Impact of Physical Activity Levels on Pulmonary Function among Female Office Workers

https://doi.org/10.32337/KACPT.2024.12.3.57
대한심장호흡물리치료학회지 제12권 제3호 2024.11. PP.57~62

Ji-Yeon Lee PT, PhD[1], Jin-Seop Kim PT, PhD[2], Kyoung-Hee Kim PT[3*]
[1]Digital Healthcare Research Institute, Sunmoon University, [2]Department of Physical Therapy, Sun Moon University, [3]The Sarang Hospital

Purpose : This study aimed to evaluate the effect of physical activity levels on the pulmonary function of female office workers. **Methods :** The participants were 27 female office workers from small- and medium-sized enterprises in Seoul. Physical activity levels were assessed using the international physical activity questionnaire, being calculated as METs. Pulmonary function was measured using a hand-held spirometer, focusing on the forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), FEV_1/FVC, and peak expiratory flow (PEF). The Mann–Whitney test was used to compare lung function according to the physical activity level. Correlation and regression analyses were performed to examine the relationship between physical activity levels and pulmonary function. **Results :** Participants with high physical activity levels demonstrated significantly higher FVC and FEV_1 than those with moderate physical activity levels ($p<.05$). Correlation analysis showed significant associations between physical activity levels and pulmonary function variables (FVC, FEV_1, and PEF; $p<.05$). Simple linear regression analysis revealed that physical activity levels significantly predicted FVC, FEV_1, and PEF, explaining approximately 47%, 44.6%, and 16.8% of the variances, respectively. **Conclusion :** This study reveals that higher physical activity levels positively affect the pulmonary function of office workers. Therefore, promoting physical activity among female office workers is crucial for enhancing pulmonary health.

Key words: Physical activity level, International Physical Activity Questionnaire, pulmonary function, office workers

Received: June 26, 2024 / **Revised:** August 6, 2024 / **Accepted:** Agust 14, 2024

Ⅰ. Introduction

Physical activity is defined as bodily movement that results in energy expenditure greater than resting energy expenditure, involving the use of muscles and joints(Caspersen et al., 1985). It can be performed at various intensities, increasing breathing and heart rates and causing fatigue. Physical activity and human health are closely interrelated(Bouchard et al., 2012). Globally, about 31% of the adult population is physically inactive, and this trend is continuously increasing(Hallal et al., 2012). Rapid technological advancements and industrialization have led to significant changes in individual lifestyles, resulting in decreased levels of daily physical activity levels and an increased sedentary behavior(Verdú et al., 2021). Addressing physical inactivity is essential considering the health, economic, environmental, and social consequences.

Modern office workers, in particular, spend prolonged periods sitting due to extensive computer use. Numerous studies have shown that office jobs significantly contribute to sedentary behavior(Thorp et al., 2012; Clemes et al., 2014; Vandelanotte et al., 2015). Workers in such roles often maintain unnatural, static postures for extended periods, significantly contributing to musculoskeletal pain (Dong et al., 2022; Tang, 2022; Dos Santos et al., 2023).

Sedentary behavior, characterized by low energy expenditure activities such as sitting or reclining, can alter the normal curvature of the spine and cause biomechanical changes in posture, significantly impacting respiratory function(Panahi & Tremblay, 2018). Most office workers

* This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education(RS-2023-00275755)

교신저자: 김경희
주소: 05733 서울특별시 송파구 마천로 227 더사랑병원, 전화: 02-6959-5522, E-mail: kyeong9653@naver.com

spend the majority of their working hours sitting, which limits mobility and significantly reduces physical activity levels(Thorp et al., 2012). In particular, female office workers often do not engage in additional exercise beyond their routine office activities, which further heightens concerns about respiratory health(Harris et al., 2009; Kim & Kim, 2015). Along with physical inactivity, sedentary behavior can lead to various health issues, including hypertension, cardiovascular diseases and musculoskeletal diseases, and is considered a major risk factor for increased mortality worldwide(Desai & Joshi, 2019; Evans et al., 2012).

Therefore, promoting behavioral changes and physical activity is crucial in preventing or delaying the onset of metabolic diseases among office workers. Leisure-time physical activities of moderate to vigorous intensity are widely recognized for their positive health benefits on cardiovascular health and for extending life expectancy. Regular walking(at least 30 minutes per session, five days a week) and vigorous physical activity(at least 20 minutes per session, three days a week) have been shown to lower the incidence of hypertension by 1.7 times compared to those who do not participate in such activities, and sedentary behavior has been linked to an increased risk of cardiovascular diseases(Boudreaux et al., 2023; Bellettiere et al., 2019).

The evidence linking physical activity to lung health is weak. Previous studies studies have focused on specific groups such as athletes or COPD patients. A prospective study among residents in Denmark reported that higher levels of physical activity were associated with lower risks of pulmonary function decline and COPD.

The purpose of this study is to investigate the effect of physical activity levels on the pulmonary function of female office workers. This research aims to provide fundamental data on the importance of managing physical activity for a healthier working life.

Ⅱ. Methods

1. Participants

A total of 27 female office workers from small and medium-sized enterprises in Seoul participated in the study. The study was conducted with females aged 20-30s who fully understood the purpose and content of the research and consented to participate in accordance with the ethical guidelines of the Declaration of Helsinki. Participants were recruited based on specific inclusion criteria: having a BMI under 25, being non-smokers, and free from any surgical or neurological diseases, as well as respiratory diseases other than COVID-19. This ensured a healthy baseline for the study, focusing on individuals without conditions that could confound the results related to pulmonary function and physical activity levels.

2. Measurement tools and Methods

1) Physical Activity levels

Physical activity levels were assessed using the International Physical Activity Questionnaire(IPAQ), a widely used and validated tool designed to measure physical activity over the last 7 days. Categorical and Continuous scores were classified according to Guidelines for Data Processing and Analysis of the IPAQ, which is structured to capture information about the frequency, duration, and intensity of physical activities across various domains.

For the analysis of the IPAQ data, the values used were 3.3 MET for walking, 4.0 MET for moderate physical activity, 8.0 MET for vigorous physical activity(Oh et al..2007; Ainsworth et al., 2011; Forde et al. 2018). The total amount of physical activity(PA) was calculated in METs, and the metabolic equivalent of task(MET-min/week) was calculated as follows: intensity of each physical activity(MET level) × physical activity period(minutes/day) × number of physical activities(day/week).

In the methodology of assessing the category score of weekly physical activity(PA) using the International Physical Activity Questionnaire(IPAQ), the following three group categories were defined:

(1) Low PA: Total energy expenditure is less than 600 MET-minutes per week.

(2) Moderate PA: This category is defined by achieving one of the following:

- Engaging in vigorous-intensity PA for at least 20 minutes per day on 3 or more days per week.
- Engaging in moderate-intensity PA and/or walking for at least 30 minutes per day on 5 or more days

per week.

- Engaging in any combination of walking, moderate-intensity, or vigorous-intensity activities on 5 or more days per week, resulting in a minimum total PA of at least 600 MET-minutes per week.

(3) High PA: This category is defined by achieving one of the following:

- Engaging in vigorous-intensity PA for at least 20 minutes per day on 3 or more days per week, resulting in a minimum total PA of at least 1500 MET-minutes per week.
- Engaging in any combination of walking, moderate-intensity, or vigorous-intensity activities on 7 or more days per week, resulting in a minimum total PA of at least 3000 MET-minutes per week.

According to the categorical scores, the physical activity levels were classified as follows: 0 individuals in the low level, 23 individuals in the moderate level, and 4 individuals in the high level.

2) Pulmonary function

Pulmonary function was measured using a hand-held Spirometer(Spiropalm 6MWT, COMED, Italy). The subjects' respiratory function was evaluated by forced vital capacity(FVC), forced expiratory volume in 1 second(FEV_1), FEV_1/FVC, and PEF. The test was conducted with the subject seated, leaning forward approximately 15 degrees. The head and neck were slightly raised to ensure an open airway. After a full inhalation, the subject performed a forced expiratory maneuver for at least six seconds while maintaining the posture. Proper use of the mouthpiece, maximum inhalation, and correct exhalation techniques were demonstrated, followed by ample practice time. All evaluations were repeated three times, and each evaluation was measured again after a one-minute break. The highest value was recorded as the result.

3. Data Analysis

The normality of the data was assessed through a normality Shapiro-Wilk Test, which revealed deviations from a normal distribution. To compare pulmonary function based on categorical classifications of physical activity levels, the Mann-Whitney U test was conducted. To evaluate the relationship between physical activity levels and pulmonary function indices, Pearson correlation coefficients (r) were calculated. Simple linear regression analysis was conducted to evaluate the effect of physical activity levels on pulmonary function. All statistical analyzes used IBM SPSS 22, and the significance level (α) was set at .05.

Ⅲ. Results

1. General characteristics of research subjects

A total of 27 subjects participated in this study, and their general characteristics are shown in Table 1.

Table 1. General characteristics of participants (n=27)

Gender (male/female)	0/27
Age (year)	29.14±6.49[a]
Height (cm)	161.37±3.91
Weight (kg)	54.68±5.36
Smoking habits (yes/no)	0/27
BMI (kg/㎡)	21.03±2.33

[a]Mean ± Standard Deviation

BMI: body mass index

2. Comparison of Pulmonary Function Based on Physical Activity Levels

There were no participants in the experimental group with low-intensity physical activity levels. A comparison between the moderate and high physical level groups showed that statistically significant differences in FVC and FEV_1($p<.05$) (Table 2).

Table 2. Comparison of pulmonary function among groups according to the physical activity level (n=27)

Variables	Moderate (n=23)	High (n=4)	Z	p
FVC (L)	2.82±0.41[a]	3.58±0.46	1.00	0.002**
FEV_1 (L)	2.49±0.38	3.04±0.25	2.50	0.003**
FEV_1 /FVC (%)	87.91±5.23	85.00±4.08	30.50	9.287
PEF (L)	5.69±1.39	6.18±1.09	36.00	0.495

[a]Mean ± Standard Deviation,

FVC: Forced vital capacity, FEV_1: forced expiratory volume in 1 second, PEF: peak expiratory flow, **$p<0.01$

3. Correlation Between Physical Activity Levels and Pulmonary Function

The correlation analysis between physical activity levels and pulmonary function variables showed significant correlations with FVC, FEV_1, and PEF($p<.05$)(Table 3).

Table 3. Correlation between physical activity and lung function

	PA METs	FVC	FEV_1	FEV_1 /FVC	PEF
PA METs	1	0.686**	0.668**	-0.086	0.409*
FVC	0.686**	1	0.936**	-0.206	0.332
FEV_1	0.668**	0.936**	1	0.143	0.544**
FEV_1/ FVC	-0.086	-0.206	0.143	1	0.553**
PEF	0.409**	0.332	0.544**	0.553**	1

PA: Physical Activity, FVC: Forced vital capacity, FEV_1: forced expiratory volume in 1 second, PEF: peak expiratory flow, *p<0.05, **p<0.01

4. Impact of Physical Activity Levels on Pulmonary Function

To verify the impact of physical activity levels on pulmonary function, a simple linear regression analysis was conducted(Table 4). Physical activity level was entered as the independent variable, while the pulmonary function variables FVC, FEV_1, and PEF were entered as dependent variables.

The results indicated that the regression models for FVC(F=22.198), FEV_1(F=20.135), and PEF(F=5.035) were significant($p<.05$). The independent variable, physical activity level, explained approximately 47% of the variance in FVC, 44.6% of the variance in FEV_1 and about 16.8% of the variance in PEF. These findings suggest that physical activity levels have a statistically significant impact on these pulmonary function measures.

Table 4. Linear regression models for the independent variable(physical activity level) and the pulmonary function

	FVC	FEV_1	FEV_1/FVC	PEF
β	994.007	1159.133	-12.060	0.001
Adj R^2	0.449	0.424	-0.032	0.134
R^2	0.470	0.446	-.007	0.168
F	22.198	20.135	0.187	5.035
p value	0.000	0.000	0.669	0.034
Durbin -Watson	2.081	1.831	1.180	1.190

FVC: Forced vital capacity, FEV_1: forced expiratory volume in 1 second, PEF: peak expiratory flow

Ⅳ. Discussion

The findings of this study underscore the significant impact that physical activity levels have on pulmonary function in female office workers.

A research focusing on older U.S. adults demonstrated that higher levels of physical activity were correlated with better PEF, further supporting the positive relationship between physical activity and lung function(Dong et al., 2024). In Marangoz et al.(2016) ‘s study, they reported that individuals who engage in regular exercise exhibit better lung function metrics, such as maximal voluntary ventilation(MVV), FVC, and vital capacity(VC), compared to those who lead a sedentary lifestyle. Kaneko(2020) examined the association between lung volume, respiratory muscle strength, physical activity, and sedentary behavior in older adults and found that sedentary time and the proportion of non-locomotive moderate physical activity were independently associated with FVC and PEF. This supports the notion that both the amount and type of physical activity, as well as the duration of sedentary behavior, can significantly impact lung health. Our results align with these findings, reinforcing the positive impact of physical activity on lung function.

In particular, the findings showed that the group of workers with high physical activity levels had significantly better FVC and FEV_1 values compared to the moderate activity group.

Although our study was conducted on female office workers who spend prolonged periods seated and thus has a different population than previous studies, the underlying mechanisms linking physical activity and improved pulmonary function are still relevant. This suggests that increased physical activity can lead to substantial improvements in lung function, underscoring the importance of moderate and vigorous physical activity for maintaining respiratory health.

Additionally, correlation analysis revealed significant associations between physical activity levels and pulmonary function variables, including FVC, FEV_1, and PEF. Simple linear regression analysis further indicated that physical activity levels significantly predicted FVC, FEV_1 and PEF, explaining approximately 47%, 44.6% and 16.8% of the variances, respectively. These associations underscore the critical role of physical activity in maintaining and enhancing respiratory health, indicating that physical activity levels are significant predictors of pulmonary function.

Physical activity enhances lung tissue elasticity and increases lung capacity, allowing for greater volumes of air to be inhaled and exhaled(Font-Ribera et al., 2011). Regular physical activity strengthens the respiratory muscles, improving their ability to facilitate effective breathing (Burtscher et al., 2022). This leads to higher values of FEV_1 and FVC, contributing to better FEV_1/FVC ratios and PEF.

PEF is a measure of the highest speed at which air can be expelled from the lungs. It reflects the strength and function of the respiratory muscles(Akınoğlu et al., 2019). The significant prediction of PEF by physical activity levels indicates that a variety of physical activities including regular exercise enhances the efficiency and power of these muscles, leading to better overall lung function(Macka et al., 2020; Güneş et al., 2023).

The findings have significant implications for occupational health, particularly for office workers who tend to lead sedentary lifestyles. Therefore, it highlights the importance of integrating active physical activity into daily routines to enhance pulmonary function.

This study has several limitations. First, this study involved a small number of participants, particularly none in the low-activity group. Additionally, pulmonary function is significantly influenced by age, which wasn't fully analyzed due to the limited sample size. Future studies should include a larger cohort to facilitate age-stratified analyses, providing more comprehensive insights into how age affects the relationship between physical activity levels and pulmonary function. This study used a cross-sectional study design, which may be limited in establishing a causal relationship between physical activity and lung function. It is important to evaluate the long-term effects of physical activity on lung function over time through longitudinal studies. The physical activity data used in the study relied on self-report, which is at risk of bias such as memory distortion and under/overestimation. Future research should compare physical activity METs by using objective physical activity METs measurement data instead of self-reported data in the form of questionnaires. Considering these limitations, caution is needed in interpreting the study results, and these limitations need to be addressed through follow-up studies.

Ⅴ. Conclusion

This study reveals that higher levels of physical activity positively impact the pulmonary function of female office workers. Therefore, promoting physical activity among female office workers is crucial for enhancing pulmonary health.

Reference

Ainsworth BE, Haskell WL, Herrmann SD, Meckes N, Bassett DR, Tudor-Locke C, et al. 2011 compendium of physical activities: a second update of codes and MET values. Med Sci Sports Exerc, 43;1575-1581, 2011.

Akınoğlu B, Kocahan T, Özkan T. The relationship between peripheral muscle strength and respiratory function and respiratory muscle strength in athletes. J Exerc Rehabil, 15(1);44, 2019.

Bellettiere J, Healy GN, LaMonte MJ, et al. Sedentary behavior and prevalent diabetes in 6,166 older women: the objective physical activity and cardiovascular health study. J Gerontol: Series A, 74(3);387-395, 2019.

Bouchard C, Blair SN, Haskell WL. Physical activity and health. Human Kinetics. 29, 2012.

Boudreaux BD, Romero EK, Diaz KM. Sedentary behavior and risk of cardiovascular disease and all-cause mortality in United States adults with hypertension. J Hypertens, 41(11);1793-1801, 2023.

Burtscher J, Millet GP, Gatterer H, et al. Does regular physical activity mitigate the age-associated decline in pulmonary function?. Sports Med, 52(5);963-970, 2022.

Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public

Health Rep, 100(2);126, 1985.
Clemes SA, O'connell SE, Edwardson CL. Office workers' objectively measured sedentary behavior and physical activity during and outside working hours. J Occup Environ Med, 56(3);298-303, 2014.
Desai S, Joshi O. The paradox of declining female work participation in an era of economic growth. Indian J Labour Econ, 62;55-71, 2019.
Dong Y, Jiang P, Jin X, et al. Association between long-term static postures exposure and musculoskeletal disorders among university employees: A viewpoint of inflammatory pathways. Front Public Health, 10;1055374, 2022.
Dong B, Yue Y, Wang Z, et al. Association between physical activity, peak expiratory flow, and cognitive function in aging: a cross-sectional analysis. BMC Geriatr, 24(1);460, 2024.
Dos Santos IN, de Oliveira AS, Viscardi LG, et al. Occupational risks and musculoskeletal complaints among industrial workers: a cross-sectional study. Rev Bras Med Trab, 21(2), 2023.
Evans RE, Fawole HO, Sheriff SA, et al. Point-of-choice prompts to reduce sitting time at work: a randomized trial. Am J Prev Med, 43;293-297, 2012.
Font-Ribera L, Villanueva CM, Nieuwenhuijsen MJ, et al. Swimming pool attendance, asthma, allergies, and lung function in the Avon Longitudinal Study of Parents and Children cohort. Am J Respir Crit Care Med, 183;582-588, 2011.
Forde C. Scoring the international physical activity questionnaire (IPAQ). University of Dublin, 3, 2018.
Güneş M, Yana M, Güçlü MB. Physical activity levels respiratory and peripheral muscle strength and pulmonary function in young post-COVID-19 patients: A cross-sectional study. Wien Klin Wochenschr, 135(9-10);251-259, 2023.
Hallal PC, Andersen LB, Bull FC, et al. Global physical activity levels: surveillance progress, pitfalls, and prospects. The Lancet, 21;380(9838);247-257, 2012.
Harris TB, Ferrucci L, Walsh, S, Hozawa A. Associations of Elevated C-Reactive Protein Levels with Physical Activity and Functional Limitations in Elderly Persons: Results from the Health, Aging, and Body Composition Study. Am J Epidemiol, 169(7);845-854, 2009.
Kaneko H. Association of respiratory function with physical performance, physical activity, and sedentary behavior in older adults. J Phys Ther Sci, 32(2);92-97, 2020.
Kim Y, Kim JH. Workplace physical activity and its relationship with health outcomes among office workers: A review. Occup Med J, 65(6);472-478, 2015
Mackała K, Kurzaj M, Okrzymowska P, et al. The effect of respiratory muscle training on the pulmonary function, lung ventilation, and endurance performance of young soccer players. Int J Environ Res Public Health, 17(1);234, 2020.
Marangoz I, Aktug ZB, Çelenk Ç, et al. The comparison of the pulmonary functions of the individuals having regular exercises and sedentary individuals. Biomed Res, 27(2);357-359, 2016.
Oh JY, Yang YJ, Kim BS, et al. Reliability and Validity of the Korean Version of the Short Form International Physical Activity Questionnaire (IPAQ). Korean J. Fam. Med, 28(7);532-541, 2007.
Panahi S, Tremblay A. Sedentariness and health: is sedentary behavior more than just physical inactivity? Front Public Health, 6;389159, 2018.
Ryde GC, Brown HE, Gilson ND, et al. Are we chained to our desks? Describing desk-based sitting using a novel measure of occupational sitting. J Phys Act Health, 11;13181323, 2014.
Tang KHD. The prevalence, causes and prevention of occupational musculoskeletal disorders. Glob Acad J Med Sci, 4(2);56-68, 2022.
Thorp AA, Healy GN, Winkler E, et al. Prolonged sedentary time and physical activity in workplace and non-work contexts: a cross-sectional study of office, customer service and call centre employees. Int J Behav Nutr Phys Act, 9;1-9, 2012.
Vandelanotte C, Short C, Rockloff M, et al. How do different occupational factors influence total, occupational, and leisure-time physical activity?. J Phys Act Health, 12(2);200-207, 2015.
Verdú E, Homs J, Boadas-Vaello P. Physiological changes and pathological pain associated with sedentary lifestyle-induced body systems fat accumulation and their modulation by physical exercise. Int J Environ Res Public Health,18(24);13333, 2021.