Evaluation of pulmonary function tests in long and short distance runners.

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Abstract: Physical exercise has been reported to improve many health indices and well-being of individual of any age. Among various physical exercises, running is hugely popular and convenient leisure time activity. Running reduces the risk of respiratory illness. Runners have increased pulmonary/respiratory capacity compared to non-exercising individuals. All parameters of PFT like forced vital capacity (FVC), forced expiratory volume in 1st second (FEV1), forced expiratory volume in three second (FEV3), peak of expiratory flow rate (PEFR) and FEV1/FVC ratio were significantly high in long distance runners and controls.The study included a total of 50 each of long and short distance runners. Additionally, 50 age matched individuals with leisure-time physical activity or activities done for less than 20 minutes or less than 3 times/week were included in the study. The PFT was performed by using Medspiror (Computerized spirometry).All PFT indices like forced vital capacity (FVC), forced expiratory volume in 1st second (FEV1), forced expiratory volume in three second (FEV3), peak of expiratory flow rate (PEFR) and FEV1/FVC ratio were significantly high in long and short distance runners as compared to controls.running being an aerobic exercise has beneficial effect on respiratory system. Both regular long distance and short distance running enhance the pulmonary capabilities of an individual. The study emphasizes on modification of life style from sedentary to regular physical exercise for improving pulmonary functions.

Keywords: Long distance runners, short distance runner, physical exercise pulmonary function test, spirometry, respiratory system.

1.Introduction.

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Regular physical exercise and healthy balanced diet is not only important for maintaining physical health but also for mental well-being of an individual. Physical exercise has been reported to improve many health indices and well-being of individual of any age.[1] Sedentary life style is one of the major risk factor for variety of chronic, non-communicable diseases (NCD) particularly type 2 diabetes, cardiovascular disease (CVD) and musculoskeletal disorders.

Any type of physical exercise (running, swimming, weight training) have beneficial effect on various physiological process of body in general and respiration and circulation in particular. Among various physical exercises, running is hugely popular and convenient leisure time activity.[2] Many researchers have highlighted advantages of running. Running can be performed at ease without any limitation of time, equipment, place and specialized training. Generally, regular runners are reported to have a 25 to 40 % less risk of premature death and live approximately 3 years longer than non-runners. [3]

As runners perform strenuous exercise physical activity, they have high levels of cardiorespiratory fitness. Running reduces the risk of respiratory illness. In addition it also reduces the mortality associated with pneumonia and aspiration pneumonia.

Owing to regular and vigorous exercise during running, runners usually have increased pulmonary/respiratory capacity compared to non-exercising individuals.[4] However, pulmonary function and its relationship to performance in regular exercising population have always been a controversial topic for sport physiologists.

Although the relationship between running and parameters like lactate threshold, respiratory muscle fatigue, and echocardiography are studied for assessing the respiratory/pulmonary indices, these tests are not cost effective and user friendly. [5] On the other hand, spirometery is an easy and reliable tool for assessing pulmonary function tests (PFT). The word spirometry is derived from Latin word ‘Spiro’ that means ‘to breathe’ and the word ‘Metron’ is Greek word for ‘to measure’.[5]

Although PFT is well studied in patients with respiratory illnesses, occupational hazards and individuals with sedentary life styles, only few studies are available on comparison of PFT in long and short distance runners, especially from India. Therefore the present study was conducted in a tertiary care academic hospital with an aim to assess PFT in long and short distance runners.

2.Material and methods.

The present descriptive cross sectional study was conducted in the Department of Physiology. The study population included a total of 50 long distance runners (running for 2 to 2.5 hours/day with constant pace) and 50 short distance runners (running for 50 meter followed by rest for 10 to 15 second and again running for 50 meter). A total 50 age matched individuals with leisure-time physical activity or activities done for less than 20 minutes or less than 3 times/week were recruited as controls. Following were inclusion and exclusion criteria

Inclusion criteria

1. Individuals belonging to age group 18-30 years
2. Both sexes
3. Non smokers
4. Non obese
5. Willing to participate in the study

Exclusion criteria

1. Chronic disease
2. Respiratory illness

3. Individual on medication

Participants from both the groups were informed about aim of the study. They were made aware of the procedure by demonstrating the technique. The PFT was carried out as per the standard protocol as suggested by Miller *et al.*[6] The PFT was performed by using Medspiror (Computerized spirometry) after reinforcing the method of test to each participant. All measurements were obtained between 8 AM to 12 noon to prevent any diurnal variation in pulmonary/lung functions.

Demographic features (age, sex) and anthropometric measurements (height, weight) of each participant of the study were recorded and analyzed. The data was entered in Microsoft Excel and analyzed using SPSS version 19.0 statistical software. The *P* value of < 0.05 was considered as significant.

Results.

The gender wise distribution of participants of the study is shown in figure 1.

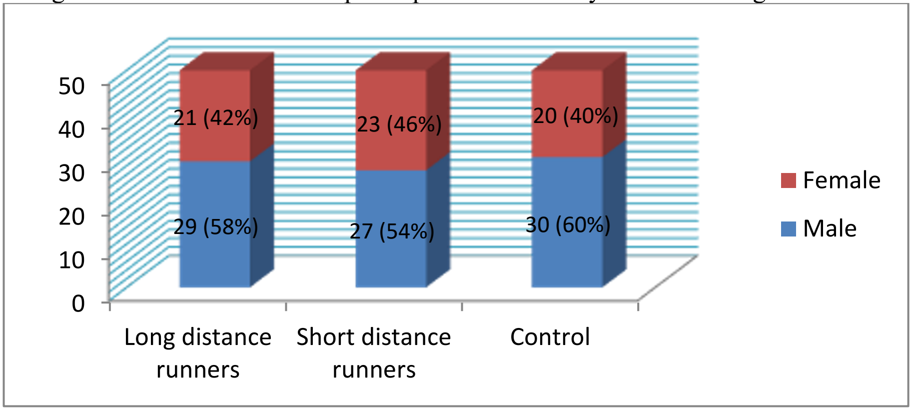

Figure 1: Gender wise distribution of participants.

As shown in figure1, a total of 29 (58%) participants from long distance runner group were males and 21 (42%) were females whereas 27 (54%) participants from short distance runner group were males and 23 (46%) were females. In control group, the numbers of male and female participants were 30 (60%) and 20 (40%) respectively. There was no significant difference observed in gender of both the groups (Chi square test, *P* value >0.05). The mean age and anthropometric measurement of participants is shown in table 1

Table 1. Anthropometric measurement of participants.

Anthropometric measurement	Group			T test *P* value
	Long distance runners (± SD)	Short distance runners (± SD)	Control (±SD)	
Age (in years)	22.02 (2.9)	23.03 (2.1)	22.7 (2.2)	>0.05
Weight (in kg)	58.2 (1.27)	58.8 (1.8)	56.3 (1.7)	>0.05
Height (cm)	161.8 (3)	162.3 (3.1)	158.2 (2.8)	>0.05
Body Mass Index	23.8 (1.3)	23.8 (1.3)	24.2 (1.2)	>0.05

As shown in table 1, there was no significant difference observed between variables like age, weight, height and body mass index (BMI) of long distance runners, short distance runners and controls and these variables were comparable.

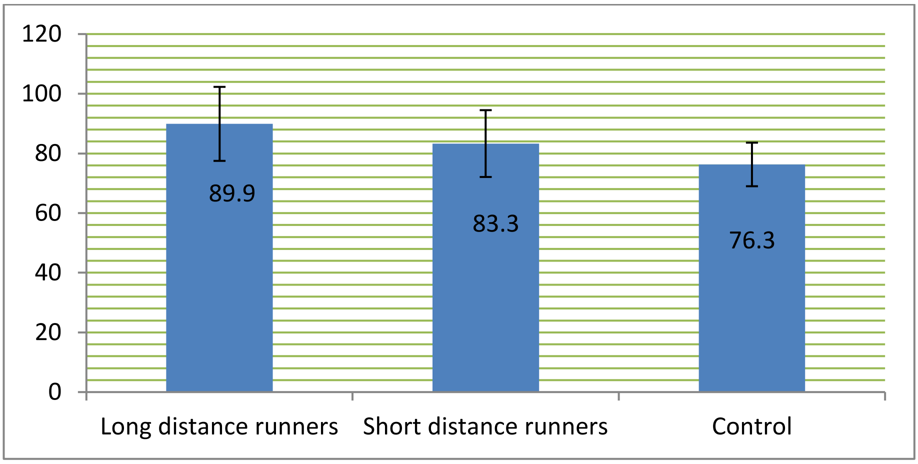

Figure 2: Mean Percentage of Forced vital capacity (FVC).

The mean % of forced vital capacity (FVC) FVC of participants is shown in figure 2, in long distance runners FVC was 89.9(±12.7), it was 83 (±11.2) in short distance runners whereas in participants from control group mean % of FVC was 76.3(± 7.3).

As shown in figure 3, mean % of forced expiratory volume in 1st second (FEV1) in long and short distance runners were 88.5 (± 13.9) and 84.3 (± 10.2) respectively. The participants from control group had mean % of FEV1 74.6 (± 9.6).

The mean percentage of forced expiratory volume in three second (%FEV3) was high in long distance runners (87.9 ±14.9) and short distance runners (85.8 ±11.3) whereas it was 74.6 (± 6.7) for control group (Figure 4). As shown in figure 5, the mean percentage of peak of expiratory flow rate (% PEFR) was high in long distance runners (94.2 ±14.2) and short distance runners (90.8 ±12.1) compared to participants from control group (84.2 ±11.1). Mean % FEV1/FVC ratio of participants is shown in figure 6. It was high in long distance runners (95.9±11.9) and short distance runners (92.3 ±13.7) in comparison to control group (83.7 ±9.2).

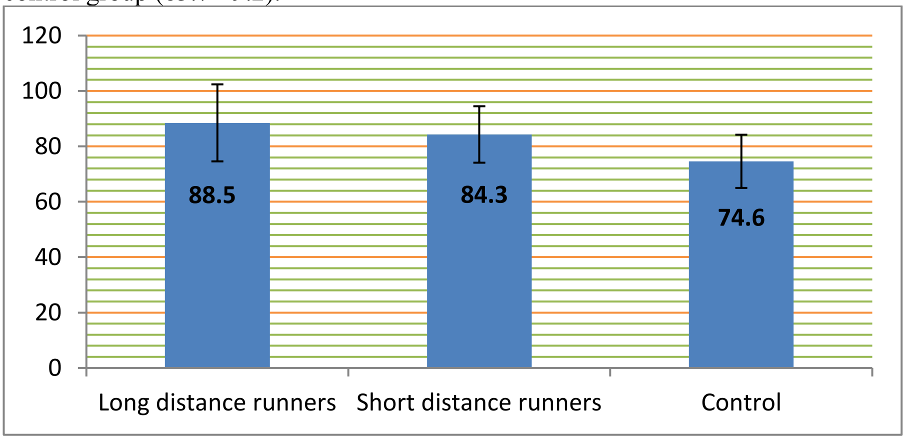

Figure 3: Mean percentage of forced expiratory volume in 1st second (%FEV1).

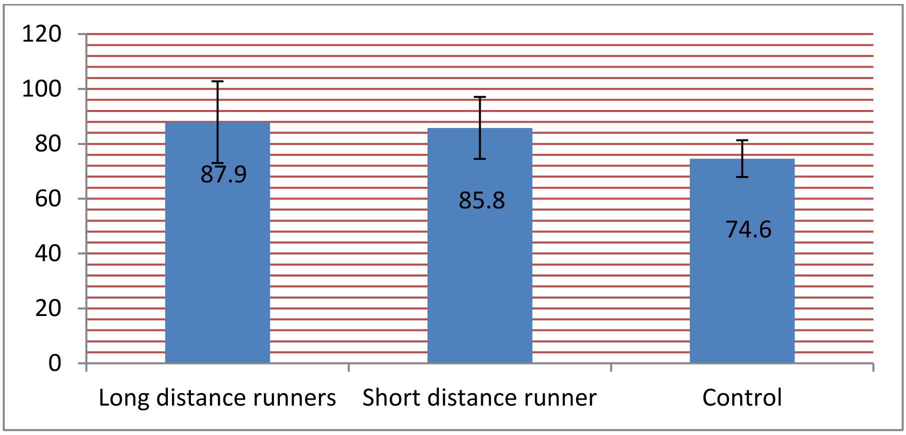

Figure 4: Mean percentage of forced expiratory volume in three second (%FEV3).

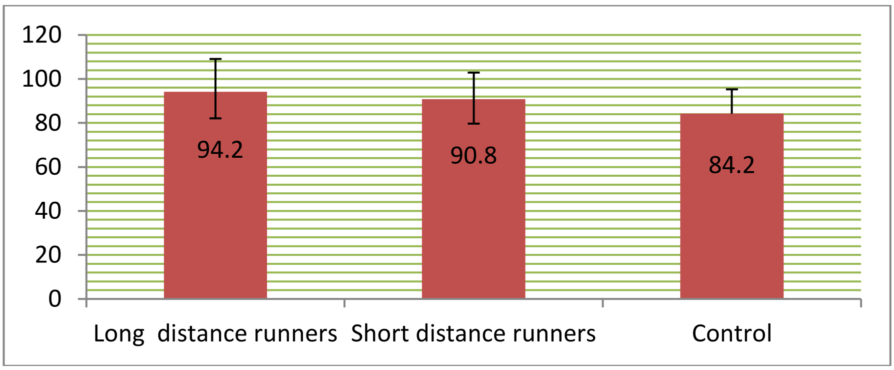

Figure 5: Mean percentage of peak of expiratory flow rate (% PEFR).

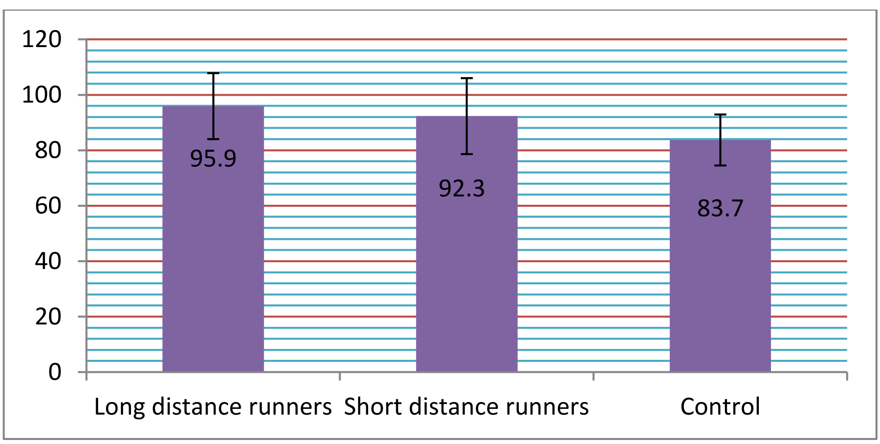

Figure 6: Mean % FEV1/FVC ratio.

Table 2: Comparison of pulmonary function tests in long distance runners and controls.

	Group			**One-way ANOVA test**
Parameter	Long distance runner	Short distance	Control (± SD)	***P* value**

	(± SD)	runner (± SD)		
FVC	89.9 (12.7)	83 (11.2)	76.3 (7.3)	<0.001*
FEV1	88.5 (13.9)	84.3 (10.2)	74.6 (9.6)	<0.001*
FEV3	87.9 (14.9)	85.8 (11.3)	74.6 (6.7)	<0.001*
PEFR	94.2 (14.2)	90.8 (12.1)	84.2 (11.1)	<0.001*
FEV1/FVC ratio	95.9 (11.9)	92.3 (13.7)	83.7 (9.2)	<0.001*

***statistically significant**

As shown in table 2, when parameters of PFT were analyzed using one way ANOVA test there was a significant difference observed between all parameters of PFT in long distance runners, short distance runners and controls.

3.Discussion

Any kind of physical exercise has several benefits on human body. Regular running, whether for a long or a short distance facilitate development of strength, speed and general endurance. [7] Aerobic exercises like cycling, running and swimming have special benefit on respiratory system as it improves the muscle strength of lungs.

In this study, PFT of long distance runners and short distance runners was evaluated using spirometry. PFT is employed to measure lung volumes, bronchial obstruction, gas exchange, lung compliance and ventilatory capacity. Spirometry, body plethysmography and single breath transfer factor are various methods for PFT.

Office based PFT is known as spirometry. Spirometry serves as a robust tool for primary care physicians to diagnose and manage respiratory problems. It is the most basic and easiest test to measure the pulmonary function parameters and to differentiate lung disorders.

In this study, important indices of lung function like FVC, FEV1, FEV3, PEFR and FEV1/FVC ratio were studied using spirometry. FVC is the maximum volume of air expired forcefully and rapidly after a maximal inspiration.[6] Normally FVC equals VC or FVC and VC should be within 200ml of each other. FVC was significantly high in long distance runners (89.9±12.7) and short distance runners (83 ±11.2) as compared to participants from control group mean (76.3± 7.3). During running, muscular exercise increases both rate and intensity of respiration and improves FVC. It also increases the oxygen consumption and the diffusion rate. Akhade *et al* also reported FVC to high in runners as compared to non-runners.[8] Various factors like increased muscle strength, decreased air trapping, reduced airway resistance, decrease in blood lactate levels and improved pulmonary compliance is responsible for improved FVC in exercising population.

As per definition, FEV1 is the volume of air expired in first second of an FVC maneuver.[6] When FEV1 is of predicted value it is considered to be abnormal. FEV1 was higher in long distance runners (88.5± 13.9) and short distance runners (84.3 ± 10.2) compared to control group (74.6± 9.6). In regular runners, higher expiratory power and overall low air movement resistance in the lungs may reason a possible reason for high FEV1 compared to participants from control group. Researchers like [8,10]reported high FEV1 in runners compared to non-runners whereas in the study [11]contrast finding was reported.

Several studies have emphasized the importance of PEFR. PEPR is the maximal expiratory flow achieved during a maximum forced expiration initiated at total lung capacity (TLC). It primarily measures large airway function.[6] When the mean percentage of PEFR was compared in participants of this study, it was high in long distance runners (94.2 ±14.2) and short distance runners (90.8 ±12.1) as compared to control group (84.2 ±11.1). PEPR can be reliably utilized as a valuable tool for rapid and reliable assessment for PFT in athletes. Similar to findings of [9,12]/FVC ratio was high in runners compared to control. The FEV1/FVC coupled with other indices of PFT can be reliably utilized for detecting abnormal respiratory physiology.

4.Conclusion.

From this study, it can be concluded that, running being an aerobic exercise has beneficial effect on respiratory system. Both regular long distance and short distance running enhance the pulmonary capabilities of an individual. The study emphasizes on modification of life style from sedentary to regular physical exercise for improving pulmonary functions.

References

1. Chakravarty E, Hubert H, Lingala V, Fries J. Reduced disability and mortality among aging runners: a 21-year longitudinal study. Arch Intern Med 2008 11; 168:1638-1646.
2. Lee D, Brellenthin A, Thompson P, Sui X, Lee I, Lavie C. Running as a key lifestyle medicine for longevity. Progress in cardiovascular diseases. 2017; 60:45-55.
3. Lavie C, Lee D, Sui X, Arena R, O'Keefe J, Church T et al. Effects of running on chronic diseases and cardiovascular and all-cause mortality. In Mayo Clinic Proceedings 2015; 90:1541-1552. Elsevier.
4. Madhu B, Tanaji W, Bikalp T, Kushwaha A, Malhotra V, Hira D. Relationship between short-distance run and variables of pulmonary function tests. Natl J Physiol Pharm Pharmacol. 2015; 5: 149-152.
5. Sewa D, Ong T. Pulmonary function test: spirometry. Proceedings of Singapore Healthcare. 2014; 23:57-64.
6. Miller M, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A *et al*. Standardization of spirometry series “ATS/ERS Task Force”: Standardization of Lung Function Testing. Eur Respir J 2005; 26: 319-338.
7. Bolotin A, Bakayev V. Response of the respiratory system of long and middle distance runners to exercises of different types. Journal Phys Edu Sport 2017; 17:2214-2217.
8. A. Prakash, “Shadow of the pandemic and the Beleaguered Liberal-Democratic Script in India,” *India Rev.*, vol. 20, no. 2, pp. 104–120, Mar. 2021,
9. Shashikala KT, Jaiswal S. Assessment of pulmonary functions FVC, FEV1, and FEV1/FVC ratio among athletes and non-athletes. Natl J Physiol Pharm Pharmacol 2022; 12(09):1335-1338.
10. Prakash S, Meshram S, Ramlekkar U. Athletes, Yogis and individuals with sedentary life styles, Do their lung functions differ? Indian J Physiol Pharmacol. 2007; 51 (1): 76-80.
11. I. AFP, “This clip has been edited -- the original video shows Rahul Gandhi making a clear statement,” AFP India. Accessed: Oct. 18, 2022.
12. Vedala S, Paul N, Mane AB. Differences in pulmonary function test among the athletic and sedentary population. Natl J Physiol Pharm Pharmacol 2013; 3:118-123.