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Strength Training and Pulmonary Function Among Students at Universitas Kristen Indonesia

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ABSTRACT

This study examined changes in vital capacity (VC) and forced expiratory volume in one second (FEV1) following strength training among students at Universitas Kristen Indonesia. A quasi-experimental pre-test-post-test study recruited 40 male students aged 17–23 years through purposive sampling. Twenty students performed strength training for 6–8 weeks, while 20 controls did not receive the training programme. Spirometry measured VC and FEV1 before and after the study period. Shapiro–Wilk tests, paired t-tests, and independent samples t-tests assessed the data. Mean VC increased from 3.9500 to 4.2435 L in the training group and decreased from 3.9630 to 3.9460 L in controls. Mean FEV1 increased from 74.20% to 85.25% in the training group and from 77.75% to 77.85% in controls. Within-group improvements in the training group were significant for both outcomes ($p < .001$), whereas control-group changes were not significant. The source reported significant between-group differences in change scores for both outcomes ($p < .001$). Strength training was associated with improved pulmonary measurements in this sample. Nonrandom allocation, unequal smoking distributions, and inconsistencies in reported change scores limit causal interpretation

INTRODUCTION

University students may spend substantial time in sedentary academic activities. Physical activity therefore remains relevant to student health and physical conditioning. The World Health Organization (2020) recommends regular aerobic activity and muscle-strengthening activities for adults. Resistance exercise provides a distinct training stimulus that warrants investigation alongside aerobic exercise.

Pulmonary function can be assessed through spirometric measurements. Vital capacity (VC) describes the maximum volume exhaled after a maximal inspiration, while forced expiratory volume in one second (FEV1) measures the volume exhaled during the first second of a forced expiration. These parameters reflect different aspects of respiratory performance. Their interpretation requires attention to individual characteristics and measurement quality (Pellegrino et al., 2005).

Previous research provides experimental evidence linking resistance and endurance exercise to pulmonary adaptation (Khosravi et al., 2013). However, results from other populations and exercise modalities cannot directly establish the response of students to a university-based strength-training programme. A local comparison of trained and untrained students can provide preliminary evidence, provided that differences in baseline characteristics and training exposure receive careful consideration.

This study examined changes in VC and FEV1 among students at Universitas Kristen Indonesia over a 6–8-week period. It compared pre-test and post-test measurements within each group and assessed differences in change scores between students who performed strength training and those who did not.

LITERATURE REVIEW

Strength Training and Respiratory Adaptation

Strength training uses external resistance or body weight to challenge skeletal muscles. Training frequency, intensity, exercise selection, and progression determine the stimulus and influence adaptation (Ratamess, 2012). The physiological rationale in the thesis links improved muscular performance and thoracic stability to more effective ventilation. This pathway is plausible, but the present study did not directly measure respiratory muscle strength or thoracic mechanics.

Khosravi et al. (2013) examined pulmonary function following endurance and resistance training. Their work provides a basis for evaluating strength training as a potential contributor to pulmonary adaptation. Differences in participant characteristics and programme design nevertheless require caution when comparing studies.

Pulmonary Outcomes and Study Hypotheses

VC and FEV1 serve as complementary outcomes. VC represents an exhaled volume, whereas FEV1 captures early forced expiratory performance. FEV1 appears as a percentage in the source results; the source does not specify the reference equation underlying this percentage. The article therefore retains the reported unit without treating it as a measured volume in litres.

H1: Changes in VC differ between students who perform strength training and students who do not perform the training programme.

H2: Changes in FEV1 differ between students who perform strength training and students who do not perform the training programme.

The conceptual framework links strength-training exposure to changes in VC and FEV1. Age, smoking status, body size, and other physical activity may influence these outcomes. The study reports age and smoking status but does not provide an adjusted model for these potential confounders.

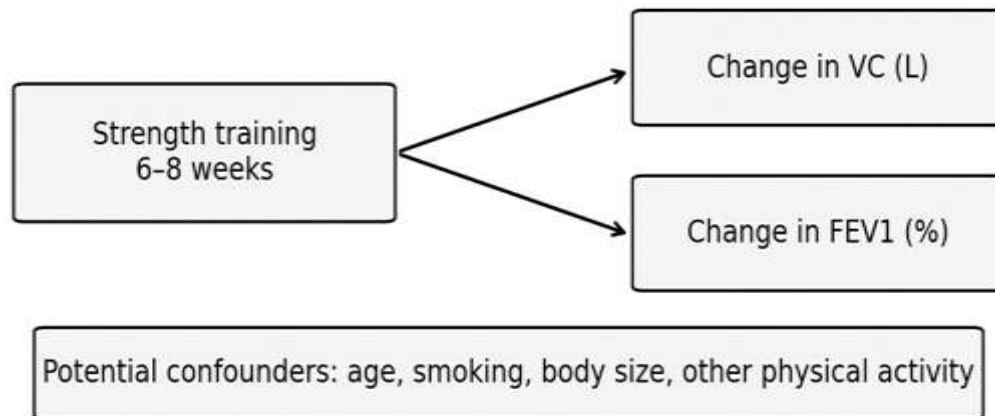


Figure 1. Conceptual Framework

METHODOLOGY

Design and Setting

The study used a quasi-experimental design with intervention and control groups assessed before and after the study period. Data collection took place from October to December 2025 at the Integrated Laboratory of the Faculty of Medicine and the Sport and Health Center of Universitas Kristen Indonesia. The source does not report random assignment.

Participants and Sampling

The researchers recruited 40 active male students from the 2022–2025 entry cohorts through purposive sampling. Participants were 17–23 years old, agreed to follow the study procedures, and provided informed consent. The study excluded students with respiratory diseases, including asthma, bronchitis, tuberculosis, and chronic obstructive pulmonary disease, and those with injuries or mobility limitations that could interfere with exercise. Each group included 20 students.

The thesis used the Federer expression, $(t - 1)(n - 1) \geq 15$, where t denotes the number of groups and n denotes participants per group. With two groups, the expression yielded at least 16 participants per group. The researchers enrolled 20 per group. This calculation was not an outcome-specific statistical power analysis.

Training Exposure and Measurements

The training group performed strength training for 6–8 weeks. Reported training frequency was three to five sessions per week. Controls did not receive the strength-training programme. A modified IPAQ-SF questionnaire and interviews captured exercise habits and participant characteristics. The source does not provide sufficient details on exercise selection, load, sets, repetitions, session duration, progression, or adherence to reproduce the programme fully.

The researchers measured vital signs before spirometry and used a calibrated digital spirometer to assess VC and FEV1. They entered demographic and anthropometric information, instructed participants to seal their lips around the mouthpiece and close the nose, and guided maximal inspiratory and expiratory manoeuvres. They repeated instructions and measurements up to three times when necessary. The thesis does not document the spirometer model, prediction equation, or formal acceptability and repeatability criteria.

Statistical Analysis and Ethics

SPSS supported descriptive and inferential analysis. Frequencies and percentages describe participant characteristics. Means and standard deviations summarize pulmonary measurements. Shapiro–Wilk tests assessed normality. Paired samples t-tests compared measurements within groups, and independent samples t-tests compared changes between groups. The significance threshold was $p < .05$. All reported analyses derive from the supplied thesis; no participant-level reanalysis was possible.

The thesis states that the Faculty of Medicine of Universitas Kristen Indonesia granted ethical approval and that participants signed informed consent forms. The researchers protected personal information and minimized disruption to academic activities.

RESULTS

Participant Characteristics

The sample included 40 male students. Most participants were 21 years old. The training and control groups each contained 20 students. Smoking was more common in controls than in the training group (Table 1).

Table 1. Participant Characteristics and Training Exposure

Characteristic	Category	n	%
Age (years)	17	1	2.5
Age (years)	18	4	10.0
Age (years)	19	10	25.0
Age (years)	20	5	12.5
Age (years)	21	17	42.5
Age (years)	22	2	5.0
Age (years)	23	1	2.5
Training exposure	3–5 sessions/week	20	50.0
Training exposure	No training	20	50.0
Smoking, training group	Smoker	8	40.0
Smoking, training group	Nonsmoker	12	60.0

Characteristic	Category	n	%
Smoking, control group	Smoker	13	65.0
Smoking, control group	Nonsmoker	7	35.0

Note. Age and training percentages use the total sample (N = 40); smoking percentages use the respective group denominator (n = 20).

Pulmonary Measurements

Table 2. Pulmonary Measurements Before and After the Study Period

Outcome	Group	Pre-test, mean $\pm$ SD	Post-test, mean $\pm$ SD
VC (L)	Training	3.9500 $\pm$ 0.74713	4.2435 $\pm$ 0.70178
VC (L)	Control	3.9630 $\pm$ 0.59189	3.9460 $\pm$ 0.59022
FEV1 (%)	Training	74.2000 $\pm$ 22.21095	85.2500 $\pm$ 21.82677
FEV1 (%)	Control	77.7500 $\pm$ 22.70144	77.8500 $\pm$ 23.07032

Mean VC and FEV1 increased in the training group. Controls showed a small decrease in VC and a small increase in FEV1. Table 2 uses the more precise descriptive values reported in the thesis narrative

Normality and Within-Group Comparisons

Table 3. Shapiro-Wilk Normality Tests

Variable	Training pre	Training post	Control pre	Control post
VC	.721	.795	.995	.998
FEV1	.406	.574	.267	.254

The reported normality-test p values exceeded .05. Tests of change scores yielded p = .211 for VC and p = .388 for FEV1. The source does not specify separate change-score tests for each group

Table 4. Paired Samples T-Tests as Reported in the Source

Outcome	Group	Mean pre – post	SD of difference	t	p
VC (L)	Training	-0.29935	0.17617	-7.451	< .001
VC (L)	Control	0.01700	0.05602	1.356	.191
FEV1 (%)	Training	-11.05000	6.43571	-7.679	< .001
FEV1 (%)	Control	-0.10000	2.48998	-0.180	.859

Within-group changes were statistically significant in the training group for both outcomes. Neither outcome changed significantly in controls. Negative differences in Table 4 indicate higher post-test values because the paired comparison uses pre-test minus post-test.

Between-Group and Smoking Subgroup Comparisons

Table 5. Between-Group Differences in Change Scores Reported in the Source

Outcome	Reported mean difference	p
VC (L)	0.312	< .001
FEV1 (%)	11.10	< .001

The source reports significant differences in change scores between groups. These results support the stated hypotheses at the reported significance level, subject to the numerical verification issues described below. FEV1 differences represent percentage-point changes in the reported percentage measure.

Table 6. Descriptive Changes by Smoking Status

Group	Smoking status (n)	VC change, mean $\pm$ SD (L)	FEV1 change, mean $\pm$ SD
Training	Smoker (8)	0.14 $\pm$ 0.06	9.50 $\pm$ 4.24
Training	Nonsmoker (12)	0.40 $\pm$ 0.14	12.08 $\pm$ 7.56
Control	Smoker (13)	-0.03 $\pm$ 0.06	-1.15 $\pm$ 1.57
Control	Nonsmoker (7)	0.01 $\pm$ 0.05	2.00 $\pm$ 2.83

The training-group nonsmokers had larger descriptive changes than smokers. No subgroup significance tests or smoking-adjusted effect estimates were reported; these observations do not establish an interaction between training and smoking.

DISCUSSION

The findings indicate that students who performed strength training had improved VC and FEV1 measurements over the study period. Controls showed little change. The direction of the findings is consistent with the proposed physiological rationale and with research examining pulmonary responses to endurance and resistance training (Khosravi et al., 2013). However, the numerical inconsistencies in the source prevent a definitive statement about the exact magnitude of the training effect.

Improved muscular performance and respiratory coordination may help explain the observed changes. Strength training can produce neuromuscular adaptation, which provides a possible basis for more effective breathing manoeuvres (Ratamess, 2012; Powers et al., 2021). The study did not measure inspiratory pressure, expiratory pressure, or respiratory muscle activation. These mechanisms therefore remain interpretations rather than demonstrated mediators.

VC and FEV1 require separate interpretation. A change in VC can reflect altered maximal ventilatory performance, while FEV1 depends on the forced expiratory manoeuvre and airway-related factors. Spirometry also depends on participant effort and measurement quality (Pellegrino et al., 2005). Repeated testing may introduce familiarization effects, and the limited documentation of acceptability and repeatability restricts assessment of measurement reliability. Smoking deserves particular attention because its distribution differed between groups. The source's smoking-stratified results show different descriptive responses, but the analysis did not adjust for smoking or other potential confounders. Nonrandom recruitment may also select students with different baseline fitness, motivation, or exercise habits. Similar baseline mean pulmonary measurements alone do not eliminate these differences.

The study contributes preliminary evidence from a university setting. Its findings can inform the design of a more standardized trial, but they do not establish long-term respiratory benefit, prevention of respiratory disease, or efficacy in women or patients with lung disease. Those conclusions would require different populations, stronger allocation procedures, and additional outcome measures.

CONCLUSIONS AND RECOMMENDATIONS

Students who performed strength training for 6–8 weeks showed significant within-group improvements in VC and FEV1 in the supplied analysis. Controls showed no significant within-group changes, and the thesis reported significant between-group differences. The findings suggest an association between strength training and improved pulmonary measurements in this sample of male students. The exact effect estimates require reconciliation before journal submission.

A university exercise programme may use these findings to guide further evaluation of structured strength training. Programme documentation should specify exercise type, load, progression, frequency, adherence, and spirometry quality controls. Researchers should also account for smoking, body size, baseline fitness, and other physical activity when estimating training effects.

FURTHER STUDY

This research still has its limitations, so further studies on the topic of Strength Training and Pulmonary Function Among Students at Universitas Kristen Indonesia are needed to improve this research and provide more insights for readers and the author.

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