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Effect of physical training on gender difference in trained personal

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ABSTRACT

Many controlled studies and neurological studies demonstrate that men and women are physically and mentally different. The purpose of this study is to find out whether there is any gender difference in respiratory capacity between trained athletes of both gender. This study was conducted at Kolkata (Serampore area), West Bengal, India. Subject was trained table tennis players of age group was 14 – 17 years. Significant differences have been found in height (cm), W/H ratio and PIF (l/s) between male and female lawn tennis players and all these values are significantly higher (P<0.05) in male than female players. Greater mean height in trained male than female tennis player of same age range is advantageous for male. This might be due to their own growth pattern under the influences of different specific hormones which is not considered in this study. Higher centrally located fats in trained male than female tennis player in this age range might be due to less affectivity of physical training in male. Higher central fat distribution may hinder different lung capacities by influencing abdominal cavity. Higher peak inspiratory flow in trained male than female tennis player indicates inspiratory muscles are more powerful in male player of this age range. So, it can be concluded from this study that gender differences in lung capacities can be minimize by proper training load in female trained player at least in 14-17 years age range. This study also claimed that stature is not only the decisive factor for differences in lung capacities in male and female trained tennis player of 14-17 years age range. Body composition, central fat distribution, active inspiratory muscles and proper physical training have definite role in improving lung capacities of trained male and female tennis player.

Keywords: Lung Capacity, Physical Tanning, Tidal Volume, Peak expiratory flow, Peak Inspiratory flow Rate.

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INTRODUCTION

The volume of adult male lung is about 10-12% higher than adult female lung volume having same age and height[1]. The smaller lung volume of female appears to be established within first few years of life. It is attributable to a lower rate of alveolar multiplication in girls than boys [23] but the reason of lower alveolar multiplication rate is unknown. It is also reported that within each sex, a substantial variation in lung volume among the subjects having same age and stature[24]. These findings suggest that lung growth does not completely obey the longitudinal growth pattern. Despite of same stature, the length of lower limb differs in male and female. This difference in lower limb length contributes a major role in male and female lung size[12]. It is also reported that smaller lung volume of female could be entirely accounted for smaller radial rib cage dimension, the axial dimension, which is determined by the position of the diaphragm in thoracic cage[4]. All these findings suggest that thoraco-abdominal configuration is another major factor for difference in lung volumes of male and female. It is also reported that differences in thoraco-abdominal configuration have impact on respiratory muscles[5,6]. Systemic differences in thoracic dimension and configuration between male and female consisting in disproportionately smaller radial rib cage dimension and shorter diaphragm also have been reported[3]. All these differences between sedentary male and female are due to their innate genetics and hormones. The innate characteristics like genetics and hormones also have important roles in athletic differences between men and women. These include height, weight, muscle mass, body fat and aerobic capacity. The physiological differences between men and women are so great that elite male and female athletes rarely compete with each other. These differences generally give men a competitive edge in sports that reward absolute strength, acceleration and speed. However, these differences are easily overstated, and in a few cases, female athletes are the ones who have the advantage over male athletes because of their particular physiological characteristics. Due to higher estrogenic level, women have more body fat than men. In addition, women's bodies are less muscular, but their joints are more flexible, which gives them greater range of motion - an advantage in sports such as gymnastics. The wider female pelvis also affects the alignment and movement of the extremities. Men have higher levels of testosterone which enables men to develop larger skeletal muscles and higher proportion of Type 2 muscle fibres that generate power, strength and speed. Testosterone also increases the production of red blood cells, which deliver oxygen to the tissues per unit time more in male than female. Only a few studies have been documented in lung capacities of trained male and female players of this age ranges (14-17years). This age range is very crucial for both physiological and physical development. Physical training influences different hormonal system of the body which trigger the development in physique and physiological mechanism. The most important requirement of athletic development is the aerobic capacity. Without the improvement in cardio respiratory mechanism of players, proper performance level cannot be achieved. It is also evident that male players have 8 to 10% higher performance level than female players due to their innate genetics and hormonal system. If these innate differences between male and female can be minimizing by proper training, obviously the performance level of female athletes will be same or close to the male athletes. Most of the studies reveal that male have more physical abilities than female due to their better physique and physiological systems. But it is always neglected how to minimize these gender differences between male and female athletes in sports arena. If gender gap can be minimize by proper training in proper time then only female athletes can be consider at par with the male athletes. In general, differences in physique and physiological systems are not very prominent in male and female during childhood. So it can be assume that influence of own innate systems start at pubertal stage and becomes prominent gradually. Actually, 14 -17 years age range is the period when the differentiation in male and female physique initiate. So, it might be the best time to influence the hormonal system by physical training to initiate the development of different physiological system as well as physique. Tennis is a most popular game and gaining attraction in young generation. So it needed more attention in scientific research. Most of the researchers concentrate upon physical fitness and abilities of the players. Most of the reported studies dealt with grown up players and only a few reports are available in junior players, despite the facts that junior forms the base of any sports. Moreover, there is lack of evidences regarding anthropometric measurements, body composition, and internal physiological systems like different lung capacities in junior male and female tennis players. Not only that, tennis is such a game where male and female take parts together in mixed doubles event. If proper training can minimize the gender gap of different physiological system in female, then the performance level must be improve. Considering all these points, this study is set up to find out the probable scientific reasons in 14-17 years trained male and female players, which will hopefully reveal logical solutions in gender gap phenomenon. Additional information like anthropometry and lung capacities of this age range might be helpful for their trainers to quantify the proper training schedule without causing any sports injuries in junior male and female players. Current study is based on trained male and female tennis players of same age ranges (14-17 years). In this age range, male and female have their own active hormonal mechanism which influences the physiological system of the body. The athletic differences in male and female players including height, weight, fat content, muscle mass and aerobic capacity, are gradually prominent due to their own hormonal influences. The main hypothesis of this study is based on lung capacities of trained male and female players within same age ranges (14-17 years) when the influences of their predominant hormonal system actively participate. Moreover, it is evident that different lung capacities depend on the activities of respiratory muscles and thoraco-abdominal configuration. So, it can be assumed that proper training might be minimizing the gender gap in this age range.

Aims and Objectives

1. Comparative study of body size and body composition in trained male and female tennis players in same age ranges (14-17 years).
2. Current status of different lung capacities in trained male and female tennis players in same age ranges (14 -17 years).
3. Whether different lung capacities of trained male and female players differ in same age ranges or not.

Methodology

Subject: Human, age ranges 14-17 years were participated.

Number of participants: Men=(n = 10), Woman = (n=7).

Details of Participants: They were trained for at least 2 years with the practice session of 5 days per week and duration of around 2-4 hours per day. Prior permission of this project was sanctioned by Institutional Human Ethics Committee. Tennis players were taken from registered Tennis club and the criterion was participation at least in district level competition. No one complained about health problem except a few reporting cold & cough during winter season. Individual National Standard of Living Index and Sports Competition Anxiety Test were performed. All anthropometric measurements and different lung capacities were carried out in departmental laboratories of University of Calcutta. A written permission was taken from the club authority to conduct the tests with the consents from the guardians of those tennis players. Ambient temperature and humidity were measured by dry bulb, wet bulb and globe thermometer. All measurements were taken between 10 am to 4 pm same day. Age of the subject was determined from their date of birth of births recorded in school registered and it was rounded off to the nearest whole number.

Anthropometric Measurements: All the measurements of the participants were done by Level 1 Anthropometrics accredited by International Society for Advancement of Kinanthropometry (ISAK).

Stature (cm): Height was measured by ISAK method by an anthropometric rod in standing posture with bare feet condition.

Body Weight (kg): It was measured by standard electronic weighing machine with minimal clothing and bare footed.

Skin folds Measurement (mm): Skin fold thickness (biceps, triceps, sub scapular, and supraspinale) for determining the fat % and total fat mass were measured with a skin fold calliper which requires a constant closing compression of $10 g.mm^{-2}$ throughout the range of measurements. The subjects were asked to assume a relaxed standing position with the right arm hanging by the side and the hand in mid-prone position. Biceps skin fold was measured from the point on the anterior surface of the arm at the level of mid-acromiale-radiale landmark, in the middle of the muscle belly. Triceps skin fold was measured from the point on the posterior surface of the arm, in the mid-line, at the level of marked mid mid-acromiale-radiale landmark. Sub scapular skin fold measurements were taken with the fold running obliquely downwards from the sub scapulars landmark at 45º angle. Supraspinale skin fold measurements were taken from the intersecting point of two lines- (i) the line from the marked iliospinale to the anterior axillary border and (ii) the horizontal line at the level of marked iliocristale.

Total Fat Mass (Kg) And Lean Body Mass (Kg): For calculating Total Fat Mass (kg) and Lean Body Mass (kg), Body Density (g/mm^3) and Fat percentage (%) was first calculated. It was calculated by using the formula of Jackson and Pollock, 1967. The following formula was utilized for calculation of Body Density (g/mm^3), Fat percentage (%), Total Fat Mass (kg) and Lean Body Mass (kg) for 9-11 years male players.

$$\boldsymbol{Body\ density\ (Kg/mm3)} = 1.112502 - 0.0013125 \times (X\_1) + 0.0000055 \times (X\_1)2 - 0.0002440 \times (X\_2).$$

Where, x_1 = sum of skin fold of biceps, triceps, sub scapular and supraspinale and x2 = age in years.

$$\boldsymbol{Total\ Body\ Fat\ Percentage}\ (\%) = [(4.95/(Body\ Density)) - 4.50] \times 100,$$

$$\boldsymbol{Total\ Body\ Fat\ Mass\ (Kg)} = [((\%\ of\ Body\ Fat)/100) \times Body\ weight\ in\ kg]$$

Lean body mass: or fat free mass is the qualitative expression of body tissues, such as, muscles, nerve fibres, etc. which was determined by the following formula:

Lean 10. Body Mass (kg) = Body Weight in (kg) – Total Fat Mass (kg)

Waist/ Hip Ratio: Waist–hip ratio or waist-to-hip ratio (WHR) was calculated as circumference of waist measurement divided by circumference of hip measurement ($W \div H$).

Waist Circumference (cm): The subjects stands in front, who abducts the arm slightly, allowing the tape to be passed around the abdomen. The stub of the tape and the housing were then both held in the right hand while the anthropometrics uses the left hand to adjust the level of the tape at the back to the adjudged level of the narrowest point. The anthropometrics resumes control of the stub with the left hand and, using the cross handed technique, positions the tape in front at the target level. The subject should breathe normally and the measurements were taken at the end of a normal expiration (end tidal). If there was no obvious narrowing, the measurements was taken at the mid- point between the lower costal (10^{th} rib) border and the iliac crest.

Hip Circumference (cm): The subject assumes a relaxed standing position with the arms folded across the thorax. The subject's feet should be together and the gluteus muscles relaxed. Person who measured passes the stub around the hip from the side and the stub of the tape and the case both were then held in the right hand while the left hand to adjust the level of the tape at the back to the adjudged level of the greatest posterior protuberance of the buttocks. The person resumes control of the stub with the left hand, and using a cross hand technique, positions the tape at the side, checking that it was held in a horizontal plane at the target level, before taking the measurement.

Lung Function Parameter

Pulmonary Function Test By Spirometer: The Pulmonary Function Test (PFT) was performed in the laboratory by using automatic Spirometer (Spirovit, SP

1 Model) according to the guideline recommended by American thoracic society. The testing was adequately encouraged to perform their optimum level and also the procedures were quite simple and non-invasive and harmless to the participants. The Spirometer was calibrated on the day prior to use and a new filter was introduced. Following variables were measured in each player after proper demonstration trails -

TV (Lit): Tidal volume is the amount of air inhaled or exhaled normally at rest.

SVC (lit): Slow vital capacity (SVC) is the maximum volume of air that can be exhaled slowly after slow maximum inhalation.

FVC (lit.): Forced vital capacity (FVC) is the volume of air that can forcibly be blown out after full inspiration, measured in litres.

IV. FEV1sec (lit): FEV1 is the volume of air that can forcibly be blown out in one second, after full inspiration.

FEV1/FVC (lit): FEV1/FVC (FEV1%) is the ratio of FEV_1 to FVC.

FEF25-75% (lit/sec): Flow speed of the expired air by 25%-75% of the vital capacity.

PEF (lit/sec): Peak expiratory flow (PEF) is the maximal flow (or speed) achieved during the maximally forced expiration initiated at full inspiration, measured in litres per minute or in litres per second.

PIF (lit/sec): Peak Inspiratory Flow Rate (PIFR) is the fastest flow rate during the inspiratory cycle.

MVV (lit/min): Maximum voluntary ventilation (MVV) is the maximum amount of air that can be inhaled and exhaled within one minute as deeply as possible.

RESULTS

The mean, standard deviation and level of significance of selected anthropometric variables such as age (years), height (cm), weight (kg), fat %, lean body mass (kg), chest circumference (cm), W/H ratio of male and female tennis players are shown in Table 1. Insignificance difference are observed in age (years), weight (kg), fat%, lean body mass (kg) and chest circumference (cm) of male and female tennis players (Table 1). But height (cm), and W/H ratio are significantly ($p<0.05$) higher in male lawn tennis players in comparison to female players (Table 1).

The mean values, standard deviation and level of significance of selected lung capacities like TV(lit) ,SVC (lit), FVC(lit), FEV1 (lit), FEV1/FVC (%), FEF25-75%(l/s), PEF(l/s), PIF(l/s) and MVV(lit/min) of male and female trained tennis players are represented in Table 2. Insignificant difference are observed in TV (lit), SVC (lit), FVC (lit), FEV1(lit), FEV1/FVC (%), FEF25-75% (l/s), PEF(l/s) and MVV (lit/min). Only significant difference ($p<0.05$) is found in PIF (l/s) between male and female trained tennis players (Table 2).

DISCUSSION

A young body is flexible and susceptible to various stimuli. These stimuli may sometimes exceed the limit of biological tolerance of the body. Thus it may become inadequate for the level of development of somatic and motor capacities in child. This may affect the process of body growth and maturation. Somatic features are an important factor for conditioning and achievement in sports[13] and one of the important aspect taken into consideration during the selection process in specific sports events.

In this cross sectional study, insignificant differences are observed in age (years), weight (kg), fat %, lean body mass (kg) and chest circumference (cm) between male and female lawn tennis player (Table-1). The amount of body fat and a central pattern of fat distribution might be related to lung function via several mechanisms, such as mechanical effects on the diaphragm (impeding descent into the abdominal cavity) and on the chest wall (changes in compliance and in the work of breathing and elastic recoil)[8]. The reduction in physical activity affects body composition factors like fat percentage and muscle mass of body. With decrease in body fatness, there is increase in aerobic fitness[9]. This study reflects insignificant difference in fat% between male and female tennis players. Most of the studies reveal that female have higher percentages of body fat than male[7] though the age ranges are different. This contradiction of findings might be of different reasons like age, ethnicity, body build, training pattern and specific training load for players. Lean body mass has definite relationship with lung function[11] of individual. It is found that reduced FEV1 may be due to reduced skeletal and consequently respiratory muscle[2]. This study reveals insignificant differences in lean body mass between 14-17 years male and female tennis players though male players have significantly higher stature than female players (Table-1). It might be due to comparatively less amount of fat% in trained female players. Apparently, chest circumference is a determinant measure for estimating status of lung for healthy individual. This study shows insignificant difference in chest circumference between male and female tennis players of 14-17 years age group and might be due to insignificant age variation between male and female players or more appropriate training load for female tennis players. More studies are required to find out the proper reasons for this in 14-17 years trained players. The ratio of waist and hip circumference dimensions has been used for calculating WHR index which indicates central obesity of individual. This study indicates male have significantly higher central fat than female trained tennis players in this age ranges. As there are no reference values in these age ranges for trained individual, it cannot be as certain the probable reasons from this study until further studies have been carried out.

Table 1: Statistical Analysis of Lung Capacities Between Male and Female Trained Tennis Players: (Age 14-17 Years)

Sl.No	Variables	Mean ± Standard Deviation		P Value	Level of Significance
		Male Tennis Players (N=10)	Female Tennis Players (N=7)		
1	Age (Years)	15.5±1.27	14.43±1.13	0.09	Not Significant
2	Height (Cm)	165.19±7.54	159.04±2.09	0.03	P<0.05
3	Weight (Kg)	55.4±10.91	56.57±10.08	0.82	Not Significant
4	Fat %	11.85±6.99	15.79±6.03	0.23	Not Significant
5	Lean Body Mass (Kg)	48.32±7.46	47.16±5.56	0.72	Not Significant
6	Chest Circumference (Cm)	83.43±10.69	80.81±8.50	0.58	Not Significant
7	W/H Ratio	0.8±0.06	0.74±0.04	0.02	P<0.05

Table 2: Statistical Analysis of Lung Capacities Between Male And Female Trained Tennis Players: (Age 14-17 Years): Represents The Mean ± Standard Deviation Values and the Level of Significance of TV (Lit), SVC (Lit), FVC (Lit), FEV1 (Lit), FEV1/SVC(%),FEF25-75%(L/S), PEF (L/S), PIF (L/S), MVV (L/Min)

Sl.No	Variables	Mean ± Standard Deviation		P Value	Level of Significance
		Male Tennis Players [N=10]	Female Tennis Players [N=7]		
1	TV (Lit)	0.87±0.32	0.74±0.14	0.29	Not Significant
2	SVC (Lit)	2.95±0.64	2.76±0.22	0.39	Not Significant
3	FVC (Lit)	3.03±0.92	2.95±0.40	0.81	Not Significant
4	FEV1 (Lit)	2.41±0.72	2.10±0.2	0.33	Not Significant
5	FEV1/SVC (%)	80.29±14.69	76.66±19.14	0.68	Not Significant
6	FEF25-75% (L/S)	2.37±0.85	2.04±0.67	0.39	Not Significant
7	PEF (L/S)	3.72±1.23	2.80±1.12	0.13	Not Significant
8	PIF (L/S)	3.58±1.19	1.94±0.28	0.001	P<0.05
9	MVV (L/Min)	83.33±27.77	79.81±9.39	0.72	Not Significant

The lung capacities i.e. TV (lit), SVC (lit), FVC (lit), FEV1 (lit), FEV1/FVC (%), FEF25-75%(l/S), PEF(l/S), PIF(l/min) and MVV(l/min) are assessed in 14-17 years trained male and female tennis players (Table-2) to ascertain whether any significant differences are exist or not. In this study the mean values of FVC and FEV1 in male trained tennis players are 3.03 lit and 2.41 lit respectively while in female, FVC and FEV1values are 2.95 lit and 2.10 lit respectively. FEV1/FVC (%) is 80.29% and 76.66% respectively in male and female trained tennis players. The maximum voluntary ventilation (MVV) is 83.33 lit/min and 79.81lit/min respectively in 14-17 years trained male and female tennis players. All these insignificant differences in lung capacities between male and female trained tennis players indicate lung capacities are almost identical in 14-17 years age range. It might be due to the insignificant differences in body composition between the two groups and effective training load for female tennis players though stature of male players are significantly higher than female tennis players. So, it can be claimed from this study that differences in lung capacities not only depend upon stature but there may be other factors which influences lung capacities of 14-17 years trained male and female tennis players. Insignificant differences in body fat% and lean body mass between 14-17 years trained male and female, and effective training schedule in female trained tennis players definitely have some important role to minimizing the gender differences in lung capacities.

This study reveals that peak inspiratory flow or PIF is significantly higher in male than female trained tennis players (Table-2). PIF (l/sec) is a reliable measure for airway resistance and inspiratory muscle strength of human. It has already been reported that aerobic and interval training improves inspiratory muscle strength[14]. It is also reported that increased in strength of inspiratory muscle have no contribution in maximal oxygen consumption in human[10]. In this study the higher significant PIF in male trained players have an additional advantages over female in terms of higher inspiratory muscle strength.

CONCLUSION

This study is conducted to evaluate the lung capacities of 14-17 years male (n=10) and female (n=7) trained tennis players. In this study the male tennis players are compared with female players, having similar age range in selected physical and lung variables, like , height (cm), weight (kg), fat%, lean body mass (kg), chest circumference (cm), W/H ratio, TV (Lit), SVC (lit), FVC (lit), FEV1 (lit), FEV1/FVC (%), FEF25-75% (l/s), PEF (l/s), PIF (l/s) and MVV(lit/min). Significant differences have been found in height (cm), W/H ratio and PIF (l/s) between male and female lawn tennis players and all these values are significantly higher ($P<0.05$) in male than female players. Greater mean height in trained male than female tennis player of same age range is advantageous for male. This might be due to their own growth pattern under the influences of different specific hormones which is not considered in this study. Higher centrally located fats in trained male than female tennis player in this age range might be due to less affectivity of physical training in male. Higher central fat distribution may hinder different lung capacities by influencing abdominal cavity. Higher peak inspiratory flow in trained male than female tennis player indicates inspiratory muscles are more powerful in male player of this age range.

In this study insignificant difference has been found in TV (lit), SVC (lit), FVC (lit), FEV1 (lit), FEV1/FVC (%), FEF25-75%(l/s), PEF(l/s) and MVV(lit/min) though male player are significantly more taller than female trained tennis player. All these insignificant differences in lung capacities between male and female trained tennis players indicating lung capacities are almost identical in 14-17years age range. It might be due to the insignificant differences in body composition between the two groups and effective training load for female tennis players though stature of male players are significantly higher than female tennis players.

So, it can be concluded from this study that gender differences in lung capacities can be minimize by proper training load in female trained player at least in 14-17 years age range. This study also claimed that stature is not only the decisive factor for differences in lung capacities in male and female trained tennis player of 14-17 years age range. Body composition, central fat distribution, active inspiratory muscles and proper physical training have definite role in improving lung capacities of trained male and female tennis player.

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