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Comparison of Lung Volumes and Capacities Between Elite Indian Female Sports Persons And Sedentary Controls.

Exercise Physiology

KEYWORDS : Vital Capacity (VC), Expiratory Reserve volume (ERV), Inspiratory capacity (IC), Maximum Voluntary Ventilation (MVV), Forced Expiratory Volume in one sec (FEV1), Peak Expira

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ABSTRACT

Lungs are the major organs for respiratory exchange and pulmonary ventilation is generally known to have a linear relationship with O2 consumption at different grades of exercise. Training has been seen to improve pulmonary functions and therefore lung volumes and athletes tend to have larger diffusion capacities at rest and exercise than non athletes. It is conjectured that although a larger lung volume need not affect endurance capacity of an athlete directly, it can provide a greater alveolar capillary surface area for diffusion.

Evaluation of pulmonary function can be carried out by conducting lung function test and are of utmost importance for accessing the physiological fitness of an individual. Although the pulmonary functions are affected by age, sex, height, weight, ethnicity and socio economic status, numerous studies have demonstrated that athletes are able to achieve significantly higher pulmonary function values both in terms of volumes as well as flow rates than their sedentary counterparts that may be otherwise matched.

*The study was conducted on total of 40 adult female volunteers between the age ranges 18 to 24 years of which 25 volunteers constituted the Elite Sports persons group who were participating in the respective senior who were studying in different P.G. degree courses in Patiala. Each of the volunteers was restricted to a physical examination that includes measurement and recording of Date of birth, stature, weight and body surface area. On a subsequent day the volunteers were accessed for their static and dynamic lung volumes by using the portable computerized Spiro meter. The measurement included VC, ERV, IC, MVV, FEV1, PEF and others. The tests were carried out in the laboratory of the department of physiology, S.A.I. N.S.N.I.S., Patiala where the temperature and humidity levels were controlled at 23*C(+2*C) and 55% (+ 5%) was respectively.*

Introduction:

Physical performance in various competitions depends on the integrated status of various physiological mechanism of an individual i.e. health fitness and the capacity of the various physiological systems to adapt, to meet the challenges of competitive situations apart from various types of techniques, tactics and skills. Optimum level of performance depends upon the development of these adaptations through training. Therefore the main purpose of the physiological research is to evaluate and monitor the training schedule efficiently. The most important factor for a marathoner but also in all other sports events which include long duration activity, VO2max plays the key role. Maximal Oxygen intake may be the most physiologically significant and most commonly measured parameter in the physiological assessment of well trained athletes.

Pulmonary ventilation is generally known to have a linear relationship with oxygen consumption at different levels of exercise(Hans degan et al,2013). Oxygen consumption is also known to increase the resting state and intense exercise. Lung function parameters tend to have a relationship with lifestyle such as regular exercise and non exercise (Wassermann et al, 1994; Twisk et al, 1998). Due to regular exercise, athletes tend to have an increase in pulmonary capacity when compared to non-exercising individuals, especially when the exercise is strenuous(Hulke SM et al 2011). Lung function tests provide qualitative and quantitative evaluation of pulmonary function and are therefore of definitive value in the diagnosis and therapy of patients with obstructive and restrictive lung disease (Robinson & Kjeldgaard, 1982).

The parameters used to describe lung function are the lung volumes and lung capacities. While the various lung volumes reflect the individual's ability to increase the depth of breathing the capacities is simply a combination of two or more lung volumes.

MATERIALS AND METHODS:

The study was conducted on a total of 40adult female volunteers between the ages range of 18-24 years of which 25 volunteers were elite female senior national campers participating in the respective national camps held at SAI, NS NIS, Patiala. The control group comprised of 15 sedentary females who were carrying their P.G. Degree programmes in Punjabi University, Patiala.

The volunteers participating in the study were assessed for the lung function test which was conducted on the volunteers on a subsequent day, under comparable ambient conditions. The lung function tests comprised of elucidating the various static and dynamic (flow) volumes, including the Vital Capacity (VC), Expiratory Reserve volume (ERV), Inspiratory capacity (IC), Maximum Voluntary Ventilation (MVV), Forced Expiratory Volume in one sec (FEV_1), Peak Expiratory Flow (PEF) and others. Lung Function Test were carried out in the Exercise Physiology Lab, SAI NS NIS, Patiala. A computerized portable Spirometer (Erich Jaeger, Germany) was used to measure the aforementioned lung volumes/flows.

RESULTS AND DISCUSSIONS.

Table _I compares the selected mean (+SD) of physical profiles of the female sports persons and their sedentary counterparts. The mean decimal age was found to be significantly higher for control group ($p<0.01$). However no significant difference was observed in the means of height, weight and body surface area.

Table – 1 : Table shows comparison of means (+SD) and t-values of Selected Physical Transients between the elite Indian female sports persons and the Sedentary counterparts.

Group	N	DecAge (yrs)	Height (cm)	Weight (kg)	BSA(m2)
Female Sports Persons	25	20.38 (+2.621)	161.23 (+3.922)	54.96 (+5.139)	1.589 (+0.087)
Sedentary Counter parts	15	23.64 (+2.367)	157.787 (+6.121)	54.037 (+7.497)	1.55 (+0.124)
Total	40	21.63 (+2.967)	159.9 (+5.098)	54.60 (+6.074)	1.57 (+0.103)
t-values		-4.012**	1.982	0.308	0.770

Note: Figures in parenthesis denotes + S.D.

Note: *significant at 0.05, **significant at 0.01

P=2.72 at 0.01

P=2.03 at 0.05.

Table 2 (a) compared the mean (+ S.D.) of selected Static Lung Volumes of Sports persons and controls. The female athletes displayed significantly higher measured volume of vital capacity (r) ($p< 0.01$) which corresponded to more than 101.8% of the predicted value as compared to only about 84% in the case of sedentary control group.

This is in agreement with the studies of (Asmussen and Neilson; 1956). Physical training possibly causes an increase in vital capacity in trained sportspersons by increasing development of the respiratory musculature (Ghosh et al, 1985; Yadav and Dass 2001). The former had observed that vital capacity was significantly higher for Basketball, Hockey, Boxing and Table Tennis players when compared with the matched sedentary individuals. In a study conducted by Mckay et al 1983 it was observed that sports persons exhibited 30% higher VC than what was predicted from the nomogram. In the present study the sedentary individuals could only attain 84% of the predicted from Cournard's nomogram whereas the sports persons attained a measured value of 101.8% of the predicted value.

Studies on comparison of lung volumes between female athletes and sedentary counterparts are few. Also Adegoke and Argoundade: (2002) discovered in a study involving Nigereian sports persons (both male and female) could not establish significant difference between the female athletes and female sedentary counterparts and have opinioned that since female sports exercises are generally known to be less strenuous that those of men, lung volume of female athletes show no significant difference when compared with the female sedentary counterparts. This seems to be in argument with our studies which have however, shown that in case of elite female sports persons significant difference do exist in the vital capacity and other static lung volumes, when compared with female sedentary counterparts.

The measured Expiratory Reserve Volume (ERV) was found to be 1.52 liters in case of female sports persons which was observed to be higher than those observed in sedentary controls although no significant difference was observed. The predicted ERV in both the groups were found to be matched. However it is important to note that the sports persons exhibited ERV values which were approximately 1.29% of the age and sex predicted nomogram values as against only about 103% observed in case of sedentary controls.

The measured inspiratory capacity IC (r) was found to be higher in female sports persons although the difference was not significant.

The Measured maximum voluntary ventilation (MVV) was found to be significantly higher ($p<0.01$) in the sports persons (115.7 litres/min) as against (98.5 litre/min) in case of sedentary controls. This corresponded to a percentage more than (151%) of measured MVV as compared with only (76.8%) observed in case of controls. Akabas et al (1989) and Somme and Davis (1982) have conjectured that MVV can be improved by exercise that train the respiratory musculature. Since MVV is dependent upon the speed and efficiency of filling up and emptying of the lungs, higher values of MVV are expected in hilly areas a s compared to the plains (Das et al, 1981). Joshi & Joshi (1998), found a significant increase in MVV in female athletes which was attributable to strengthening of the respiratory muscles, and improvement in the elastic properties of the lung and chest which might have been incidental to regular practice of forced breathing. Similar observation was made in the present study too.

Table 2 (b) compared the mean (+SD) of dynamic lung volumes which are associated with time and flow volumes of the lungs.

The Measured Forced Vital Capacity (r) in case of sports persons was measured to be 3.5 litres as against 2.93 liters in case of sedentary controls. This would means that the sports persons displayed as FVC which is 102% as compared with only about 86% of sedentary controls and this difference is highly significant ($p<0.01$). Since the FVC depends upon the physiological status of the lungs and the speed with which this volume can be moved and is indicative of the expiratory power and overload resistance. Normally about 85% of the VC should be expelled in 1 sec. (Mahler & Harper, 1988).

FEV1 (Forced Expiratory Volume) in 1 sec was also found to be higher in case of female sports persons as compared with their control group ($p<0.01$). FEV1% was found to be 108.62% which is significantly higher ($p<0.01$) that their control group who exhibited an FEV1% of only (93.02%) of the predicted value. Therefore the female sports persons had significantly higher FEV1 volumes (Ghosh et al, 1985) had observed that the mean FEV1 of football, hockey, swimming and volleyball players to be significantly higher than their control counterparts, which is in agreement with our observations. Joshi & Joshi (1998), also similarly observed that FEV1 in female sports persons was significantly higher that their non sports counterparts.

The measured peak expiratory flow volume PEF (r) was found to be significantly greater in control group ($p<0.01$) than their female athletic counterparts. Joshi & Joshi (1998) also failed to show a significantly increase PEF in women athletes when compared to sedentary counterparts.

Results from the previous studies and present one suggest that the intensity and severity of the sports possibly determines the extent of strengthening of the respiratory muscles which in turn results in an increase in lung volumes. However the static lung volumes were seen to be affected more, than dynamic ling volumes, as a result of regular physical exercise.

Table 2 (a) : Table shows the comparison of means (+ SD) and t-values of selected static Lung Volumes between the Elite Indian female sports persons and the Sedentary counterparts.

Group	N	VC (r) (L)	VC (p) (L)	VC (%)	ERV (r) (L)	ERV (p) (L)	ERV (%)	IC (r) (L)	IC (p) (L)	IC (%)
Female sports persons	25	3.52 (±0.397)	3.46 (±0.234)	101.81 (±12.98)	1.52 (±0.456)	1.20 (±0.115)	128.69 (±42.42)	1.76 (±0.601)	2.26 (±0.160)	78.34 (±27.719)
Sedentary sports persons	15	2.90 (±0.524)	3.46 (±0.309)	83.993 (±14.229)	1.344 (±0.511)	1.293 (±0.035)	103.55 (±38.26)	1.50 (±0.479)	2.617 (±0.275)	69.9 (±21.834)
Total	40	3.28 (± 0.53)	3.464 (±0.262)	94.96 (±15.92)	1.45 (±0.479)	1.233 (±0.104)	119 (±42.21)	1.66 (±0.564)	2.22 (±0.213)	75.127 (±25.644)
t-values		3.553**	0.092	3.629**	0.973	-3.754**	1.772	1.309	1.032	0.535

Note: Figures in parenthesis denotes + S.D.
Note: *significant at 0.05, **significant at 0.01

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P=2.72 at 0.01
P=2.03 at 0.05.

Table 2 (b) : Table shows the comparison of means (+ SD) and t-values of selected Dynamic Lung Volumes between the Elite Indian female sports persons and the Sedentary counterparts.

Group	N	MVV (r) (L/min)	MVV (p) (L/min)	MVV (%)	FVC (r) (L)	FVC (p) (L)	FVC (%)	FEV1 (r) (L)	FEV1 (p) (L)	FEV1 (%)	PEF (r) (L)	PEF (p) (L)
Female sports persons	25	115.73 (±21.37)	85.20 (±26.47)	151.53 (±58.97)	3.50 (±0.485)	3.43 (±0.213)	102.56 (±15.009)	3.14 (±0.464)	2.94 (±0.229)	108.62 (±21.36)	5.90 (±1.739)	6.58 (±0.434)
Sedentary sports persons	15	98.1 (±19.56)	109.8 (±5.375)	76.874 (±3.49)	2.926 (±0.502)	3.442 (±0.296)	85.66 (±11.96)	2.76 (±0.482)	2.954 (±0.261)	93.20 (±14.29)	5.87 (±1.079)	6.81 (±0.367)
Total	40	108.967 (±22.19)	94.664 (±24.12)	122.82 (±62.23)	3.28 (±0.562)	3.43 (±0.244)	95.83 (±16.23)	2.99 (±0.501)	2.94 (±0.239)	102 (±20.23	5.89 (±1.503)	6.669 (±4.20)
t-values		-**4.402****	2.425*	-3.271**	3.282**	-0.060	3.762**	2.366*	0.013	4.372**	-0.381	2.561*

Note: Figures in parenthesis denotes + S.D.
Note: *significant at 0.05, **significant at 0.01
P=2.72 at 0.01
P=2.03 at 0.05.

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