Journal of Physical Education
OPEN ACCESS
e-ISSN Online: 2774-2334
p-ISSN Online: 2774-2326
https://journal.unesa.ac.id/index.php/bimaloka/

University student participation in physical activity toward lung vital capacity differences: comparative study of smokers and non-smokers

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Received: 29/04/2025; Accepted: 30/10/2025; Published: 31/10/2025

How to cite: Putra, K. P., Al Ardha, M. A., Tingsapat, S., Wibowo, C., & Sidi, A. A. (2025). University student participation in physical activity toward lung vital capacity differences: comparative study of smokers and non-smokers. *Bima Loka: Journal of Physical Education*, *5*(2), 85–91. https://doi.org/10.26740/bimaloka.v5i2.40042

Abstrak

Merokok merupakan salah satu faktor risiko terjadinya gangguan fungsi paru, bahkan pada individu yang secara fisik aktif. Zat-zat berbahaya dalam rokok diketahui dapat mengganggu kerja paru, merusak jaringan paru, yang dalam jangka panjang dapat menurunkan kapasitas vital paru. Di sisi lain, aktivitas fisik secara teratur terbukti mampu meningkatkan kapasitas paru. Namun, belum banyak penelitian yang secara spesifik membandingkan kapasitas vital paru antara pria perokok dan bukan perokok yang sama-sama aktif secara fisik. Penelitian ini bertujuan untuk mengetahui perbedaan kapasitas vital paru antara pria perokok dan bukan perokok yang aktif secara fisik. Penelitian ini melibatkan 50 mahasiswa laki-laki berusia 20–23 tahun yang rutin berolahraga minimal dua kali seminggu. Subjek dibagi menjadi dua kelompok: 25 perokok dan 25 bukan perokok, dengan karakteristik morfologis yang serupa. Kapasitas vital paru diukur menggunakan spirometer digital yang terhubung dengan komputer. Hasil penelitian menunjukkan bahwa kelompok bukan perokok memiliki kapasitas vital paru yang secara signifikan lebih besar dibandingkan kelompok perokok, dengan selisih rata-rata sebesar 0,41 liter ($p<0,05$). Temuan ini menunjukkan bahwa meskipun sama-sama aktif secara fisik, kebiasaan merokok tetap berdampak negatif terhadap kapasitas vital paru. Perbedaan ini, meskipun tidak tergolong fatal secara fisiologis, berpotensi memengaruhi performa olahraga, khususnya dalam cabang olahraga yang bergantung pada kapasitas respirasi seperti olahraga berbasis aerobik dan freediving.

Kata-kata kunci: individu aktif, kapasitas vital paru, respirasi, merokok

Abstract

Smoking is a known risk factor for impaired lung function, even among physically active individuals. The harmful substances contained in cigarettes are known to disrupt lung function and damage lung tissue, which, over time, can reduce vital lung capacity. On the other hand, regular physical activity has been proven to enhance lung capacity. However, there is still a lack of research specifically comparing the vital lung capacity between physically active male smokers and non-smokers. This study aimed to determine the differences in vital lung capacity between physically active male smokers and non-smokers. The study involved 50 male university students aged 20–23 who regularly exercised twice weekly. Subjects were divided into 25 smokers and 25 non-smokers with similar morphological characteristics. Vital lung capacity was measured using a digital spirometer connected to a computer. The results showed that the non-smoker group had a significantly larger vital lung capacity than the smoker group, with an average difference of 0.41 liters ($p<0.05$). These findings indicate that although both groups were physically active, smoking habits still negatively impacted vital lung capacity. Although the difference

may not be fatal from a physiological standpoint, it can potentially affect sports performance, particularly in disciplines that rely heavily on respiratory capacity, such as aerobic-based sports and freediving.

Keywords: *active person; lung vital capacity; respiration; smoking*

INTRODUCTION

The human respiratory system is essential for maintaining overall health and physical fitness (Rolfe, 2019). One of the primary indicators of respiratory function is lung vital capacity (VC), which refers to the maximum volume of air that can be exhaled after a maximum inhalation. Various factors, including smoking habits and physical activity, influence vital capacity (Ramalho & Shah, 2021).

Smoking has long been a significant concern in public health due to its detrimental effects on multiple body systems. Tobacco smoke contains thousands of harmful chemicals that can trigger inflammation, oxidative stress, and the destruction of lung tissue (Li & Hecht, 2022). These cumulative effects lead to reduced lung function, an increased risk of chronic obstructive pulmonary disease (COPD), and diminished pulmonary capacity (Ruvuna & Sood, 2020). On the other hand, regular physical activity is well known to enhance cardiorespiratory function, strengthen respiratory muscles, and improve ventilatory efficiency (Sukadiono et al., 2022).

However, among physically active individuals, particularly males who engage in regular exercise, it remains unclear to what extent smoking habits affect lung vital capacity. Does physical activity offer a protective effect against lung damage caused by smoking, or does the negative impact of smoking persist regardless of physical activity levels? This question becomes increasingly relevant given the significant number of physically active individuals, including athletes and recreational exercisers, who continue to smoke (Omare et al., 2021; Osullivan et al., 2021).

This research is important because there is a clear gap in scientific knowledge regarding the interaction between smoking habits and physical activity and lung function, particularly vital capacity. Most studies have compared lung function between smokers and non-smokers without considering physical activity as a potential modifying factor. However, in both the general population and sports communities, it is common to encounter physically active smokers (Heydari et al., 2015; Kaczynski et al., 2008), and the scientific understanding of the consequences remains limited.

Furthermore, understanding the cumulative effects of two contrasting lifestyle factors (smoking and exercise) will help design more targeted health promotion and preventive strategies. If physical activity does not fully mitigate the detrimental effects of smoking on lung function, then health campaigns must be more specifically directed and evidence-based. Conversely, if exercise is found to provide partial protection against lung function decline, rehabilitation programs for smokers could incorporate structured physical activity interventions.

This study is essential as it will provide scientific insights into the interaction between healthy behaviors (physical activity) and unhealthy habits (smoking) and lung function. This study examines the differences in lung vital capacity among physically active individuals who smoke and those who do not smoke. The findings are expected to serve as a foundation for health education initiatives, early prevention of respiratory dysfunction, and the development of targeted health interventions for physically active smokers.

METHOD

This analytic observational study investigates the differences in lung vital capacity between physically active male smokers and non-smokers. The subjects in this study are 50

males aged 20-23 years old who actively engage in any kind of physical exercise, a minimum of twice a week. They are divided into two groups: the smoker group, comprising 25 subjects, and the non-smoker group, comprising 25 subjects. The subjects were selected using purposive sampling by applying inclusion and exclusion criteria. The inclusion criteria applied are male, age between 20-23 years old, non-athlete but actively engage in physical exercise at least twice a week as recreational activity with minimum of 30 munites per day, chest circumference between 80-90 cm, body weight between 55-60 kg, height between 165-170 cm, no history of respiratory diseases, not currently ill or undergoing specific medical treatments, and willing to participate in the study by signing an informed consent form. The exclusion criteria encompass any conditions that do not meet the inclusion criteria. The Faculty of Medicine and Health Science, Satya Wacana Christian University Research Ethics Committee evaluated and approved the research design, Ethical Approval Number 3/26.04/2023041101/EA/2023.

All subjects who met the inclusion criteria were asked to provide their consent by signing an informed consent form. Spirometry tests were then performed on all subjects from both groups using a MIR Spirobank II spirometer that is connected to a computer. Each subject underwent the spirometry test three times, and the highest recorded value was used for analysis. All tests were conducted in a seated position, and subjects were instructed not to look at the monitor during the procedure to minimize the risk of intentionally altering their breathing pattern. The values for lung vital capacity were displayed directly on the computer screen in Liters (L). There was no special conditioning of the subjects before the spirometry examination. The subjects were not asked to fast or to stop smoking in the case of smokers. Thus, the subjects' condition during the spirometry test was expected to reflect their everyday state, not an artificially altered one. The data from both groups were first used to determine their mean differences. Next, a normality test was conducted to assess the normal distribution of the data. Subsequently, an independent t-test was performed to determine whether there was a significant difference between the data of the two groups.

RESULT

Table 1 indicates that the non-smoker group appears to have a larger lung vital capacity (approximately 0.41 liters) than the smoker group. The results of the normality test using the Kolmogorov-Smirnov and Shapiro-Wilk test (Table 2) showed that the data were normally distributed for each group ($\alpha>0.05$). The independent t-test was conducted to compare the mean of each group (Table 3). The independent t-test results indicate a significant difference ($p<0.05$) between the data of the two groups.

Table 1. Descriptive statistics

Group	N	Mean (L)	Std. Deviation	Min (L)	Max (L)
Smokers	25	3.26	0.51	2.1	4.26
Non-Smokers	25	3.67	0.50	2.52	4.54

Table 2. Results of the normality test

Group	Kolmogorov-Smirnov			Saphiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Smokers	0.09	25	0.20*	0.98	25	0.96*
Non-Smokers	0.12	25	0.20*	0.95	25	0.40*

Table 3. Results of the independent t-test

	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	SE
Equal variances assumed	0.00	0.95	2.78	48	0.00*	0.40	0.14

The results indicate a difference in lung vital capacity of 0.41 liters between the smoker and non-smoker groups. Both groups should have benefited from the physical activity habit, but the smoker group, surprisingly, has a lower lung vital capacity compared to the non-smoker group. It remains uncertain whether this is due to specific mechanisms resulting from the smoking habit, which leads to a decrease in lung vital capacity, or if smokers do not receive the benefits of increased lung vital capacity from physical activity habit due to the hindrance caused by smoking habits.

DISCUSSION

This study's findings indicate a significantly lower lung vital capacity among smokers, even though all subjects were physically active males with similar morphological characteristics. While a difference of 0.41 liters or approximately 12.6% may not seem clinically alarming, it reveals that smoking habits continue to impair physiological function despite regular physical activity. This is important because physical activity is generally known to enhance lung function (Fuertes et al., 2018). The fact that smokers fail to attain this expected improvement implies that the deleterious effects of smoking might override the benefits of exercise, at least in terms of lung volume (Sapada et al., 2023).

In real-world sports settings, differences in lung vital capacity may be less observable, especially since athletic performance depends on a combination of physiological, psychological, technical, and tactical factors. It is not uncommon to encounter athletes who smoke yet still perform well (Moslemi-Haghighi et al., 2011). This observation might lead to the misconception that smoking does not significantly impair performance. However, lung capacity remains a key component of VO_2max and aerobic endurance, which are critical in most sports, particularly endurance disciplines. The lowered lung capacity observed in smokers could mean a reduced VO_2max, which in turn may prevent these individuals from reaching their full athletic potential, especially in sports demanding prolonged oxygen delivery or breath-hold capacity, such as running, cycling, swimming, or freediving (Putra, Karwur, et al., 2020; Putra, Pratama, et al., 2020).

The social acceptability of smoking among young adults and amateur athletes might contribute to the persistence of this habit. Previous studies have shown that smoking prevalence remains relatively high among university students, including those involved in sports (Saiphoklang et al., 2020). This is particularly concerning given that student-athletes are expected to model healthy behaviors. The behavior may stem from the fact that many of them are not professional athletes, and therefore do not face the same performance pressures that might otherwise motivate a smoke-free lifestyle. Moreover, amateur athletes or recreational exercisers may engage in sports solely for enjoyment or social reasons, without a strong commitment to optimizing performance or long-term health.

Smoking, like air pollution, affects the cardiorespiratory system through mechanisms such as airway inflammation, increased mucus production, changes in mucus properties, oxidative stress, and alveolar damage (de Paula Santos et al., 2021; Dondi et al., 2023; Kress et al., 2022). These conditions, although sometimes subclinical in young smokers, can limit respiratory efficiency and recovery, particularly under high physical demand. Hence, even if a decline in lung vital capacity may not immediately translate into medical pathology, it still constitutes a barrier to optimal physiological function (Tainio et al., 2021). This becomes especially relevant for individuals involved in sports that require high lung volumes or breath control.

This study highlights the importance of addressing smoking behavior in physically active populations. The damage caused by smoking may be silent and gradual, yet it is measurable and impactful (Caliri et al., 2021). Health and fitness educators, coaches, and

policymakers must continue to emphasize that physical activity cannot fully negate the harmful effects of smoking (Edwards, 2004). On the contrary, smoking may hinder the full realization of exercise-induced adaptations. Future studies are needed to investigate the exact pathophysiological mechanisms by which smoking suppresses improvements in lung function, as well as to develop effective intervention strategies tailored for active populations.

CONCLUSION

This study concludes a significant difference in lung vital capacity between physically active male smokers and non-smokers, with the smoker group exhibiting a lower vital capacity of 0.41 liters (approximately 12.6%). Despite engaging in regular physical activity, smokers do not attain the same pulmonary benefits as non-smokers, suggesting that smoking may impair the positive adaptations typically gained from exercise. These findings underscore the persistent negative impact of smoking on lung function and highlight the need for stronger health education and preventive strategies targeting smoking behavior, particularly among young and physically active individuals.

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