

Effect Of an Eight-Week Deep Breathing Program on Vital Capacity in Female Physiotherapy Students: A Pre-Test Post-Test Study

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Abstract—Deep-breathing exercises are commonly used in physiotherapy to improve respiratory function, but evidence regarding their effect on vital capacity in healthy young adults is limited. This study assessed changes in vital capacity following an eight-week structured deep-breathing program in female physiotherapy students. A single-group pretest–posttest design was used, with 100 participants having complete pre- and post-intervention measurements. Participants performed structured deep-breathing exercises twice daily for eight weeks, and vital capacity was assessed before and after the intervention. Vital capacity increased from 2.806 ± 0.346 L to 3.700 ± 0.525 L, with a mean increase of 0.894 ± 0.558 L. The pre- to post-intervention difference was statistically significant (Wilcoxon $W = 22.0$, $p < 0.001$). An eight-week structured deep-breathing program was associated with a significant improvement in vital capacity. However, the absence of a control group limits causal interpretation, and controlled studies are recommended to confirm these findings.

I. INTRODUCTION

Vital capacity is an important measure of pulmonary function and reflects the maximum volume of air that can be expired after a maximal inspiration. Assessment of lung volumes and ventilatory function is widely used in respiratory and rehabilitation research. Accurate respiratory-function measurement depends on standardized testing procedures and appropriate interpretation of the measured variables. The American Thoracic Society and European Respiratory Society emphasize standardized procedures for obtaining reliable spirometric measurements.^[1]

Respiratory function is influenced by several factors, including age, sex, body dimensions, physical activity,

respiratory muscle performance, and habitual breathing pattern. In young adults, respiratory function is generally well preserved; however, lifestyle factors and physical inactivity may influence cardiorespiratory fitness and breathing behavior. Physiotherapy students represent a population in which breathing exercises may be particularly relevant because respiratory assessment and therapeutic breathing techniques form part of physiotherapy education and clinical practice.

Breathing exercises are commonly used in physiotherapy to facilitate control of breathing, improve thoracoabdominal movement, and optimize respiratory muscle activity. Diaphragmatic breathing is characterized by greater contribution of the diaphragm and abdominal movement during inspiration. Experimental work in healthy individuals has demonstrated that breathing exercises can alter breathing pattern, including increasing tidal volume and modifying the contribution of the abdomen and rib cage during respiration.^[2]

There is also evidence that diaphragmatic breathing may influence pulmonary-function measurements. In a study of healthy adults, diaphragm breathing exercise produced significant changes in functional vital capacity and slow vital capacity following the intervention.^[3] Other experimental research has reported improvements in respiratory-function variables following structured diaphragm-respiration exercise, suggesting that repeated respiratory exercise may influence lung volumes and respiratory muscle performance.^[4]

The potential physiological effects of diaphragmatic breathing are not limited to changes in breathing

pattern. Research using incentive spirometry and diaphragmatic breathing has demonstrated changes in diaphragmatic mobility, supporting the concept that respiratory exercises can modify the mechanical behavior of the respiratory system.^[5] In addition, a systematic review and meta-analysis of diaphragmatic breathing interventions in clinical populations found improvements in selected pulmonary-function measures, although the evidence varied according to the population and intervention protocol.^[6]

Evidence from healthy young adults is also relevant to the present study. Previous research involving college students has demonstrated significant improvements in vital capacity following programs incorporating breathing exercises, although the absence of control groups in some studies makes it difficult to determine whether the observed improvement can be attributed exclusively to breathing practice.^[7] More recent research has similarly reported improvements in pulmonary-function measures following breathing-based interventions in young adults.^[8]

Despite these findings, the effects of a structured deep-breathing program on vital capacity in female physiotherapy students remain of interest. This population is relatively young and generally has an understanding of therapeutic exercise techniques, making it appropriate for investigating a standardized breathing intervention. Furthermore, a simple breathing program that can be performed regularly without specialized exercise equipment may have practical applications in physiotherapy education and health-promotion settings.

The present study therefore examined changes in vital capacity following an eight-week structured deep-breathing intervention among female physiotherapy students. A single-group pretest–posttest design was used, with vital capacity assessed before and after the intervention. The primary objective was to determine whether vital capacity demonstrated a significant change following the intervention.

Aim-

To evaluate the change in vital capacity following an eight-week structured deep breathing program in female physiotherapy students.

Objectives-

1. To assess vital capacity at baseline and following completion of the deep breathing intervention.

2. To evaluate the change in vital capacity after the eight-week breathing program.
3. To examine the significance of the difference between baseline and post-intervention vital-capacity measurements.
4. To quantify the improvement in vital capacity associated with the intervention.

II. MATERIALS AND METHODS

Study Design –

A single-group pretest–posttest study design was used to evaluate changes in vital capacity following an eight-week structured deep-breathing intervention.

Participants

Participants were female physiotherapy students aged 18–25 years who met the predefined eligibility criteria for the study. Participants with pathological conditions likely to affect vital capacity and those regularly participating in other exercise or yoga programs were excluded. For the present analysis, 100 participants with complete paired pre- and post-intervention vital-capacity measurements were included. Participants with incomplete paired measurements were excluded from the final analysis.

Intervention

Participants performed structured deep diaphragmatic breathing for eight weeks. The exercise was performed in a crook-lying/semi-Fowler's position, with the shoulders relaxed and the upper chest kept relatively quiet while allowing abdominal movement during inspiration.

Participants were instructed to inhale deeply, hold the breath for approximately six seconds, and then exhale slowly through the mouth. The breathing exercise was performed twice daily, in the morning and before bedtime, with 15 repetitions per session according to the original study protocol.

The physiological rationale for diaphragmatic breathing is supported by previous research demonstrating changes in breathing pattern and thoracoabdominal motion during diaphragmatic breathing exercises.^{1, 2}

Assessment of Vital Capacity

Vital capacity was assessed using an incentive spirometer and recorded in liters.

Before assessment, the procedure was demonstrated to each participant. Participants were seated with the back and upper limbs supported and were instructed to perform a maximal respiratory maneuver through the mouthpiece. The original protocol required participants to perform three readings, with a rest period of approximately 10–13 seconds between attempts. The highest of the three readings was recorded as the participant's vital-capacity value. Standardized pulmonary-function testing procedures emphasize consistent participant positioning, appropriate instructions, repeatability, equipment quality control, and standardized measurement procedures to improve the reliability of respiratory measurements.³

Outcome Measures

The primary outcome measure was vital capacity measured in liters.

Measurements were obtained at:

- Baseline: before commencement of the intervention.
- Post-intervention: following completion of the eight-week breathing program.

The same measurement procedure was used at both assessment points.

Ethical Considerations

Ethical clearance was obtained from the relevant institutional ethics committee before commencement of the study. The study procedure was explained to eligible participants, and written informed consent was obtained from all participants before participation.

Statistical Analysis

Data were analyzed using descriptive and inferential statistical methods. Continuous variables, including pre- and post-intervention vital capacity, were summarized using mean $\pm$ standard deviation (SD), along with the median and minimum–maximum range to describe the central tendency and variability of the measurements. The change in vital capacity for each participant was also calculated by subtracting the pre-intervention value from the post-intervention value. As the study involved repeated measurements obtained from the same participants before and after the eight-week intervention, the pre- and post-intervention observations were considered paired and were not treated as independent samples. The primary

inferential analysis was performed using the Wilcoxon signed-rank test, a non-parametric test appropriate for comparing two related measurements obtained from the same individuals. The test assessed whether there was a statistically significant difference in vital capacity between the pre-intervention and post-intervention measurements. The null hypothesis stated that there was no systematic difference in vital capacity between the two time points, whereas the alternative hypothesis stated that a difference existed. A two-sided p -value < 0.05 was considered statistically significant. The magnitude and direction of change were additionally described using the mean and median change in vital capacity. Statistical results were interpreted in conjunction with the descriptive findings to determine whether vital capacity demonstrated an improvement following the structured deep-breathing intervention.

Results-

The final analysis included 100 participants with complete paired pre- and post-intervention vital-capacity measurements. The mean pre-intervention vital capacity was 2.806 ± 0.346 L, which increased to 3.700 ± 0.525 L following the eight-week structured deep-breathing intervention. The median vital capacity increased from 2.780 L at baseline to 3.560 L post-intervention. Pre-intervention values ranged from 2.10 to 3.50 L, while post-intervention values ranged from 3.10 to 4.67 L.

The mean individual increase in vital capacity was 0.894 ± 0.558 L, with a median increase of 0.780 L. Individual changes ranged from -0.260 to $+2.220$ L, indicating some variability in response to the intervention. Overall, most participants demonstrated an improvement in vital capacity following the intervention.

The Wilcoxon signed-rank test showed a statistically significant difference between pre- and post-intervention vital-capacity measurements ($W = 22.0$, $p < 0.001$). A paired-samples t -test also demonstrated a statistically significant pre–post difference ($t(99) = 16.02$, $p < 0.001$), supporting the consistency of the observed improvement.

These findings indicate a significant increase in vital capacity following the eight-week structured deep-breathing program.

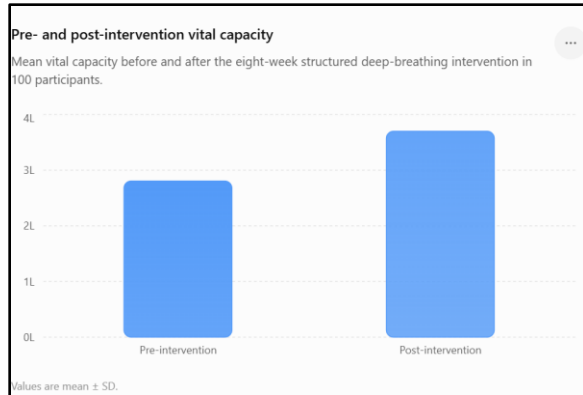


Figure 1. Pre- and post-intervention vital capacity.

Table 1. Descriptive statistics of vital capacity

Parameter	Pre-intervention	Post-intervention
Sample size	100	100
Mean (L)	2.806	3.700
SD (L)	0.346	0.525
Median (L)	2.780	3.560
Minimum (L)	2.10	3.10
Maximum (L)	3.50	4.67

Table 2. Change in vital capacity

Parameter	Value
Mean change	+0.894 L
SD of change	0.558 L
Median change	+0.780 L
Minimum change	-0.260 L
Maximum change	+2.220 L

III. DISCUSSION

The present study evaluated the changes of an eight-week structured deep-breathing program on vital capacity in female physiotherapy students. The analysis of 100 complete paired observations demonstrated a significant increase in vital capacity following the intervention. Mean vital capacity increased from 2.806 ± 0.346 L at baseline to 3.700 ± 0.525 L after the intervention, representing a mean increase of 0.894 ± 0.558 L. The Wilcoxon signed-rank test demonstrated a statistically significant pre- to post-intervention difference ($W = 22.0$, $p < 0.001$). The observed improvement is physiologically plausible because diaphragmatic breathing emphasizes controlled diaphragmatic excursion and coordinated thoracoabdominal movement. Previous research in healthy adults has demonstrated that diaphragm-focused breathing exercises can influence

pulmonary-function measures, including functional and slow vital capacity. Yong et al. reported significant changes in functional vital capacity and slow vital capacity following diaphragm-breathing and feedback-breathing exercises in healthy adults.^[1] The improvement observed in the present study may also be related to repeated practice of a controlled breathing pattern. Regular deep breathing may facilitate greater awareness of respiratory movement and improve coordination of the respiratory musculature. Earlier research on breathing control has reported beneficial effects on measures related to respiratory mechanics, including abdominal movement, diaphragm excursion and tidal volume, although the magnitude and consistency of effects have varied between studies.^[2]

Evidence from more recent research also supports a potential relationship between diaphragmatic breathing and pulmonary function. Ristovski et al. reported that a brief diaphragmatic-breathing intervention in healthy young adults produced significant improvements in chest expansion and forced vital capacity compared with the control condition.^[3] Although their intervention was acute and their outcome was forced vital capacity rather than the vital-capacity measure used in the present study, the findings provide additional physiological support for investigating breathing-based interventions in healthy young adults.

The magnitude of improvement observed in the present dataset was relatively large, with a mean increase of approximately 0.894 L. This finding should, however, be interpreted cautiously. The present study used a single-group pretest–posttest design without a control group. Consequently, the observed improvement cannot be attributed exclusively to the breathing intervention. Familiarization with the respiratory measurement procedure, improved participant effort during the second assessment, changes in physical activity, motivation, or other changes occurring during the eight-week period may have contributed to the observed difference.

This limitation is particularly important when interpreting respiratory-function outcomes. Breathing interventions can influence breathing pattern and respiratory performance, but evidence varies according to the population, intervention protocol, duration and outcome measure. A recent systematic

review of diaphragmatic-breathing randomized controlled trials found considerable heterogeneity in intervention parameters and methodological quality, emphasizing the need for standardized and adequately controlled studies.^[4]

Evidence from clinical populations also provides supportive but indirect evidence. A systematic review and meta-analysis of diaphragmatic breathing in individuals following stroke found significant improvements in forced vital capacity, FEV₁ and peak expiratory flow compared with control conditions.^[5] Similarly, a meta-analysis of pursed-lip and diaphragmatic breathing interventions in individuals with COPD reported improvements in several pulmonary-function outcomes.^[6] However, these populations differ substantially from the healthy young female physiotherapy students included in the present study. Therefore, findings from clinical populations should not be directly generalized to the present population.

The present findings are particularly relevant from a physiotherapy perspective because structured breathing exercises are relatively simple and can be incorporated into exercise and rehabilitation programs. Nevertheless, the evidence should be interpreted as demonstrating a significant within-participant change, rather than establishing definitive treatment efficacy. A randomized controlled trial with an appropriate comparison group would provide stronger evidence regarding the independent effect of the breathing intervention.

Another consideration is the use of vital capacity as the primary outcome. Contemporary pulmonary-function assessment generally recommends standardized spirometry procedures and appropriate quality-control criteria to improve measurement reliability.^[7] Future studies should therefore use standardized spirometric assessment and report relevant parameters such as FVC, FEV₁, FEV₁/FVC, predicted values and quality-control indicators where appropriate.

The present study also has practical relevance because the intervention does not require complex equipment or specialized training beyond appropriate instruction. This may make structured breathing exercises feasible in educational and community physiotherapy settings. However, the feasibility and effectiveness of such programs should be evaluated prospectively with

adherence monitoring and standardized intervention dosage.

An additional strength of the present analysis is the availability of participant-level paired observations, allowing the magnitude and direction of individual changes to be examined rather than relying solely on group means. Nevertheless, the analysis was restricted to 100 complete paired observations, and the underlying dataset should be verified against the original study records before publication.

Finally, the present findings should be interpreted in the context of the previous publication from which the study originated. The earlier publication reported significant improvement in vital capacity following the breathing intervention, but the aggregate values reported in that publication differ from those obtained from the current participant-level dataset. Therefore, the present manuscript should be transparently described to the journal as a reanalysis/revised presentation of previously published study data, rather than as an entirely independent new study.

IV. CLINICAL IMPLICATIONS-

The present findings indicate that an eight-week structured breathing program may be associated with improvement in vital capacity.

From a physiotherapy perspective, breathing exercises may be considered as an accessible component of respiratory exercise programs. They can be taught with relatively minimal equipment and may be suitable for supervised or educational settings.

However, the present findings should be regarded as evidence of an association within a single-group pre-post design rather than definitive evidence of treatment efficacy.

Strengths-

The study has several strengths:

1. A clearly defined pre-intervention and post-intervention outcome was available.
2. Participant-level measurements allowed calculation of individual change scores.
3. The same participants were evaluated before and after the intervention.
4. A non-parametric paired analysis was used to account for the paired nature of the measurements.
5. The intervention was relatively simple and potentially reproducible.

V. LIMITATIONS

1. The study used a single-group pretest–posttest design without a control group.
2. The sample consisted only of female physiotherapy students, limiting generalizability.
3. The analysis was restricted to participants with complete paired pre- and post-intervention measurements, which may have resulted in exclusion of participants with incomplete data.
4. Familiarization with the respiratory measurement procedure may have influenced post-intervention performance.
5. The intervention was not objectively monitored for adherence throughout the eight weeks.

VI. CONCLUSION

The present analysis demonstrated a statistically significant increase in vital capacity following an eight-week structured deep breathing program.

Among 100 complete paired observations, mean vital capacity increased from 2.806 ± 0.346 L before the intervention to 3.700 ± 0.525 L after the intervention. The mean individual improvement was 0.894 ± 0.558 L, and the Wilcoxon signed-rank test demonstrated a statistically significant pre-post difference ($W = 22.0$, $p < 0.001$).

The findings suggest that structured deep breathing may be associated with improved vital capacity in female physiotherapy students. Nevertheless, controlled randomized studies are needed to establish whether the observed improvement can be attributed specifically to the intervention.

Ethics Statement-

Ethical approval was obtained from the institutional ethics committee prior to commencement of the study. The study procedures were explained to all eligible participants, and written informed consent was obtained from participants who agreed to participate.

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