

VO₂ max is also called as aerobic capacity. Pulse and VO₂ max are the most important factor that determines one's ability to sustain high intensity exercise for longer time. In our study, it can be concluded that runners had maximal ability to exercise for longer time than controls, as runners had lesser resting pulse rate and higher VO₂max.

The higher value of VO₂max in athletes is result of training, besides some genetic endowment on them.¹⁰

We found significant higher values of VO₂ max in runners when compared with controls and volleyball players.

Our findings coincide with the study of Das Gupta PK et al¹¹. They observed higher values of VO₂ max in runners than non- athletes . Higher VO₂max in athletes was due to higher stroke volume and arterial-venous O₂ difference. Verma SK et al observed statistically significant difference in mean VO₂max of sedentary group and that of active athletes in India¹². They observed runners had higher VO₂max than football, volleyball and hockey players.

The decrease in pulse rate and increase in VO₂max in medical student compared to control group in the present study can probably explained by various physiological mechanisms discussed below:

Cardiac output is the most important limiting factor for VO₂ max. Cardiac output depends upon stroke volume and heart rate. Endurance training is associated with increase in stroke volume and thus increases in cardiac output. In athletes, exercise causes dilatation of ventricles. Exercise training causes vagal dominance which leads to decrease in the heart rate.¹³ Due to the lower heart rate, more time is allowed for ventricular filling; this increases the end-diastolic diameter of the ventricles. Increase in the size of left ventricular chamber increases the reserve capacity of chambers as well as increases force of contraction of left ventricle to

volleyball players. VO₂ max and HGS was significantly higher ($p < .05$) in runners and volleyball players respectively.

pump out more volume of blood during each stroke.¹⁴

Second factor affecting VO₂ max is increase in oxygen extraction by muscles. With exercise training there is increased capillary in muscle. It increases the blood supply to muscle and more extraction of oxygen. Increased density of capillary is correlated with increase in VO₂ max.¹⁵

Muscle strength and muscle endurance can be combined into one component of health related physical fitness; termed as muscular fitness. In the present study, muscle strength and muscle endurance was assessed by handgrip dynamometry.

Muscle strength is related to ability to perform activities that require high levels of muscular force. Muscular Strength is defined as to the maximum force that can be produced by a muscle or muscle group in a single contraction. Previous studies show that there was direct correlation in grip strength and overall body strength.^{16, 17} Nutritional status has also been correlated to handgrip strength.¹⁸ Handgrip strength assesses the muscles of forearm and hand which involved in gripping activities.

In the present study, sports women (runners and volleyball players) had higher handgrip strength than control group but it was significantly higher in volleyball players as compared to runners. Shyamal Koley et al estimated the dominant HGS and its correlations with some hand and arm anthropometric variables in Indian female volleyball players than control group. Grip strength was strongly correlated with anthropometric parameters in players.¹⁹

In the present study hand grip strength in volleyball players might have increased due to regular practice. There is muscle development of the dominant hand. Muscle that function under no load, even if they are exercised for longer period there is increase in muscle mass and thus increase in muscle strength. Therefore increase in muscle mass in sports women which leads to maximum force generation during contraction.

Hand grip strength is a physiological variable that is affected by a number of factors like age, gender and body size. There is a strong correlation between grip strength and various anthropometric traits. Handgrip strength is a significant predictor of performance in various sports activities.²⁰

Muscular endurance refers to the ability of a muscle group to execute repeated contraction over a period of time sufficient to cause muscular fatigue or to maintain a specific percentage of the maximum voluntary contractions for prolonged period of time.²¹

In the present study, we were not able to find any significant difference in HGE between controls and sports women. Our results were not consistent with study done by Juan G. Bonitch Gongora et. al (2013).²¹ More studies are needed to establish the relationship.

CONCLUSION

From this study it was concluded that there is positive impact of exercise on cardiothoracic fitness and muscle strength. Runners showed a superior aerobic capacity in terms of VO₂ max when compared with controls and volleyball players because runners had lower heart rate (pulse) due to which stroke volume increased.

Handgrip strength found to be higher in volleyball players as compared to control and runner. Handgrip strength in volleyball players might have increased due to regular practice. There is muscle development of the dominant hand and increase in muscle mass. Therefore increase in muscle mass in sports women leads to maximum force generation during contraction.

We were not able to find any difference in HGE between controls and sports female. So, we need more study to establish this relationship.

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SUMMARY

Present study was aimed to evaluate and compare the physical fitness in medical students. This study was conducted in 15 runners, 15 volleyball players and 30 control (non exercising group). To determine cardiorespiratory fitness we recorded pulse, blood pressure and maximal oxygen uptake (VO₂ max). To assess muscular fitness; handgrip strength and hand grip endurance were recorded. When compared we found that runners had maximal ability to exercise for longer time than controls, as runners had lesser resting pulse rate and higher VO₂ max and both runners and volleyball players had higher handgrip strength than control group but it was significantly higher in volleyball players as compared to runners. Thus present study shows that there is positive impact of exercise on cardiorespiratory fitness and muscle strength in medical students.

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