

The Relationship between Oxygen Saturation and Forced Vital Capacity (FVC) of the Lungs in Older Adults

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Abstract. Oxygen saturation in older adults tends to decline as a result of physiological changes in the lungs and the cardiovascular system. In this population, forced vital capacity (FVC) of the lungs decreases due to alterations in lung elasticity, respiratory muscle weakness, and increased resistance in the small airways. Evaluating the relationship between these two parameters is important for understanding age-related physiological changes in respiratory function. This study aimed to analyze the relationship between oxygen saturation and forced vital capacity in older adults. This study employed an analytical observational design with a cross-sectional approach. The study subjects consisted of 72 older adults who met the inclusion and exclusion criteria and were selected using purposive sampling. Oxygen saturation was measured using a standard pulse oximeter, while forced vital capacity was assessed using a digital spirometer. Data were analyzed using a correlation statistical test with a predetermined level of significance. The results showed that there was no significant relationship between oxygen saturation and forced vital capacity in older adults ($p > 0.05$). Although variations in oxygen saturation and FVC values were observed among the study subjects, the relationship between the two variables did not demonstrate a statistically significant correlation. This study concludes that oxygen saturation is not significantly associated with forced vital capacity in older adults; therefore, these two parameters may be considered independent indicators in the assessment of pulmonary function in the elderly population.

Key words: FVC; older adults; oxygen saturation; spirometry

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INTRODUCTION

The increasing proportion of the elderly population represents a global demographic shift that has led to a growing burden of age-related health problems, particularly those affecting the respiratory system. Aging is accompanied by progressive structural and functional changes in the lungs, including reduced pulmonary elasticity, diminished respiratory muscle strength, and increased stiffness of the chest wall. Collectively, these changes contribute to a gradual decline in pulmonary ventilatory function, most notably reflected by a reduction in Forced Vital Capacity (FVC). Importantly, decreased FVC in older adults has been consistently associated with reduced functional capacity, limitations in physical activity, and an elevated risk of morbidity and mortality (Lee, 2017).

Beyond structural deterioration, aging-related pulmonary changes also affect gas exchange efficiency. In this context, peripheral oxygen saturation (SpO₂) serves as a practical, non-invasive indicator of systemic oxygenation and is widely used in both clinical and community health settings. In older adults, lower SpO₂ values may arise from impaired ventilation, altered ventilation-perfusion matching, or reduced alveolar diffusion capacity. Previous studies have demonstrated that compromised pulmonary function is associated with reduced SpO₂ levels at rest and during low-intensity activities, thereby highlighting the



interdependence between ventilatory capacity and oxygenation status (Cunha et al., 2023). Moreover, decreased oxygen saturation has been shown to adversely affect exercise tolerance and overall quality of life in the elderly population (Kang, 2022).

Despite these established associations, the existing literature predominantly focuses on populations with specific pulmonary pathologies, such as chronic obstructive pulmonary disease (COPD), or on individuals undergoing targeted clinical interventions. Consequently, evidence regarding the direct relationship between peripheral oxygen saturation and Forced Vital Capacity in community-dwelling older adults remains limited. Several studies have prioritized alternative pulmonary parameters or evaluated the effects of respiratory training interventions without explicitly examining SpO₂ as a correlate of FVC (Sedaghati et al., 2023; Weinmayr et al., 2020). This gap underscores the need for further investigation into whether SpO₂ can serve as a simple surrogate marker for early declines in lung capacity among the elderly.

Addressing this gap, the present study offers a novel contribution by systematically examining the relationship between peripheral oxygen saturation and Forced Vital Capacity in an elderly population using an observational framework. In addition to evaluating the primary association, this study incorporates common aging-related risk factors, including nutritional status and smoking habits, to provide a more comprehensive understanding of pulmonary function decline. Such an approach is expected to strengthen the evidence base for using SpO₂ as a feasible and accessible screening tool for the early identification of reduced lung function in older adults (Isnaeni et al., 2024).

Accordingly, this study aims to analyze the relationship between peripheral oxygen saturation (SpO₂) and Forced Vital Capacity (FVC) in older adults. The findings are anticipated to inform promotive and preventive strategies for maintaining respiratory health in the elderly and to support evidence-based clinical decision-making in primary healthcare settings (de Sousa Dias et al., 2022).

METHODS

This study employed an analytic observational design with a cross-sectional approach to examine the relationship between oxygen saturation and forced vital capacity (FVC) of the lungs in older adults. The cross-sectional design was selected to allow the simultaneous assessment of both variables within a defined population at a single point in time. The study was conducted in August 2025 in Lopana Village, East Amurang District, South Minahasa Regency. The target population consisted of all community-dwelling older adults aged ≥ 60 years who were registered and actively participated in elderly integrated health service (Posyandu Lansia) activities. From this population, a total of 72 participants were recruited using purposive sampling based on predefined inclusion and exclusion criteria. The inclusion criteria comprised older adults who were able to communicate effectively, demonstrated cooperative behavior, and were willing to participate as respondents by providing written informed consent. The exclusion criteria included older adults with a history of acute pulmonary disease, severe cardiovascular disease, or any condition that could interfere with pulmonary function assessment. In the present study, oxygen saturation was designated as the independent variable, whereas forced vital capacity (FVC) served as the dependent variable.

Data collection procedures were standardized to minimize measurement bias. Oxygen saturation was measured using a YX103 digital finger pulse oximeter while the participants were in a seated position and at rest. Subsequently, forced vital capacity was assessed using a standard spirometer in accordance with the American Thoracic Society (ATS) guidelines. Each FVC measurement was performed three times, and the highest value was selected for analysis.

to ensure measurement reliability. All measurements were conducted by the principal investigator and trained healthcare personnel.

In addition to the primary variables, demographic and clinical characteristics—including age, sex, body mass index, and smoking habits—were collected through structured interviews to provide a comprehensive description of the study population. These data were used to support the interpretation of the main findings.

Data analysis was performed using IBM SPSS Statistics version 23. Descriptive analysis was used to summarize the characteristics of the participants. Categorical variables were presented as frequencies and percentages, whereas numerical variables were presented as means or other appropriate measures of central tendency according to the data distribution. Data normality was assessed using the Kolmogorov–Smirnov test to determine the distribution of oxygen saturation and pulmonary forced vital capacity (FVC) variables. The association between oxygen saturation and pulmonary FVC was analyzed using the Spearman rank correlation test, as both variables were not normally distributed. A p-value of < 0.05 was considered indicative of statistical significance. This study received approval from the Health Research Ethics Committee.

RESULTS AND DISCUSSION

The results indicated that the majority of respondents were female, with fewer male participants (Table 1). Sex-related differences have important implications for pulmonary function, as men typically exhibit larger lung volumes and greater forced vital capacity due to differences in body size and thoracic anatomical structure. However, in older adults, these differences may diminish as a consequence of physiological aging processes and reduced lung elasticity. Therefore, the predominance of female respondents in this study should be carefully considered when interpreting the relationship between oxygen saturation and forced vital capacity (Ekström et al., 2017).

Table 1. Distribution of Respondents by Sex

Sex	n	Percentage (%)
Man	30	41.67
Woman	42	58.33
Total	72	100

The age distribution of the respondents indicated that most participants belonged to the young elderly group (60–69 years), with a smaller proportion classified as older elderly (Table 2). Increasing age is closely associated with a decline in pulmonary function resulting from structural and functional changes, including reduced alveolar elasticity, decreased respiratory muscle strength, and increased chest wall stiffness. These age-related alterations directly contribute to a reduction in forced vital capacity and may also influence oxygen saturation. Previous studies have shown that the decline in lung function occurs progressively with advancing age; therefore, age constitutes an important confounding factor in the analysis of the relationship between oxygen saturation and forced vital capacity in the elderly population (Thomas et al., 2019).

Table 2. Distribution of Respondents by Age

Age group (years)	Frequency (n)	Percentage (%)
60-69 (young elderly)	44	61.11
70-79 (middle-aged elderly)	26	36.11
≥ 80 (elderly people)	2	2.78
Total	72	

The distribution of respondents' body mass index (BMI) encompassed a range of categories, including underweight, normal weight, overweight, and obesity (Table 3). Based on the Body Mass Index (BMI) classification table, the majority of participants had a normal nutritional status, comprising 49 individuals (68.06%). This finding indicates that most older adults included in this study had BMI values within the normal range according to the classification criteria used. Participants classified as underweight accounted for 12 individuals (16.66%), indicating that a proportion of the older adults still had an inadequate nutritional status. This condition warrants attention, as underweight status in older adults may be associated with reduced muscle mass, physical frailty, and an increased risk of adverse health outcomes. The overweight category included 9 participants (12.50%), whereas only 2 participants (2.78%) were classified as having Class I obesity. No participants were categorized as having Class II obesity (0%). These findings suggest that the prevalence of overweight and obesity in the study population was relatively low compared with the proportion of participants who had a normal BMI. Recent evidence indicates that the combined assessment of BMI and sarcopenia status is more effective in predicting functional decline and health outcomes in older adults than BMI alone (Chalerm Sri et al., 2022).

Table 3. Distribution of Body Mass Index (BMI) of Respondents

Body Mass Index	Amount	Percentage (%)
Underweight	12	16.66
Normal	49	68.06
Overweight	9	12.50
Obesity 1	2	2.78
Obesity 2	-	-
Total	72	100

Implications for the Relationship Between Oxygen Saturation and Pulmonary Forced Vital Capacity

Considering the characteristics of the respondents, sex, age, and BMI emerge as key factors that can influence pulmonary function and oxygen saturation in older adults. Therefore, controlling for these variables is essential when analyzing the relationship between oxygen saturation and forced vital capacity to ensure that the findings accurately reflect the true association. These results highlight the importance of adopting a comprehensive approach when assessing respiratory function in the elderly population (Santana et al., 2018).

In this study, the mean forced vital capacity (FVC) among elderly participants was 1.99 liters (Table 4), reflecting age-related physiological changes in the respiratory system. Declines in pulmonary tissue elasticity, reductions in respiratory muscle strength, and increased chest wall stiffness collectively impair the lungs' ability to achieve maximal inspiration and expiration. Current spirometry standards recognize that a reduction in FVC is a common occurrence in older adults, even in those without overt pulmonary disease (Graham et al., 2019).

Table 4. Mean Values of Forced Vital Capacity and Oxygen Saturation

	Amount (n)	Average
SpO2 (%)	72	98.77
KVP (L)	72	1.99

Conversely, the mean oxygen saturation of 98.77% indicates that pulmonary oxygenation remained within the normal range (Table 4). This is likely due to the capacity of the aging respiratory and cardiovascular systems to maintain an adequate ventilation–perfusion balance and efficient gas diffusion at rest. Previous studies have demonstrated that, despite age-related declines in lung volume and ventilatory capacity, peripheral oxygen saturation can remain normal in the absence of significant pulmonary or cardiovascular disorders (Skloot, 2017).

Table 5. Data distribution test result

Kolmogorov-Smirnov ^a			
	Statistic	df	Sig.
KVP	.278	72	.000
SpO2	.179	72	.000

The normality of the data was evaluated using the Kolmogorov–Smirnov test for samples larger than 50, which yielded a p-value of < 0.05 (Table 5). This result indicates that the data were not normally distributed. Consequently, due to the non-normal distribution, Spearman's correlation test was used to assess the relationship between oxygen saturation and forced vital capacity.

Relationship Between Oxygen Saturation and Forced Vital Capacity

Spearman correlation analysis in this study revealed a correlation coefficient of $r = -0.205$ with a significance value of $p = 0.084$ (Table 6). This indicates a very weak negative relationship between oxygen saturation and forced vital capacity (FVC) in the elderly. However, because the p-value exceeds the threshold for statistical significance ($p > 0.05$), it can be concluded that no statistically significant relationship exists between oxygen saturation and FVC in the studied population. These findings suggest that changes in FVC do not necessarily correspond to alterations in peripheral oxygen saturation in elderly individuals at rest.

Table 6. Spearman correlation test results

		SpO2	KVP
Spearman's rho	SpO2		
	Correlation Coefficient	1.000	-.205
	Sig. (2-tailed)	.	.084
	N	72	72
	KVP		
	Correlation Coefficient	-.205	1.000
	Sig. (2-tailed)	.084	.
	N	72	72

The aging process physiologically results in reduced lung elasticity, increased chest wall stiffness, and decreased respiratory muscle strength, all of which contribute to a decline in pulmonary vital capacity. However, in elderly individuals without severe pulmonary disorders, compensatory ventilation and perfusion mechanisms are often sufficient to maintain oxygen saturation within the normal range. As a result, declines in pulmonary function do not necessarily manifest as changes in SpO₂ values. These findings are consistent with previous reports indicating that resting oxygen saturation tends to remain stable despite age-related reductions in spirometric parameters (Thomas et al., 2019; Schneider et al., 2021).

Oxygen saturation measured by pulse oximetry reflects peripheral blood oxygenation rather than pulmonary ventilatory capacity directly. The accuracy of SpO₂ measurements can be affected by factors such as peripheral perfusion, extremity temperature, skin pigmentation, and cardiovascular conditions, which are commonly observed in older adults. These factors may cause variations in SpO₂ values that are not directly related to forced vital capacity (FVC), resulting in a weak or non-significant correlation between the two variables (Shi et al., 2022; Poorzargar et al., 2022).

The results of this study align with previous research indicating that, in elderly populations or individuals without severe obstructive lung disease, the relationship between resting oxygen saturation and spirometric parameters is often non-significant. Conversely, stronger correlations are typically observed in populations with chronic pulmonary conditions, such as chronic obstructive pulmonary disease (COPD) or pulmonary fibrosis, particularly when measurements are taken during physical activity or exercise testing (Dias, 2022; Li et al., 2024).

The lack of a significant relationship observed in this study may be partly due to its cross-sectional design, which captures data at a single point in time and cannot reflect the dynamic changes between declining pulmonary function and oxygenation status. Furthermore, the sample size and variability in participant characteristics—such as nutritional status, physical activity, and comorbidities—may have acted as confounding factors influencing the correlation analysis (Yan et al., 2024).

Clinically, these findings indicate that measuring oxygen saturation alone is insufficient to assess pulmonary function in older adults accurately. Therefore, the evaluation of respiratory function in the elderly should adopt a comprehensive approach, combining spirometry, clinical assessment, and other functional tests. Future studies are recommended to use longitudinal designs, recruit larger sample sizes, and include oxygen saturation measurements during physical activity to provide a more precise understanding of the relationship between oxygen saturation and forced vital capacity in older adults.

CONCLUSION

The results of this study showed that there was no statistically significant association between oxygen saturation and pulmonary forced vital capacity (FVC) among older adults residing in Lopana Village, East Amurang District, South Minahasa Regency ($p > 0.05$). This finding indicates that changes in pulmonary FVC among the participants were not accompanied by meaningful changes in oxygen saturation levels. This may be explained by the fact that oxygen saturation reflects the blood oxygenation status, whereas FVC represents pulmonary ventilatory function. In older adults who are at rest and do not have severe respiratory disorders, physiological compensatory mechanisms may still maintain oxygen saturation within the normal range despite age-related declines in pulmonary function. Therefore, these two parameters did not demonstrate a significant association in the study population.

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