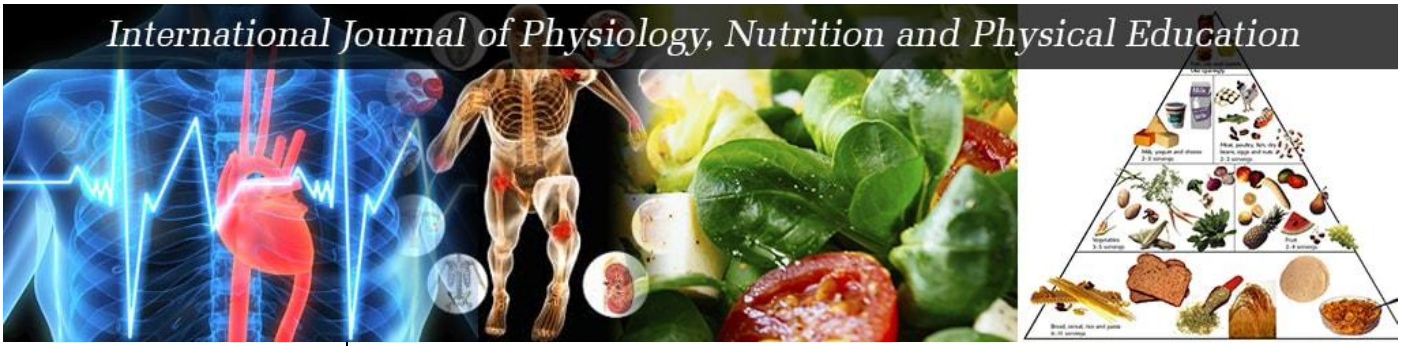

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Effect of pranayama on tidal volume of lungs

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Abstract
The volume of air that enters or exits the lungs during each respiratory cycle is known as the tidal volume. It is an essential clinical measure that enables appropriate breathing. Oxygen from the ambient air enters the lungs when a person breathes. After that, it diffuses to arterial blood via the alveolar-capillary contact. At the same time, as long as metabolism occurs, carbon dioxide will continue to form. The purpose of expiration is to release carbon dioxide and keep it from building up within the body. Tidal volume is the term used in physiology to describe the amount of inspired and expired air that contributes to stable blood levels of carbon dioxide and oxygen. The main objective of this study was to do a systematic review to examined the effects of pranayama intervention on tidal volume of lungs. Data was collected from PubMed and Web of Science. Randomized controlled trials published in English from the inception of the database until 20th October, 2025, were included. It may be concluded that strengthening respiratory muscles, enhancing lung and chest wall expansion, and conditioning the body for deeper, more efficient breathing are the main causes of the increase in tidal volume brought on by pranayama.

Keywords: Yoga, pranayama, tidal, volume, lungs

Introduction

The lungs are in charge of producing a tidal volume that can sustain sufficient ventilation. But creating accurate tidal volumes requires intricate coordination between the brain's respiratory centre and the breathing muscles. The rate and depth of breathing are controlled by the respiratory pacemaker located in the brainstem. The brainstem receives information from central and peripheral chemoreceptors that adjust the pacemaker's firing pattern and rate in response to variations in blood oxygen and carbon dioxide levels. In response, the diaphragm and other inspiratory muscles change the breathing rate and tidal volume. Maintaining appropriate blood levels of carbon dioxide and oxygen is the goal. The conducting airways, which go from the nose to the terminal bronchioles, and the gas-exchanging airways, which run from the respiratory bronchioles to the lungs' alveoli, make up the respiratory tract in terms of function. The parts of the lungs that fill with air but do not take part in gas exchange are referred to as dead space. The anatomical dead space, or air in the conducting airways, is the main factor that determines dead space. Conversely, alveoli that fill with air but do not take part in gas exchange are referred to as alveolar dead space. In essence, tidal volume is the sum of an individual's breaths. It is among the primary factors that determine alveolar and minute ventilation. The quantity of air that enters the lungs each minute is measured by minute ventilation, which is also referred to as total ventilation. It is the result of multiplying the tidal volume by the respiratory rate. In contrast, alveolar ventilation accounts for physiological dead space. It shows how much air enters the respiratory zone each minute. Tidal volume x respiratory rate equals minute ventilation. Respiratory rate x (tidal volume-dead space) equals alveolar ventilation. Alveolar ventilation depicts true ventilation since it takes dead space into account. Tidal volume and respiratory rate typically contribute equally to minute ventilation. In other words, the minute ventilation increases by the same amount when either of them is doubled. However, increasing tidal volume is a more effective method of alveolar ventilation than increasing respiratory rate. Therefore, alveolar ventilation is improved more by increasing tidal volume than by doubling respiratory rate [1].

Yoga means 'union': 'the oneness of all things' [2]; 'the union of mind, body, and spirit'; 'the unity between us and the intelligent cosmic spirit of creation'. Pranayama (literally, "control of prana") is therefore more than just breathing techniques. You can influence the energy constellation that is your body mind by using pranayama [3]. "Life force" or "life energy" is what Prana is. Yama: "control" or "discipline". Ayama: "non-restraint, " "expansion, " or "extension". Relaxation, exercise (asanas), breathing control (pranayama), a healthy diet, and meditation and positive thought are the five pillars of yoga. Pranayama is a type of yoga breathing practice that expands the lungs' capacity. The regulation of inspiration and expiration is known as pranayama [4]. Shwasa is the inspiration of prana-vayu, prashwasa is the expiration, and pranayama is the cessation of both. Pranayama enhances the body's general function. Regular pranayama practice expands the chest wall and improves nearly every lung function. There is solid scientific evidence supporting the well-documented positive effects of various pranayama [2, 3]. Pranayama enhances the respiratory system and effectively uses the diaphragmatic and abdominal muscles [4]. The respiratory musculature is strengthened by yoga, which causes the chest and lungs to expand and contract as much as possible and the muscles to work as hard as they can [5, 6].

Aim of the study

The purpose of this review was to assess pranayama's impact on tidal volume and explain the mechanism behind it.

Methods

A systematic literature search was conducted in PubMed, Web of Science, and J-Store with no data restrictions, up to 20th October, 2025. Yoga training intervention studies along with pranayama were included. In total, data from 1035 participants in 271 and 18 research articles were included for the synthesis of this review regarding measures of Tidal Volume. This methodological approach guarantees a thorough yet adaptable study appropriate for collecting the wide range of information on Pranayama on tidal volume, albeit not exactly following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses criteria. The review emphasizes the need for more investigation to determine Pranayama's effectiveness on tidal volume. The inclusion criteria; non-randomized research, commentaries, and those without main data or pertinent outcomes were not included. In order to illustrate Pranayama's influence on tidal volume, the researcher narratively aggregated data on study design, sample size, interventions, and outcomes.

Result and Discussion

The sympathetic and parasympathetic nerve systems can be brought into balance with the aid of pranayama. We can affect the neurological system by breathing. By addressing aberrant breathing patterns and lowering respiratory muscle tone, pranayama may facilitate bronchodilatation [8, 9, 10]. Both the inspiratory and expiratory muscles become stronger with yoga practice [11]. Bhastrika Pranayama is a bellows-style breathing technique that works both the inspiratory and expiratory muscles by requiring quick, powerful breathing. Breathing exercises such as Kapalbhati encourage the client to engage the diaphragm and abdominal muscles to their fullest capacity when breathing by using short, strong exhalation strokes followed by a rapid succession of contractions. Additionally, it aids in the clearance of secretions from the bronchial tree, which opens up the alveoli and respiratory tubes to allow for more air to enter [1]. The respiratory musculature is strengthened by yoga, which causes the lungs and chest to expand and contract as much as possible and the muscles to work as hard as they can. The diaphragm is used in abdominal breathing, which requires the least amount of effort to perform. Intercostal muscles are used during chest breathing [10]. It's not as effective [13]. The person's central and peripheral chemoreceptors become accustomed to the anoxia through regular breath holding exercise; the body accomplishes this by producing hypometabolism. Longer breath holds and a lessened need to breathe while doing so are the results of this. Furthermore, breath holding is supported by the training of stretch receptors in the respiratory muscles, chest wall, and alveolar walls [14]. The voluntary breath-holding period increases with pranayama training. The chemoreceptors' adaptation to hyper apnoea could be the cause of this [15]. Slow and extended inhalation and expiration occur during pranayama. It strains the collagen and elastin fibres that are strung throughout the lung parenchyma. As a result, these fibres elongate more [16]. Regular inhalation and expiration for extended periods of time during pranayama training would acclimate central and peripheral chemoreceptors to hypoxia and hyper apnoea [17]. After practicing pranayama, research by Bhargava MR *et al*. revealed a statistically significant increase in breath holding time [18]. The lung tissue and the cortex are more synchronized when the stretch receptors are acclimated. Breath holding time increases with continuous pranayama training [18, 19]. Yoga's ability to improve lung function and reduce mast cell degranulation may also be explained by the frictional stress caused by air passing through constricted airways, which damages the mucosa of the airways and prolongs airway inflammation and obstruction. Certain Pranayama use calm, smooth breathing that may reverse the process by stabilizing mast cell degranulation by lowering frictional stress [20]. Endotoxins are the primary mediator of byssinosis and obstructive lung disorders, according to an increasing number of studies [21]. The lungs' total capacity is increased via deep inspiration, air retention, and delayed expiration, which also gradually enhances the lungs' ability to ventilate. Vital energy flows to maintain the body's normal homeostasis as a result of these organs functioning properly, which aids in the prevention, management, and recovery of numerous respiratory conditions [22].

Conclusions

Pranayama can help healthy peoples to increase tidal volume of lungs, which will help them avoid respiratory illnesses in the future. Pranayama's positive effects can be applied as an adjuvant treatment for a variety of respiratory conditions. In order to sustain improved physical and mental health, the daily practice could also be a component of programs for physical fitness and lifestyle improvement. Therefore, it may be concluded that pranayama increases forceful expiratory lung volumes and chest wall expansion, which enhance respiratory breathing capacity.

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