NJPPP National Journal of Physiology, Pharmacy & Pharmacology

DOI: 10.5455/njppp.2015.5.051220141
http://www.njppp.com/

RESEARCH ARTICLE

RELATIONSHIP BETWEEN SHORT-DISTANCE RUN AND VARIABLES OF PULMONARY FUNCTION TESTS

Madhu Bhatt[1], Tanaji Wankhede[1], Bikalp Thapa[1], Arvind Singh Kushwaha[2], Vineet Kumar Malhotra[1], Dipak Hira[1]

[1] Department of Physiology, Armed Forces Medical College, Pune, Maharashtra, India
[2] Department of Community Medicine, Armed Forces Medical College, Pune, Maharashtra, India

Correspondence
Madhu Bhatt
(madhubhtt@gmail.com)

Received
30.08.2014
Accepted
03.12.2014

Key Words
Pulmonary Functions; 400-m Run Timing; Correlation; Running Performance

Background: The relationship of pulmonary functions and running performance has always been a topic of debate among the fraternity of physiologists. The relationship of submaximal exercise with lactate threshold, respiratory muscle fatigue, and echocardiography has also been widely studied. But these tests are equipment and lab intensive.
Aims and Objective: To study relationship between run timings for short distance and variables of pulmonary function tests (PFTs).
Materials and Methods: In the present study 142 healthy males participated who were non - sedentary and non-athletically trained. They performed a 400m distance run and time taken to finish the run was recorded in seconds. These same set of subjects also underwent PFT and data was recorded as % of predicted values.
Results: The recorded variables were subjected to statistical analysis and their Mean, SD, Pearson's correlation were derived. Time taken to finish 400-m run were correlated with percentage predicted values for forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), peak expiratory flow rate (PEFR), FEV1/FVC, and maximal voluntary ventilation (MVV), and the r-values were obtained: –0.12 (–0.27 to –0.32); –0.15 (–0.30 to –0.01); –0.09 (–0.25 to 0.06); –0.07 (–0.15 to 0.06); –0.12 (–0.17 to 0.02), respectively.
Conclusion: A negative correlation was found between the PFT variables and 400-m run finish timings. Therefore, evaluation of pulmonary functions may be used to screen potential athletes. This may also be used an additional criterion to monitor progress in level of physical fitness of selected athletes during the course of their supervised training period.

INTRODUCTION

To quote Sir Joseph Barcroft, "The condition of exercise is not a mere variant of the condition of rest, it is the essence of the machine."[1] Schunemann et al.[2] in a 29-year follow-up prospective study concluded that pulmonary function is a long-term predictor for overall survival rates and, therefore, recommended pulmonary function testing to be used as a tool in the general population. Earlier studies in middle-distance adolescent runners before and after 1 year of training found that adolescent athletes have superior expiratory power and overall low resistance to air movement in the lungs and therefore have higher forced expiratory volume in 1 second (FEV1) and maximal voluntary ventilation (MVV) as compared to nonathletes.[3] The relationship between pulmonary functions and running performance has always been a topic of debate among the fraternity of physiologists. The relationship of submaximal exercise with lactate threshold, respiratory muscle fatigue, and echocardiography have also been widely studied.[4,5] But these tests are equipment intensive, lab intensive, not readily accessible, and invasive. These are also limited by the time constraint. This study endeavors to find if there is a relationship between individual's running performance in terms of time taken to run short distance (i.e., 400 m) with their pulmonary function test (PFT) parameters. If a relationship is established based on their running performance, then the PFT could be used to identify potential athletes. The portability of the spirometry equipment allows us to carry out testing on a large scale in the field studies. Other available equipment for performance assessment are limited by their size and weight and therefore are not suitable for large-scale screening in the field studies.

Studies have shown that respiratory muscle fatigue is an important factor that limits performance in physical activities of high intensity.[6] There are studies to show that respiratory muscle fatigue does not limit exercise performance during moderate endurance run.[7] This study encompasses to measure run timings for participants for a short distance of 400 m, recording their PFTs (spirometry), and to study the relationship between run timings and spirometry variables.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted on 142 healthy male volunteers undergoing paramedical training in the institute. The institute was fully residential and also the candidates had an almost similar daily physical activity routine. For the recruitment of subjects, a self-administered pro forma was used. The subjects were to declare their daily routine, especially with respect to the physical activity, illness, and smoking habits. All those who had no illness that could affect their physical performance in field running or could affect their pulmonary functions were selected. Their non-sedentary and nonathletically trained status was also ascertained through the pro forma. Apparently healthy male volunteers 18–35 years of age with non-sedentary and nonathletically trained status were included in the study. Those inhabiting any condition where spirometry or running is contraindicated or had a disease were excluded. Height and weight were measured using seca balance and stadiometer (Vogel And Halke, Hamburg, Germany). Stopwatch was used for recording run timings. The PFT was performed using Medspiror PC-based spirometer (Helios 101) supplied by Recorders & Medicare Systems, India, based on software RMS Helios, version 3.1.47. In this device air flow rotates the vane and the speed is proportional to the air flow. Optical sensor detects rotations and the signal is read by microprocessor. Calibration of the spirometer was performed as per manufacturer's guidelines.

The test protocol was approved by institutional ethical committee. The participants were explained the protocol sequence. Informed consent of the subjects was undertaken in writing. They were all subjected to run tests in the morning hours. The PFT was administered to all during the same hours of the day to exclude circadian variation as a confounder.[8,9]

The PFT was performed within 2 weeks of the run test for the individuals. They were subjected to the PFT in sitting position. They were asked to refrain from physical activity on the day of the PFT. The maneuvers were explained and shown to the subjects. The subjects were also given verbal encouragement throughout the procedure. The measurements were made according to American Thoracic Society and European Respiratory Society recommendations.[10] The subjects performed at least three maneuvers. From the acceptable records the graph with maximum FVC was selected for the subject.

Statistical Analysis: The PFT variables expressed as percentage predicted for age, gender, height, weight, and ethnicity were subjected to statistical analysis (SPSS version 17.0) for studying relationship between run timings and pulmonary functions. Pearson's correlation was derived between percentage predicted values of spirometry variables and subject's running performance in terms of time taken to run a distance of 400 m.

RESULTS

The average age (years) of the subjects was 22.23 ± 1.72, height (m) was 1.73 ± 0.01, and weight (kg) was 66.86 ± 6.44. Mean time, standard deviation, along with the range in seconds taken for running 400 m was 74.7 ± 7.94 (60–100). Mean values of percentage predicted MVV, peak expiratory flow rate (PEFR), FEV1, and FEV1/FVC were 112% ± 13.3 (81%–146%), 98% ± 16.9 (48%–147%), 114% ± 13.2 (82%–145%), and 98.1% ± 5.1 (79%–112%), respectively.

Table 1: Pearson's correlation coefficient between pulmonary function test variables and 400 m run timings

Parameters	*r*-Value	95% CI	*p*-Value
400-m time and FVC % predicted	−0.12	−0.27 to − 0.32	0.07
400-m time and FEV1 % predicted	−0.15	−0.30 to 0.01	0.03
400-m time PEFR % predicted	−0.09	−0.25 to 0.06	0.12
400-m time FEV1/FVC % predicted	−0.07	−0.15 to 0.06	0.19
400-m time MVV % predicted	−0.12	−0.17 to 0.02	0.06

Table 1 shows Pearson's correlation between the PFT variables recorded as percentage predicted values and the 400-m run timings (recorded in seconds). Also mentioned are the *p*-values for statistical significance. A negative correlation was found between the run timings and the PFT variables, that is, those subjects who finished the run in lesser time had better pulmonary functions. Figure 1 shows a scatter diagram to show relationship between 400-m run timings in seconds and the percentage predicted values of MVV, PEFR, FEV1, and FEV1/FVC.

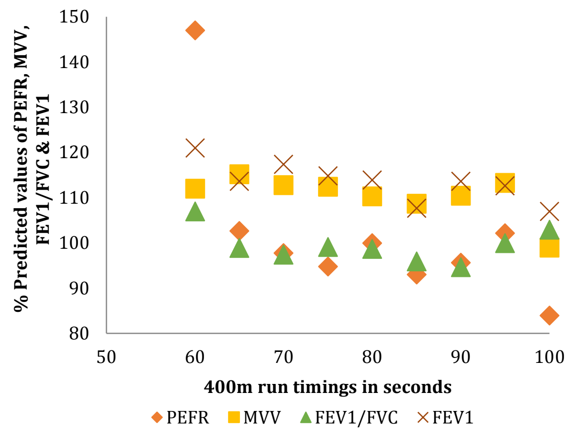

Figure 1: A scatter diagram to show relationship between 400-m run timings in seconds (*x*-axis) and percentage predicted values of PEFR, MVV, FEV1/FVC, and FEV1 (*y*-axis)

DISCUSSION

This study suggests that PFTs (percentage predicted values of MVV, PEFR, FEV1, and FEV1/FVC) are negatively correlated to running performance (time taken to finish 400-m run). In this study, a strong correlation was not seen possibly because the individuals selected were from one category and therefore involved in an almost similar routine of physical activity, though they were not athletically trained yet they were not sedentary. Prakash et al.[11] found higher lung function parameters, especially FEV1 and PEFR, in yogis practicing yoga for at least 1 h daily for 6 months as compared to individuals with sedentary lifestyle, whereas there was not much difference when compared to athletes except in PEFR. They compared the groups with each other but did not study correlation between the physical performance and lung function tests. Pringle et al.[12] found significant negative relationship between 10-km race time and the PFT variables, that is, FVC, MVV, and inspiratory capacity.[3] Cumming[13] also found significant correlation between MVV and performances in the 100-yard run, hurdles, shotput, and decathlon scores. Lakhera et al.[14] in a comparative study on sportsperson from different fields found that sports such as swimming, football, running, and wrestling are associated with higher FEV1 values as compared to basketball, gymnastic, and boxing. Also, the values were found to be highest among swimmers. Degens et al.[15] in their study conducted on master athletes and sedentary reference population found higher FEV1 values in both endurance as well as power athletes as compared to control participants. They found no difference in FEV1 between the two groups of sportsperson, that is, endurance and power athletes. This is further indicative of the fact that PFTs should be added to the battery of tests used for selection of potential sportsperson and for monitoring their fitness status. Being less equipment intensive, yet offering an objective record of a screening test that can be applied to field studies is the main strength of this study.

This study has its own share of limitations. Had the participants been from varied backgrounds (in terms of physical activity) versus the present population, which otherwise had similar routine of physical activity, we would have got stronger correlation. For this test to be used as a potential screening tool to identify potential athletes, larger longitudinal studies should be carried out.

CONCLUSION

This study has shown negative correlation between time taken to finish run of 400 m and percentage predicted values of FVC, FEV1, PEFR, FEV1/FVC, and MVV. Therefore, evaluation of pulmonary functions may be used to screen potential athletes. Athletes can also be advised to improve their lung volumes and capacities by targeted respiratory muscle training so as to improve their physical performance. This may also be used an additional criteria to monitor progress in level of physical fitness of selected athletes during the course of their supervised training period.

REFERENCES

1. McArdle DW, Katch FI, Katch VL. Exercise Physiology: Energy, Nutrition and Human Performance, 5th edn. Philadelphia, PA: Lippincott Williams & Wilkins, 2001. p. 251.
2. Schunemann HJ, Dorn J, Grant BJB, Winkelstein W Jr, Trevisan M. Pulmonary function is a long-term predictor of mortality in the general population: 29-year follow-up of the Buffalo Health Study. Chest 2000;118:656–64.
3. Lakhera SC, Kain TC, Bandopadhyay P. Lung function in middle distance adolescent runners. Indian J Physiol Pharmacol 1994;38(2):117–20.
4. Allen WK, Seals DR, Hurley BF, Ehsani AA, Hagberg JM. Lactate threshold and distance-running performance in young and older endurance athletes. J Appl Physiol 1985;58:1281–4.
5. D'Andrea A, Riegler L, Morra S, Scarafile R, Salerno G, Cocchia R, et al. Right ventricular morphology and function in top-level athletes: a three-dimensional echocardiographic study.

J Am Soc Echocardiogr 2012;25:1268–76.
6. Johnson BD, Aaron EA, Babcock MA, Dempsey JA. Respiratory muscle fatigue during exercise: implications for performance. Med Sci Sports Exerc 1996;28:1129–37.
7. Nava S, Zanotti E, Rampulla C, Rossi A. Respiratory muscle fatigue does not limit exercise performance during moderate endurance run. J Sports Med Phys Fitness 1992;32:39–44.
8. Medarov BI, Pavlov VA, Rossoff L. Diurnal variations in human pulmonary function. Int J Clin Exp Med 2008;1:267–73.
9. Hetzel MR. The pulmonary clock. Thorax 1981;36:481–6.
10. Miller MR, Hankinson J, Brusasco V, Burgos F, Casaburi R, Coates A, et al. Standardisation of spirometry. Eur Respir J 2005;26(2):319–38.
11. Prakash S, Meshram S, Ramtekkar U. Athletes, yogis and individuals with sedentary lifestyles; do their lung functions differ. Indian J Physiol Pharmacol 2007;51(1):76–80.
12. Pringle EM, Latin RW, Berg K. The relationship between 10 km running performance and pulmonary function. J Exerc Physiol 2005;8(5):22–8.
13. Cumming GR. Correlation of athletic performance with pulmonary function in 13 to 17 year old boys and girls. Med Sci Sports 1969;1(3):140–3.
14. Lakhera SC, Mathew L, Rastogi SK, Sen Gupta J. Pulmonary function of Indian athletes and sportsmen: comparison with American athletes. Indian J Physiol Pharmacol 1984;28(3):187–94.
15. Degens H, Maden-Wilkinson TM, Ireland A, Korhonen MT, Suominen H, Heinonen A, et al. Relationship between ventilator function and age in master athletes and a sedentary reference population. Age (Dordr) 2013;35(3):1007–15.

Cite this article as: Bhatt M, Wankhede T, Thapa B, Kushwaha AS, Malhotra V, Hira D. Relationship between short-distance run and variables of pulmonary function tests. Natl J Physiol Pharm Pharmacol 2015;5:149-152.
Source of Support: Nil
Conflict of interest: None declared