
Assessment and Comparative Analysis of Different Lung Capacities in Trained Athletes According to Somatotype

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Abstract: Athletic performance depends on athletic ability as well as body build. Training is a crucial factor for success. For this training, knowledge of initial levels of fitness as well as body build both is important. Physical training alters body build as well as internal physiological system in athletes. The main purpose of this study is to provide categorization of different lung capacities in trained athletes according to their body build. One hundred forty eight trained male athletes participated whose age was between 10-20 years. They were classified into endomorph, mesomorph and ectomorph. Different lung capacities were measured. One way ANOVA was done to compare three body types. Scheffe's post hoc test was also performed. Lung variables such as SVC, FVC, FEV₁ and PEF_R are found to be significantly different among endomorph, mesomorph and ectomorph. SVC and FEV₁ was found to be significantly highest in ectomorph and lowest in endomorphs. It might be due to least amount of abdominal fat and stature. FVC and PEF_R were found to be highest in mesomorph and lowest in endomorphs. Mesomorphs possess maximum muscle mass and so highest FVC. Significant differences in SVC, FVC, FEV₁ and PEF_R indicates somatotypes have definite role in different lung capacities among trained athletes. It reflects that somatotypes should also be considered during assessments of different lung capacities in trained athletes. Endomorphs have poorest lung capacities. It might be due to more fat accumulation in their body.

Keywords: Morphometric, Professional Players, Lung Parameters

1. Introduction

Right from the past, sports have been organised for different types of competition. Physical training improves athletic performances by enhancing different physiological systems of the body. Initial level of fitness (i.e. condition of heart, lungs, kidney and different physiological systems) is very crucial for athletes in order to determine work load for enhancing performance.

But along with training, an athlete's success depends on athletic ability and body build. In order to create athlete's profile and for the purpose of conditioning, body composition is very much essential at all levels in sports competition throughout a season [1]. Somatotype (body composition) was initially described by Matiegka in 1921 [2]. According to Matiegka, somatotype has four

components- bone mass, subcutaneous fat mass, muscle mass and residual mass. It was William Herbert Sheldon, who from 4000 human photographs, reconstructed that somatotype is related to three germ layers- ectomorph, endomorph, mesomorph. According to Sheldon, endomorph has slow metabolism and so they accumulate body fat. Mesomorph has normal metabolism and they develop large muscle. Ectomorphs have faster metabolism and so they lose fat mass and muscle mass [3]. Somatotype and athletic performance are related to each other. Changes in one influence the other. Each sport and its position has specific morphological requirement from athletes [4-5]. According to some authors, somatotype has got genetic basis but it is also certain that development of somatotype is dependent on certain internal and external factors. Diversity of somatotype in national sports is because of race and ethnicity of

individuals, socio-economic status, technical equipments, selection methods and training process. Professions like military, police require muscle strength. Individual somatotype both for men and women regardless of age is recommended in such cases. Somatotypisation in children and adults guide the young towards the sports that match their body composition. Heart disease, analyses of eating disorders, dyspepsia can be correlated to somatotypisation.

There are enormous studies on impact of exercise on cardiovascular system but very less on respiratory functions. Extensive studies on pulmonary functions have been carried out on normal sedentary individuals in India but less is done on athletes [6-9]. Pulmonary functions in athletes need to be investigated so as to explore the impact of sports on respiratory functions. Respiratory system can influence strength and performance in trained athletes [10-11]. Respiratory muscles become strong due to regular forceful inspiration and expiration during exercise. This helps the lungs to inflate and deflate maximally which is an important physiological stimulus for the release of surfactant [12]. It is seen in athletes that they have increased pulmonary capacity as compared to sedentary individuals [13-14].

On the basis of above mentioned conditions, it was considered important to correlate somatotype with pulmonary functions in trained athletes.

2. Aim and Objective

To find out whether there exist any correlation between somatotype and lung function parameters.

3. Method

3.1. Subject

On one hundred forty eight male trained players, aged between 10-20 years participated in this cross-sectional study. Individual NFHS (National Standard of Living Index) and SCAT (Sports Competition Anxiety Test) was carried out on each participant. Criteria of selection were minimum 2 years of training and participation in district or regional competition. The parent of each participant and the club authorities gave consent. The study followed the norms of Institutional Human Ethics Committee and ethical parts were followed carefully.

3.2. Anthropometry

For the purpose of somatotype rating, Heath Carter method [15] was followed. The following equations were used-

$$\text{Endomorphy} = -0.7182 + 0.1451 \times \Sigma\text{SF} - 0.00068 \times \Sigma\text{SF}^2 + 0.0000014 \times \Sigma\text{SF}^3 \text{ where } \Sigma\text{SF} = (\text{sum of triceps, subscapular and supraspinale skinfolds}) \text{ multiplied by } (170.18/\text{height in cm}).$$

$$\text{Mesomorphy} = 0.858 \times \text{humerus breadth} + 0.601 \times \text{femur breadth} + 0.188 \times \text{corrected arm girth} + 0.161 \times \text{corrected calf girth} - \text{height} \times 0.131 + 4.5.$$

With the help of height-weight ratio (HWR), three different equations were used to calculate ectomorphy:

If HWR is greater than or equal to 40.75 then,

$$\text{Ectomorphy} = 0.732 \times \text{HWR} - 28.58.$$

If HWR is less than 40.75 and greater than 38.25 then, Ectomorphy = 0.463 × HWR - 17.63.

If HWR is equal to or less than 38.25 then, Ectomorphy = 0.1.

3.3. Lung Function Test

With the help of automatic spirometer, Spirovit SP1 model and guidelines according to American Thoracic Society, lung function tests were performed on the subjects. The procedure was non invasive and harmless. Each day before the use, spirometer was calibrated and a new filter was used each day.

The subject was asked to breathe in and out with the mouth piece to get acquainted with the procedure. SVC- Volume of gas measured on a low complete expiration after a maximal inspiration without force. FVC-Amount of air that can be forcibly exhaled from the lungs after taking the deepest breaths possible.

FEV_{1sec}-Lung volume in litre 1sec after forced expiration.

FEV₁/SVC- It is the ratio of FEV₁/SVC.

PEFR- Maximum flow rate sustained for a period of 10 seconds during a forced expiration. It was measured by Weight's Peak Flow Meter. With a deep breath, the mouth piece was placed in between teeth and lips of the subject and air was blown into the instrument. When the pointer pointed zero, three attempts in succession were taken and the highest value among the three attempts were recorded.

3.4. Statistical Analysis

Mean values and Standard Deviations of each mentioned variables among three groups according to somatotypes and according to age were calculated. One way ANOVA was done to compare each of the parameters among the three groups. Probability of error due to random sampling is rejected at the level of p<0.05. Scheffe's post hoc test was also performed.

4. Results

When they are classified on the basis of different somatotypes, SVC, as well as FEV₁, is found to be significantly different with the highest value in ectomorph and the lowest in endomorphs in both cases. Similarly, FVC and PEFR are significantly different in different somatotypes and the highest value is seen in mesomorph and lowest in endomorphs [Table 1].

Table 1. Table showing F values of different pulmonary parameters of trained athletes belonging to different somatotypes [NS=Not Significant, n = sample size].

Variables	Somatotypes	Endomorph	Mesomorph	Ectomorph
Age (yr)	Mean \pm SD	13.13 \pm 2.50 (n=31)	14.55 \pm 2.5 (n= 49)	14.62 \pm 2.25 (n=68)
	F Values	4.614		
	Significance of F	P<0.05		
	Scheffe's F Ratio	7.113	0.029	9.652
Height (m)	Significance of Scheffe's Ratio	P<0.05	NS	P<0.05
	Mean \pm SD	1.49 \pm 0.125 (n=30)	1.590 \pm 0.137 (n=48)	1.62 \pm 0.120 (n= 67)
	F Values	7.704		
	Significance of F	P<0.05		
Weight (kg)	Scheffe's F Ratio	12.51	1.197	22.473
	Significance of Scheffe's Ratio	P<0.05	NS	P<0.05
	Mean \pm SD	46.87 \pm 12.57 (n=30)	53.95 \pm 12.45 (n=47)	44.34 \pm 10.16 (n=67)
	F Values	10.470		
SVC (l)	Significance of F	P<0.05		
	Scheffe's F Ratio	8.05	24.39	1.22
	Significance of Scheffe's Ratio	P<0.05	P<0.05	NS
	Mean \pm SD	2.20 \pm 1.15 (n=31)	3.43 \pm 1.18 (n=49)	3.44 \pm 1.28 (n=68)
FVC (l)	F Values	12.305		
	Significance of F	P<0.05		
	Scheffe's F Ratio	17.757	0.845	25.67
	Significance of Scheffe's Ratio	P<0.05	NS	P<0.05
FEV1 (l)	Mean \pm SD	2.10 \pm 1.29 (n=31)	3.43 \pm 2.05 (n=49)	3.24 \pm 1.37 (n=68)
	F Values	7.744		
	Significance of F	P<0.05		
	Scheffe's F Ratio	14.64	23	14.44
FEV1/SVC (l)	Significance of Scheffe's Ratio	P<0.05	P<0.05	P<0.05
	Mean \pm SD	1.77 \pm 0.97 (n=26)	2.40 \pm 1.04 (n=48)	2.46 \pm 0.98 (n=64)
	F Values	4.694		
	Significance of F	P<0.05		
PEF25% (l)	Scheffe's F Ratio	6.67	0.13	9.6
	Significance of Scheffe's Ratio	P<0.05	NS	P<0.05
	Mean \pm SD	74.03 \pm 16.61 (n=26)	72.78 \pm 18.10 (n=48)	71.26 \pm 20.32 (n=64)
	F Values	0.222		
PEF50% (l)	Significance of F	NS		
	Mean \pm SD	3.75 \pm 1.60 (n=10)	4.04 \pm 2.17 (n=23)	3.93 \pm 2.12 (n=54)
	F Values	0.065		
	Significance of F	NS		
PEF75% (l)	Mean \pm SD	3.06 \pm 1.56 (n=10)	3.11 \pm 1.63 (n=23)	3.1 \pm 1.7 (n=54)
	F Values	0.003		
	Significance of F	NS		
	Mean \pm SD	0.94 \pm 0.63 (n=10)	1.48 \pm 0.93 (n=23)	1.52 \pm 1.01 (n=54)
PEFR (l/min)	F Values	1.572		
	Significance of F	NS		
	Mean \pm SD	267.42 \pm 89.18 (n=31)	323.88 \pm 86.36 (n=49)	308.82 \pm 79.86 (n=68)
	F Values	4.407		
PEFR (l/min)	Significance of F	P<0.05		
	Scheffe's F Ratio	8.681	0.918	5.164
	Significance of Scheffe's Ratio	P<0.05	NS	NS

Table 2. Mean and SD of trained players Lung Function Variables.

Variables	Mean \pm SD
SVC (l)	3.58 \pm 1.08
FVC (l)	3.58 \pm 1.40
FEV1 (l)	2.55 \pm 0.97
FEV1/SVC (l)	72.03 \pm 18.42
PEF 25% (l)	3.94 \pm 2.06
PEF 50% (l)	3.1 \pm 1.65
PEF 75% (l)	1.44 \pm 0.96
PEFR (l/min)	307.43 \pm 81.8

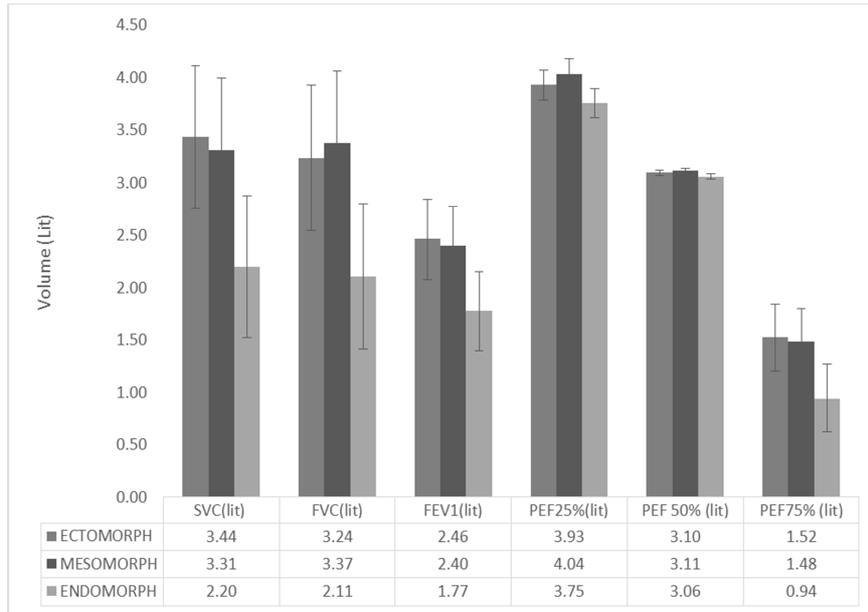


Figure 1. SVC, FVC, FEV, PEF25%, PEF50%, PEF 75% of ectomorph, endomorph, mesomorph.

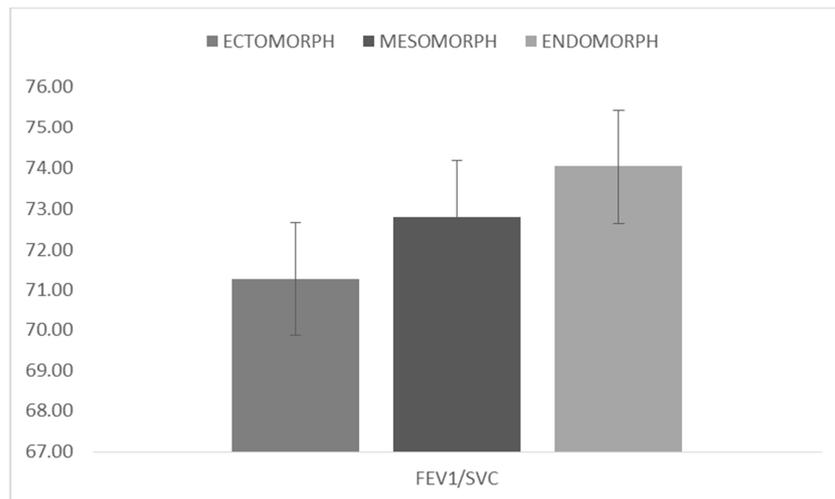


Figure 2. FEV1/SVC of ectomorph, endomorph, mesomorph.

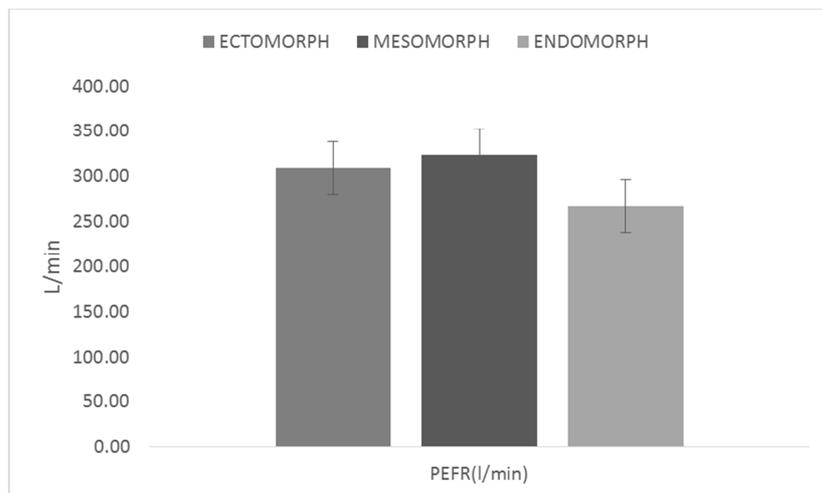


Figure 3. PEFR of ectomorph, endomorph, mesomorph.

5. Discussion

Pulmonary function is influenced by age, height, body weight and gender. Tallness and age both are probably directly proportional to higher static lung volumes and capacities [16-20]. Repetition of muscular exercise leads to increase in muscle mass and ultimately body weight. Fat deposition varies in between males and females. Fat deposition in thoracic and abdominal regions creates changes in respiratory functions like sluggish thoracic movements as well as pulmonary compliance in thoracic cavity, reduced inspiratory capacity and falling of diaphragm [21-26].

On the other hand, regular exercise increases the pulmonary capacity. Participation in the sports training for a longer time period significantly improves the oxygen transport and usage system.

Forced Vital Capacity (FVC) indicates bronchodilator response. In the present study, the maximum value is seen in mesomorphs. Forced vital capacity is highly influenced by higher and stronger respiratory muscles activities. Among the three groups mesomorph possesses maximum muscle mass, so highest FVC. Slow Vital Capacity (SVC) is the difference in the volume of gas in the lungs from complete inspiration to complete expiration and vice versa. Here, SVC is found to be highest in ectomorphs. The reason may be due to highest height and lowest fat in ectomorph among the three groups. So, ectomorph has advantage for static lung capacity. Forced Expiratory Volume at one second (FEV₁) measures airway obstruction. FEV₁ is the amount of air that can be forcibly expelled from the lungs in one second after maximal inspiration. FEV₁ was found to be significantly highest in ectomorph and lowest in endomorphs here. The reason may be due to ectomorphs have minimum airway obstruction for forceful air expulsion from the lungs among the three groups.

In the present study as ectomorphs are the tallest among the three somatotypes. As it is known that tallness is responsible for higher lung capacities [16], this can be the probable reason for ectomorphs having higher values of SVC and FEV₁ here.

Peak Expiratory Flow values depend on the strength of muscles involved in expiration, lung tissue compliance as well as size of airways. It helps in assessing ventilator capacity. On the other hand, a person's maximum speed of expiration is measured by Peak Expiratory Flow Rate (PEFR). PEFR values are lower when there is constriction in the airways. Different reference values are used for children with age till 18 years. PEFR declines as age progresses because of degeneration in musculoskeletal system. PEFR is found to be highest in mesomorph and lowest in endomorphs [Table 1]. Greg and Nunn (1973) suggested that male should have PEFR values approximately 600l/min. [27]. In the present study, it is much less than that in both cases. The difference may be due to ethnic variation, training pattern, and genetic as well as environmental factors.

6. Conclusion

Present study indicates the influence of somatotypes on different lung parameters. Here, mesomorph being muscular has the highest FVC whereas abdominal fat deposition in endomorphs leads to their minimum value in PEFR. Ectomorph, being the tallest among the three, have the highest SVC value. It also has the least airway obstruction and so highest FEV₁.

Disclosure of Interest

All the authors do not have any possible conflicts of interest.

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