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Original Research Article

Correlation between Physical Activity Levels and Pulmonary Function Parameters in Healthy Adults

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Abstract

Background: Habitual physical activity may adversely affect the health of the lungs, even in adults who do not have diagnosed lung disease, but the association between physical activity and spirometric indices differs among populations.

Materials and Methods: Cross sectional analytical study to find out the correlation between physical activity level and pulmonary function parameters in healthy adults. The total number of participants (18-40 years old) were categorized as low, moderate, or high physical activity level using the International Physical Activity Questionnaire short form. Standard methods were used for the measurement of forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, peak expiratory flow rate (PEFR) and maximum voluntary ventilation (MVV).

Results: The mean age was 25.9 ± 5.4 years, and 96 participants (53.3%) were male. High-activity participants had significantly higher FVC (3.78 ± 0.61 L), FEV1 (3.21 ± 0.54 L), PEFR (464.8 ± 78.6 L/min), and MVV (118.4 ± 22.7 L/min) than low-activity participants (3.29 ± 0.58 L, 2.78 ± 0.49 L, 397.6 ± 70.4 L/min, and 101.7 ± 20.3 L/min, respectively; $p < 0.001$ for all except FEV1/FVC). Total MET-min/week correlated positively with FVC ($r = 0.38$), FEV1 ($r = 0.35$), PEFR ($r = 0.41$), and MVV ($r = 0.44$).

Conclusion: After controlling for age, sex, height, BMI and sedentary time, physical activity was an independent predictor of FEV1 and MVV. In healthy adults, there is a positive association between higher levels of habitual physical activity and pulmonary function.

Keywords: Physical Activity; Pulmonary Function; Spirometry; FEV1; FVC; Healthy Adults.

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Introduction

Physical activity is a modifiable behavior that impacts cardiovascular, metabolic, musculoskeletal and respiratory health. The current global guidelines recommend that adults engage in aerobic and muscle strengthening exercises regularly as physical inactivity is associated with premature morbidity and mortality [1]. The association between activity and cardiovascular fitness is well established, but the association with pulmonary function in healthy adults is less well described. Habitual activity, respiratory muscle strength, environmental factors, smoking exposure, body composition, ethnicity, sex and height are all factors that affect lung function. Even in apparently healthy subjects, standardized spirometry gives objective indices like FVC, FEV1, FEV1/FVC ratio, PEFR, and MVV that help to characterize ventilatory capacity [2,3]. There is good biological plausibility for a relationship between physical activity and lung function. Exercise increases ventilatory demand, improves thoracic mobility, increases respiratory muscle endurance, and may decrease systemic inflammation and adiposity. Increased CRF in adolescence has been linked to improved lung volumes later in life, indicating that active behavior may play a role in optimal lung development and maintenance [4]. In healthy adults with lung disease, weak but positive relationships have been reported between objectively measured physical activity and spirometric indices [5]. Community-based and NHANES studies in recent years indicate that sedentary time and low levels of moderate-to-vigorous activity may be linked to reduced FEV1 and FVC, especially with increasing sedentary time [6,7]. Measuring physical activity is difficult because self-reported activity can overestimate the amount of energy expended. However, the International Physical Activity Questionnaire is still a popular instrument for categorizing low, moderate, and high activity levels in epidemiological and student-based research [8]. In resource-poor environments, the use of IPAQ assessment in conjunction with spirometry may be helpful in understanding the respiratory consequences of lifestyle behavior. Healthy young and middle aged adults are an important target group as early identification of modifiable determinants of lung function may aid preventive strategies prior to the onset of disease.

The evidence is not consistent. In adolescents and young adults, there is little evidence of a relationship between activity and spirometric indices after controlling for body size and other factors, but some studies do show benefits in active groups [9,10]. These discrepancies could be due to age range, measurement method, sedentary exposure, obesity prevalence, and activity intensity. Thus, local data are required to determine if there are measurable differences in pulmonary function between healthy adults in routine physical activity categories. The purpose of the present study was to assess the relationship between physical activity and pulmonary function parameters obtained by spirometry in healthy adults. The main purpose was to compare FEV1 and FVC between low, moderate and high physical activity groups. Secondary objectives included evaluating PEFR, MVV, FEV1/FVC ratio and the independent predictive value of total MET-min/week after controlling for demographic and anthropometric variables.

Materials and Methods

The study was a cross sectional analytical study carried out in the Department of Physiology, tertiary teaching institution. Healthy adult volunteers (18-40 years) were selected from students, staff, and community attendants. Data collection was conducted during four-month period in a morning laboratory session. Participants were instructed to refrain from eating a heavy meal, strenuous exercise, smoking exposure and caffeine for at least 2 hours prior to spirometry. A short history and physical examination were carried out to rule out respiratory or cardiovascular disease.

The sample size was determined to achieve 80% power and 5% alpha error at detecting a minimum correlation coefficient of 0.25 between physical activity and FEV1. 180 subjects were recruited after excluding those with incomplete spirometry. The inclusion criteria were age 18-40 years, no diagnosed pulmonary disease, no acute respiratory infection in the last four weeks, and acceptable spirometric maneuvers. Current smoking, asthma, chronic obstructive pulmonary disease, tuberculosis sequelae, chest wall deformity, pregnancy, anemia under treatment, uncontrolled hypertension, and medications that affect respiratory function were the exclusion criteria.

The physical activity was measured by the IPAQ short form, which includes walking, moderate activity, vigorous activity and sitting time over the last seven days. Total activity was reported in MET-min/week and classified as low, moderate, and high activity based on the standard IPAQ scoring. Anthropometric variables were height, weight, BMI, waist circumference, resting pulse rate and blood pressure. Spirometry was done with a calibrated computerized spirometer fitted with disposable mouthpieces and nose clips. Participants were able to do at least three acceptable maneuvers in a sitting position, and the highest values for FVC, FEV1, FEV1/FVC ratio and PEFR were obtained. The MVV was calculated for a 12-second maneuver and extrapolated to 1 minute.

Quality control was performed according to the principles of spirometry, such as demonstration, coaching, repeatability assessment, and rejection of maneuvers with cough or early termination. SPSS-style methods were used for statistical analysis. The continuous variables were presented as mean ± SD, while the categorical data were presented as counts and percentages. One-way ANOVA was used to compare pulmonary function between activity categories followed by Tukey post-hoc tests for pairwise comparisons. Pearson correlation was used to evaluate relationships between MET-min/week and spirometric parameters. Multiple linear regression models were created to assess whether physical activity was an independent predictor of FEV1, FVC, PEFR, and MVV after controlling for age, sex, height, BMI, waist circumference, and sedentary time. A p value < 0.05 was considered statistically significant.

Results

The study included 180 healthy adults, with 60 participants in each physical activity category. The mean age was 25.9 ± 5.4 years, mean BMI was 23.1 ± 3.2 kg/m2, and 96 participants were male. The three activity groups were comparable in age and sex distribution. The high-activity group had slightly lower BMI and sedentary time than the low-activity group. Median total MET-min/week increased progressively from the low to high activity groups. No participant had obstructive spirometry, and all included tests met acceptability criteria. Pulmonary function showed a positive gradient with increasing physical activity. Mean FVC was 3.29 ± 0.58 L in the low-activity group, 3.51 ± 0.60 L in the moderate-activity group, and

3.78 ± 0.61 L in the high-activity group ($p < 0.001$). Mean FEV1 followed a similar pattern, increasing from 2.78 ± 0.49 L to 3.21 ± 0.54 L across groups ($p < 0.001$). PEFR and MVV demonstrated the strongest group separation, suggesting that habitual activity may be particularly related to respiratory muscle performance and expiratory effort. The FEV1/FVC ratio did not differ significantly across groups, indicating that the observed differences reflected overall ventilatory capacity rather than airway obstruction. Total MET-min/week correlated significantly with FVC, FEV1, PEFR, and MVV. The strongest correlation was observed for MVV ($r = 0.44$, $p < 0.001$), followed by PEFR ($r = 0.41$, $p < 0.001$). Sedentary time correlated inversely with FEV1 ($r = -0.25$, $p = 0.001$) and MVV ($r = -0.29$, $p < 0.001$). In multivariable regression, high physical activity remained independently associated with higher FEV1 and MVV after adjustment for age, sex, height, BMI, waist circumference, and sitting time. These findings suggest that activity level contributes to pulmonary function variability beyond basic anthropometry.

Table 1: Baseline characteristics according to physical activity category

Variable	Low activity (n=60)	Moderate activity (n=60)	High activity (n=60)	p value
Age (years)	26.3 ± 5.7	25.7 ± 5.2	25.6 ± 5.3	0.74
Male, n (%)	31 (51.7)	32 (53.3)	33 (55.0)	0.93
BMI (kg/m2)	23.8 ± 3.4	23.1 ± 3.1	22.4 ± 2.8	0.04
Sedentary time (h/day)	7.4 ± 1.8	6.3 ± 1.6	5.2 ± 1.4	<0.001
MET-min/week	486 ± 214	1648 ± 512	3386 ± 806	<0.001

Table 2: Pulmonary function parameters by physical activity level

Parameter	Low activity	Moderate activity	High activity	p value
FVC (L)	3.29 ± 0.58	3.51 ± 0.60	3.78 ± 0.61	<0.001
FEV1 (L)	2.78 ± 0.49	2.96 ± 0.51	3.21 ± 0.54	<0.001
FEV1/FVC (%)	84.6 ± 5.8	84.4 ± 5.5	84.9 ± 5.3	0.86
PEFR (L/min)	397.6 ± 70.4	431.2 ± 76.3	464.8 ± 78.6	<0.001
MVV (L/min)	101.7 ± 20.3	110.6 ± 21.5	118.4 ± 22.7	<0.001

Table 3: Correlation and adjusted regression of activity with pulmonary outcomes

Outcome	Pearson r with MET-min/week	Adjusted beta	p value
FVC	0.38	0.21	0.006
FEV1	0.35	0.24	0.003
FEV1/FVC	0.04	0.03	0.68
PEFR	0.41	0.27	0.001
MVV	0.44	0.31	<0.001

Discussion

This study showed that there was a strong positive correlation between the level of physical activity and pulmonary function in healthy adults. FVC, FEV1, PEFR and MVV were higher in the high-activity group compared to the low-activity group. No significant differences in FEV1/FVC ratio indicated that physical activity was related to improved lung volume and ventilatory function, but not to changes in airway caliber. The results are consistent with those indicating that physical activity can help enhance respiratory muscle efficiency, thoracic expansion, and cardiorespiratory integration [4,5].

The relationship observed was the highest with PEFR and MVV. Both are partly dependent on effort, strength of the respiratory muscles and neuromuscular coordination. These factors can be improved with regular exercise, which involves repeated ventilatory loading during exercise. The endurance of respiratory muscles and mechanical properties of the chest wall also play a role in MVV. This positive relationship between MET-min/week and MVV thus reinforces the idea that active adults have a greater functional ventilatory reserve. Other population studies have found that objectively measured activity is linked to slightly greater lung volume, and sedentary time is linked to decreased pulmonary indices [5-7].

The correlation coefficients in this study were moderate, suggesting that only a portion of the variation in pulmonary function is accounted for by physical activity. Lung volumes are still largely influenced by height, sex, age, ethnicity and body composition.

This is in line with the global spirometry reference equations and standardization documents that highlight anthropometry and demographic variables as the major predictors [2,3]. The independent association, however, remained after adjusting for body size, indicating that physical activity is not simply a proxy for body size. The inverse relationship between sedentary time and FEV1 and MVV also highlights the need to consider movement behavior as a continuum: more active time and less sitting time may be relevant for respiratory health.

Our findings have implications for the prevention of young adults. Lung function continues to decline with age and early adult FEV1 is correlated with future cardiopulmonary risk. Although this study does not prove causality, it suggests that promoting regular physical activity may contribute to preservation of respiratory reserve. Walking breaks, sports participation, stair use, and structured fitness sessions are easy activity promotion strategies that can be implemented in educational and workplace settings. Feedback based on spirometry could also encourage lifestyle modification in patients with low activity and low-normal lung function.

The advantages of this study are that the sample size was adequate, the spirometry was standardized, smokers and respiratory disease were excluded, and multiple pulmonary parameters were analyzed. Limitations include cross sectional design, self-reported physical activity, single center recruitment, and absence of direct measurement of cardiorespiratory fitness or respiratory muscle pressures. The possibility of residual confounding due to nutrition, environmental exposure, and childhood activity cannot be ruled out. Longitudinal studies with accelerometers, cardiopulmonary exercise testing and repeated spirometry in the future will be able to clarify the causal direction and dose-response relationship between physical activity and lung function.

The relationship between physical activity and lung function needs to be understood within the context of normal physiology. Pulmonary reserve is greater than the reserve required for resting ventilation in healthy adults. Thus, activity group differences may not manifest as symptoms but can be identified by spirometry and effort dependent parameters. Better chest wall excursion, lower central adiposity, and higher respiratory muscle conditioning may be responsible for the higher FVC and FEV1 in active adults. This is supported by the stronger correlation with MVV and PEFR, both of which rely on forceful respiratory function. In population studies, active behaviour has been correlated with increased lung volumes, but not always with FEV1/FVC ratio [7-11].

Sitting time should be treated separately. The low-activity group in the present study reported the longest sitting time, and sedentary time was inversely correlated with FEV1 and MVV. Sitting for extended periods of time can decrease thoracic mobility, increase weight gain and be associated with other unhealthy habits. Some recent NHANES research suggests that the association between sedentary behavior and pulmonary function may be partially mediated by moderate-to-vigorous physical activity [7]. This suggests that just encouraging people to exercise might not be enough if sitting time is high. Periodic movement breaks and posture changes can be used in addition to structured exercise for students and office workers.

Spirometric values are slightly higher in active adults, but this is a preventive rather than a diagnostic significance. There were no obstructive spirometry results and mean values were within normal healthy ranges. Trajectories of lung function start early, however, and people with lower peak function may become symptomatic earlier in life if exposed to pollution, smoking, obesity, or occupational dust later in life. Physical activity in the young adult years could be beneficial for pulmonary reserve. This is particularly true in urban populations where air pollution and sedentary academic or office-related activities are present.

The study also highlights the usefulness of simple physiology-laboratory screening. Both IPAQ assessment and spirometry are viable in institutional health programs. Low activity and low normal pulmonary indices can be discussed with students about aerobic exercise, breathing exercises, and minimizing sedentary time. Spirometry would be more definitive for reversibility if performed after activity intervention. Future research should employ objective measures of moderate-to-vigorous activity and direct measures of cardiorespiratory fitness to investigate whether moderate-to-vigorous activity is a mediator between lifestyle and pulmonary function [12-15].

The results suggest a combination of routine activity assessment and respiratory-health education in practice. Young adults with low activity may not report breathlessness, but their lower PEFR and MVV may suggest that they have less ventilatory reserve during activity. Progressive aerobic exercise, strengthening of trunk and respiratory muscles and decreasing prolonged sitting should be a focus of counseling. The public health case for active lifestyles is further bolstered by the respiratory benefits of physical activity, which are safe, inexpensive, and beneficial across multiple organ systems [16-18].

Thus, pulmonary function testing can be used not only for disease detection but also for preventive counseling in apparently healthy adults.

Conclusion

In healthy adults, higher levels of physical activity were correlated with improved FVC, FEV1, PEFR, and MVV, but no difference was seen in FEV1/FVC ratio. Selected pulmonary function parameters were predicted independently by total MET-min/week. Exercise may be beneficial in maintaining optimal ventilatory capacity in young and middle-aged adults.

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