

The Breath of Life: Breathing Techniques as Effective “Medicine”

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Abstract

Breathing is a fundamental activity of all living organisms and is necessary for life. Although breathing is a priority, greater than 90% of living organisms use less than 50% of their breathing capacity efficiently. How a person breathes affects the functions of their entire body. Breathing exercises are regularly recommended to maintain mental peace, alleviate stress, improve psychophysiological function, and organ performance. Yoga relieves stress, depression, anxiety, and various acute or chronic mood disorders. Physical postures (asanas), breathing techniques (pranayamas) and meditation practices (dhyana) are the components of yoga that unite the mind, body, and spirit. Yogic breathing involves following a recommended breathing pattern and movements to positively affect immune function, regulate any imbalance in the autonomic nervous system, manage psychological and stress-related disorders and alleviate physiological functions, which help improve quality of life (QoL). If an individual is purposeful, these exercises are easy to learn, positively impacting life and behavior. Several experimental and computational studies support the benefits of controlled breathing methods on overall well-being. Each type of yoga provides unique physiological and psychological advantages attributed to posture, the use of mouth and nostrils, frequency and duration of breathing, laryngeal muscle contraction, glottis position, and tidal capacity. Practicing yoga is generally considered safe, although special populations—such as older individuals and those with high-risk diseases—require appropriate consultation before undergoing such practices. This review provides an overview of breathing-related practices, such as breathing as a non-pharmacological intervention to manage and overcome stress and other breathing disorders.

Keywords: Anxiety; Depression; COVID-19; Diaphragm; Heart Failure; Hernia; SARS-Cov2-2019; Stress; Yoga

Abbreviations

ADHA: Attention-Deficit/Hyperactivity Disorder; ALA: American Lung Association; ART: Auditory Reaction Time; BHT: Breath-Holding Time; COPD: Chronic Obstructive Pulmonary Diseases; DB: Diaphragmic Breathing; EEG: Electroencephalogram; FEV1: Forced Expiratory Volume in the First Second; FVC: Forced Vital Capacity; HPA: Hypothalamic-Pituitary-Adrenal; MDD: Major Depressive Disorder; MVV: Maximum Voluntary Ventilation; PANSS: Positive and Negative Syndrome Scale; PEFR: Peak Expiratory Flow Rate; PTSD: Post-Traumatic Stress Disorder; QoL: Quality of Life; RCT: Randomized Controlled Trial; VC: Vital Capacity; VRT: Visual Reaction Time

Introduction

Breathing is a vital life activity. The regulated breathing and meditation serve as a bridge between the mind, body, and spirit—helping a person to live more in the moment, away from distractions [1]. Various breathing techniques help spiritual awakening, meditation practice, and self-healing introspection. An exponential increase in the practices of yoga, Buddhism, and Tai Chi was observed during 1960–1970, called the Consciousness-Raising Era [2,3].

Psychological studies have reported breathing practices as effective therapy [4] to reduce depression, anxiety, and stress-related disorders [5,6]. Anxiety was significantly decreased in pregnant women who practiced 5 minutes of abdominal breathing for 30 continuous sessions [7].

A 3-day intervention study by Woo-Jeong, *et al.* (2010) involving pregnant women, highlighted that practicing breathing techniques 3 times a day lessened anxiety symptoms [8]. Michelle., *et al.* (2011) found that practicing breathing exercises for a day helped relieve exhaustion from emotional stress and depersonalization from “burnout” at the workplace [9]. Patients with chronic back pain reported considerable exercise improvement in anxiety and depression in a 7-day intensive residential yoga program, including *pranayama*, a type of breathing exercise [10].

Discussion

Appropriate breathing practice

Although breathing is a natural process, the benefits can be improved by using the correct breathing method. The American Lung Association (ALA) provides advice on following the correct breathing practices, such as using the nose and belly, avoiding overthinking, following a healthy lifestyle, and monitoring air quality.

The ALA has also recommended two distinct types of breathing: diaphragmatic (belly) breathing and pursed-lip breathing. It is imperative to follow both exercises for 5–10 minutes daily. The proper breathing method begins in the nose, forming the path toward the stomach as the diaphragm begins to contract, the belly expands and the lungs fill with air.

The fundamental action of proper breathing is to inhale through the nose to flow through the belly to achieve muscle lengthening. Similarly, to attain muscle shortening, breathe out slowly and exhale air through the mouth [11]. An adult person’s regular, optimal respiration rate at a resting state is 12–16 breaths per minute. This rate increases with illness, fever, and other medical conditions. Observing difficulty in breathing is an alert for evaluating any respiratory-related disease [12].

Health conditions affecting breathing patterns

- Lung conditions, such as asthma, pneumonia, chronic obstructive pulmonary disease (COPD), emphysema, pulmonary embolism, and pulmonary hypertension, can disrupt the airways, causing breathing difficulties.
- Cardiac conditions, such as coronary artery disease, congenital heart disease, arrhythmia, and congestive heart failure, can also affect breathing patterns.
- Environmental triggers, such as allergies to dust, pollen, or mold, can adversely affect breathing. Individuals—susceptible to specific allergies, under persistent stress, or having a history of chronic lung or cardiac disease—are at a greater risk of breathing problems than others without such complications.
- Low oxygen availability and intake at high altitudes can alter breathing patterns.
- Emotional triggers, such as anxiety and stress, can increase the respiratory rate with adverse effects.
- Physical triggers, such as blocked air passages and phlegm formation, cause mechanical obstruction.
- A hiatal hernia can also cause chest pain, heartburn, and difficulty swallowing, leading to altered and labored breathing.
- Obesity and extreme physical exertion, such as exercising under oppressive environmental conditions, can lead to strained breathing, adversely affecting respiratory patterns [13,14].

Mechanisms of altered breathing

Cortisol is a steroid hormone released when stress conditions are triggered, being associated with depression, anxiety, and negative emotions. The hypothalamic-pituitary-adrenal (HPA) axis controls cortisol activity and regulates metabolism, mental processing, and immunity. Inhalation of CO₂ leads to changes in plasma cortisol levels. Increased salivary cortisol levels have often been associated with heightened stress or agitation. However, even with the availability of these structured data, evidence linking emotion, attention, breathing, and cortisol is limited [4].

The diaphragm regulates the breathing pattern [4]. Deep breathing, also known as diaphragmatic breathing, is the correct breathing practice. In deep breathing, the diaphragm is contracted, and the belly is expanded with deep inhalation and passive exhalation. The cycles of diaphragmatic breathing decrease the frequency of respiration and maximize blood oxygen [15].

Breathing techniques

Various breathing techniques can be employed to treat specific health conditions or ameliorate symptoms (Figure 1).



Figure 1: Various types of breathing techniques currently used for their beneficial effects.

Qigong (pronounced as chee-gong) is an ancient healing practice in China. It is considered a therapeutic and meditative exercise related to Eastern medicine. It combines controlled breathing, meditation (as an essential element), and gentle movement to improve mental, physical, and spiritual status. In particular ways, it is similar to *Tai Chi*, which treats various health conditions, such as heart disease, high blood pressure, diabetes, insomnia, and back pain. *Qigong* practice can be active or passive. The active type of *Qigong* includes slow and controlled movements to increase and direct the energy through the body’s meridians, whereas the passive form involves calm breathing and stillness [16].

Kozo Nishino, a Japanese *Ki*-expert, established the Nishino breathing technique, which helps improve overall health and well-being. A collaborated study by Ohnishi., *et al.* (2006) revealed that Nishino’s *Ki*-energy (the energy of life or vitality) could inhibit cancer cell division and protect mitochondria from heat deterioration [17].

Pranayama, also known as yogic breathing, enhances psychological, biochemical, metabolic, neurocognitive, and respiratory functions. As such, it is helpful in the management of various clinical conditions. Yogic breathing practices are of various types, differing in the method and body posture. The following are some of the *pranayama* types:

- *Kapalabhati* (abdominal breathing)
- *Bastrika* (bellow’s breath)
- *Nadishodhana/Nadishuddhi* (alternate nostril breathing)
- *Suryanuloma Viloma* (right uninostril breathing)
- *Chandranuloma Viloma* (left uninostril breathing)
- *Suryabhedana* (right nostril-initiated breathing)
- *Ujjayi* (psychic breathing)
- *Bhramari* (female honeybee humming breathing) [18].

Ancient Indian texts on *pranayama* and yogic breathing cite that brain activity from these practices is influenced in various ways, and this notion is supported by previous studies [19].

Researchers explored the electroencephalogram (EEG) observations to identify the significance of breathing patterns, which are linked to the body and mind, during health and disease states. About 15 min of *Kapalabhati* was reported to positively affect neurocognitive abilities [20].

Bhastrika significantly reduced anticipatory response time [21], and *Mukha Bhastrika* significantly reduced auditory reaction time (ART) and visual reaction time (VRT) in school children [22].

According to Bhavanani., *et al.* (2012), an immediate reduction in ART and VRT parameters follow breathing practices in mentally disabled or challenged adolescents, who generally have higher reaction times than their healthy counterparts [23].

Randomized controlled trials (RCTs) have shown that more participants achieve mental relaxation, with only 33% experiencing anxiety compared to 67% in the control group [24].

Emotional improvements and decreased adverse effects were observed in individuals practicing distinct breathing techniques that enrich the mind and body interconnection.

The detrimental impact of stress, anxiety, and negative emotions can be counteracted by meditation, relaxation, and breathing techniques. These homeostatic interventions influence the interrelationship between respiration and emotions [25].

Breathing modulation has been adapted as a non-pharmaceutical therapy for treating depression [26], insomnia [27], and post-traumatic stress disorder (PTSD) [28]. A study by Seppälä, *et al.* (2014) analyzed the startle effects of regular *Sudarshan Kriya yoga* on veterans with PTSD and suicidal symptoms. The study found a reduction in PTSD symptoms, respiration rate, and anxiety in the veterans.

In *Sudarshan Kriya*, the stimulus of feared memories is decoupled from that of respective fear responses in which individuals re-experience the traumatic events—but in a relaxed, breathing-induced physiological state—that helps them control the senses. Once the intervention is completed, traumatic memories no longer affect the person strongly [29].

The application of “breathing therapy” in specific psychological disorders or conditions

Researchers are keen to discover complementary therapies for treatment that may result in fewer medications.

Attention-deficit/hyperactivity disorder (ADHD)

ADHD is characterized by impaired motor activities, impacting children’s health, globally. It is a complex trait disorder influenced by environmental and genetic factors. The EEG patterns demonstrate differences during waking and dream states in this population.

Researchers have investigated the positive effects of mind-body therapies on the autonomic nervous system function [30]. Although interventional therapy is the current standard of treatment, a combination of medications and behavioral therapy has effectively reduced ADHA symptoms [31].

In addition to yogic practices of physical posture, mediation, and breathing techniques, *Sahaja Yoga Meditation* as a family therapy program has been shown to reduce ADHD symptoms, resulting in a decreased medicine dosage [30,32].

Through a combination of persistent attention to breath and movements, Tai Chi has also been shown to lessen the symptoms of anxiety and hyperactivity in ADHD-affected individuals. Mindfulness-based meditation and breathing therapy significantly improves attention, performance, and self-reported ADHD symptoms [30].

Schizophrenia

The current treatment for severe mental illnesses—such as schizophrenia, bipolar disorder, and major depressive disorder (MDD), which present a heterogeneous cluster of symptoms—is pharmacological agents with follow-up monitoring.

Psychotic spectrum disorders

Various studies support the importance of yoga and breathing practices in treating many psychotic spectrum disorders. Improvements in the total positive and negative syndrome scale (PANSS) score with sub-scale measurement of the emotional effect, blunt, abstract thinking, and spontaneity are particularly useful [31–34].

Mindfulness and meditation significantly improved PANSS scores by reducing stress, anxiety, depression, and recovery time [33]. Cognitive remediation-techniques, including yoga, are considered an effective adjuvant therapy to medications for treating schizophrenia, bipolar disorders, and other spectra of mood disorders [33,34]. However, more RCTs are required to examine cognitive behavioral therapy as an intervention in this population, and establish data on the regimens’ frequency, duration, and intensity [34].

Chronic obstructive pulmonary disease (COPD)

Individuals with COPD experience altered breathing patterns and shortness of breath, especially during exercise. A study by Holland, *et al.* (2012) evaluated diaphragmatic breathing (deep abdominal-focused breathing), *pranayama* yoga and pursed-lip breathing and monitored respiratory rate and exhalation time. All three techniques improved breathing, but the specific variable for shortness of breath was different for each patient. Further research is warranted to determine the effectiveness of these techniques as adjuvant therapy in the population with COPD [13].

Beneficial physiological effects of slow and controlled breathing

The physiological effects of slow and controlled breathing are beneficial when coupled with a bidirectional network of respiratory and cardiovascular receptors, muscles, and neurons—listed as follows.

- **Respiratory:** The mechanism improves ventilation efficiency, increases arteriolar oxygenation, and reduces alveolar dead space. It also improves diaphragmatic excursion [14].
- **Cardiovascular:** The mechanism increases venous return, which augments stroke volume and cardiac output, improving the synchronization between blood pressure and heartbeat rhythm, resolving blood pressure fluctuations [14].
- **Cardiorespiratory:** The mechanism resonates the frequency between both the respiratory and cardiovascular networks. About 6 breaths per minute improve the efficiency of pulmonary gas exchange and minimize the risk of an additional cardiac drive.
- **Autonomic nervous system:** The mechanism helps stimulate the vagus nerve (vagal activity) responsible for specific sensory and motor coordination within the body. It also optimizes sympathovagal balance and improves autonomic responses [14].

Breathing techniques are often referred to with the pace of breath control. Slow breathing is associated with relaxation and overall well-being, whereas fast breathing is associated with stress and anxiety [35]. In some cases, the physiological effect of fast breathing is also beneficial, but differs from those of slow breathing. A study by Sharma, *et al.* (2013), involving 18–25-year-olds, analyzed the improvement in perceived stress and anxiety by assigning participants to slow or fast breathing *pranayama*. *Kapalabhati*, *Bhastrika* and *Kukkriya* were the slow breathing techniques, whereas *Nadishodhana*, *Pranava*, and *Savitri* were the fast breathing techniques.

Stress, heart rate, blood pressure, pulse pressure, and respiratory rate were analyzed for 12 weeks. Both slow and fast breathing *pranayama* were found to reduce stress, and were considered deep breathing exercises with a different frequency of respiration. However, slow breathing *pranayama* was also associated with improved cardiovascular parameters [36]. Cardiorespiratory parameters did not differ between slow breathing (*prana-yoga*) and fast breathing (*Sudarshan Kriya yoga*). Compared to the psychological state of life, the management scale was more substantial in the slow breathing intervention group than the fast breathing group [35].

Bellissimo, *et al.* (2020) investigated the difference in the impact of slow and fast breathing techniques on cerebral functions. *Sukha pranayama* was used for slow breathing assessment and *Kapalabhati pranayama* for fast breathing. The study reported that a fast breathing technique significantly increased oxygenation in the cerebral region, resulting in positive changes in the right and left prefrontal cortex region. However, more research is required to identify any potential mechanisms influenced by fast breathing [37].

Studies conducted using the slow breathing technique did not investigate the direct effects on the consciousness and the neural network of the cortical activities exerted by the olfactory bulb [35].

A meta-analysis conducted by Lewis, *et al.* (2007) described the effect of breathing control on various clinical outcomes with diaphragmatic breathing (DB) as one of the interventions. The DB arm showed beneficial effects on respiratory functions RR, V_T , gas exchange and

arterial oxygen saturation. On the contrary, DB also showed adverse effects on dyspnea in patients with existing high-severity respiratory problems. DB did not display any significant impact on the vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), oxygen consumption, or in respiratory muscle efficiency [38].

Grams, *et al.* (2012) analyzed another set of RCTs in a systematic review, and presented a similar observation of no significant DB impact on respiratory functions, such as FEV1 and FVC [39]. However, parameters—such as FEV1, FVC, breath-holding time (BHT), peak expiratory flow rate (PEFR), and maximum voluntary ventilation (MVV)—were found to increase after forced breathing [40].

COVID-19 and breathing techniques

SARS-CoV2-2019 (COVID-19) is significantly and adversely affecting human life, globally. Multidisciplinary interventions with pulmonary rehabilitation are the cornerstones of treatment. In these patients, the purpose is to improve respiratory and other symptoms, such as dyspnea, anxiety, complications, disability, and quality of life. Breathing exercises are recommended, such as diaphragmatic breathing, pursed-lip breathing, active abdominal contraction, yoga, *pranayama*, and *Tai Chi*.

These practices must be performed daily: 10–15 minutes, 2–3 times a day. The duration should be increased in disease progression, with a goal of 30–60 minutes. The rehabilitation intervention aims to achieve a SpO₂ of more than 90%, and maintain saturation. A continuous cycle of breathing techniques helps clear the airways, eliminating mucus through coughing or forced expectoration [41]. However, because there are only anecdotal fragments of evidence available regarding improved respiratory and other symptoms, these breathing exercises should not be considered as protecting against COVID-19 infection [42].

In addition to the physiological impact, COVID-19 has affected the mindset and psyche of the global population. Physicians recommend breathing techniques, such as *Simha Kriya* and *Isha Kriya*, to improve symptoms. Health workers, quarantined patients, recovering individuals, and COVID-19-positive people have increased stress and anxiety levels.

Simha kriya is a short-duration technique that increases lung capacity and improves the immune system. *Isha kriya* is a long-duration technique that calms the mind and body, reduces stress levels, energizes the body, and empowers individuals to handle unpleasant situations around them. The Isha Foundation, developed by Sadhguru, has developed these techniques [43].

Stress is the current “normal”. Patients and physicians seek simpler, better, and cheaper interventions to manage stress and avoid pharmacological interventions.

Although there is no literature emphasizing breathing techniques in mitigating the psychological and physical stress related to having—or the fear of contracting—COVID-19 infection, recent scientific studies have highlighted the importance of incorporating ancient mind-body techniques, meditation practices, breathing techniques, yoga, *Qi Gong*, and *Tai Chi* to alleviate symptoms of stress and anxiety.

However, a clear understanding of the mechanism of action underlying neural and physiological pathways is required to develop better and advanced treatments with such practices as core treatments. Moreover, the information should be well balanced to achieve the goal of NIH recommendations and initiatives.

The adverse effect of “over-breathing”

Deep breathing techniques—after proper training—are beneficial for living a healthy life with improved immune functions, blood pressure, digestion, and hormonal levels; also, lower levels of anxiety, diminished risk of heart disease, more manageable and tolerable panic attacks, and better focus and concentration have been noted [15].

However, not following an appropriate technique and considering heavy breathing equivalent to deep breathing can have specific adverse effects. Over-breathing leads to hyperventilation, which in turn causes excessive loss of carbon dioxide, leading to respiratory alkalosis, the raising of the pH to above 7.45, and lowering pCO₂ to below 35 mmHg. These sequelae cause impaired blood flow and lowered oxygen levels in tissues and cells (hypoxia)—inducing lightheadedness and tingling sensations, difficulty in concentrating on tasks, frequent cramps and spasms of the hand and feet, muscle twitching, and panic attacks and anxiety [46].

Breathing therapy in the future of medicine

Extensive trials and experiments in human subjects can address the cortical regulation of breathing techniques, and study flight-or-fight responses. More research on interoceptive sensations is required to assess the trigger response of panic attacks that cause asphyxiation, chest pain, nausea, dizziness, elevated heart rate, changes in breathing patterns, and amplified startle responses. Animal models can investigate acute or chronic stressors in developing predictive paradigms [44].

Medical yoga therapy (or *yoga chikitsa*) could be a future therapeutic option for physical and mental disorders or diseases. The combination of such treatment with spiritual well-being is thought to relieve stress.

This holistic therapy will be tailored to the needs of each individual to achieve maximum results. The collaborative and personalized practices will help build resilience by managing the potential triggers for stress and anxiety, which will eventually aid the patient in coping with particular conditions or symptoms. Although practicing yoga is time-consuming and not as responsive as taking medications, increasing evidence supports the benefits of investing time and money to experience its benefits. Ongoing and prospective studies may reveal the uncovered health benefits of mind-body practices and provide evidence in supporting health management [45].

Summary

Psychological and physiological changes are observed because of brain and body interactions in people who practice meditative and relaxing exercises, entirely dependent on voluntary breath control [35]. Meta-analyses and individual studies on meditation practices have also reported common effects in areas of the brain involved in emotional control, attention, memory, social control, social cognition, and reward processing. These techniques serve as brain fitness exercises and improve the functional capacity and connectivity of the neural network [47].

Neurocognitive and psychophysiological effects are due to changes in breathing pace and nostril manipulation (also known as uninostril or alternative nostril breathing) [18]. Mindfulness and meditation (mind-body training) can be performed regardless of time and place. Yoga is continuously gaining importance and recognition across the world. The Western world considers it a form of physical exercise, while the Eastern world sees it for body, mind, and spirit [48].

Slow and deep breathing efficiently removes dead space and resupplies all lung parts with air. It is better than shallow breathing, which only replenishes air at the lung base. Retention of breath (*Kumbhaka*) enhances vital energy levels in the body, and when combined with *pranayamas*, the effect is substantially enhanced [49]. Published studies have demonstrated yoga as adjuvant therapy for multiple diseases, but these data are not validated due to limitations concerning the trial designs. Studies are single-center trials or those without an adequate sample size to achieve statistical significance. Furthermore, follow-up methodologies should be included to investigate the long-term effects of these techniques. In general, robust data from extensive multicenter studies following standard yoga programs with uniform methods, along with long-term follow-up strategies and outcomes, are required to recognize mind-body practices as part of medical therapy [45].

Conclusion

The application of breathing practice as an effective, non-interventional exercise to regain proper, healthy breathing. Disease states can disrupt normal, healthy breathing. Breathing exercises are beneficial in various medical conditions, physical and psychological. As the American Lung Association has pointed out, most people breathe improperly, and there are optimal breathing practices—diaphragmatic (belly) breathing and pursed-lip breathing. In addition to the ALA's best breathing practices, numerous breathing techniques have been employed throughout history and to the current day: *Qigong*, *Pranayama*, *Kapalabhati*, *Bastrika*, *Nadishodhana/Nadishuddhi*, *Suryanuloma Viloma*, *Chandranuloma Viloma*, *Suryabhedana*, *Ujjayi*, and *Bhramari*, among others. Nevertheless, caution is needed in specific breathing exercises. Over-breathing can lead to adverse effects, such as respiratory alkalosis, hypoxia, cramps, parathesia in the distal upper and lower extremities, and panic attacks.

Conflict of Interest Statement

The authors declare that this paper was written without any commercial or financial relationship that could be construed as a potential conflict of interest.

References

1. Del Negro CA., *et al.* “Breathing matters”. *Nature Reviews Neuroscience* 19.6 (2018): 351. <https://www.nature.com/articles/s41583-018-0003-6>
2. Sargunraj D., *et al.* “Cardiac rhythm effects of .125-Hz paced breathing through a resistive load: implications for paced breathing therapy and the polyvagal theory”. *Biofeedback and Self-Regulation* 21.2 (1996): 131-147. <https://www.wikidata.org/wiki/Q71528697>
3. Beauchaine T. “Vagal tone, development, and Gray’s motivational theory: toward an integrated model of autonomic nervous system functioning in psychopathology”. *Development and Psychopathology* 13.2 (2001): 183-214. <https://pubmed.ncbi.nlm.nih.gov/11393643/>
4. Stromberg SE., *et al.* “Diaphragmatic breathing and its effectiveness for the management of motion sickness”. *Aerospace Medicine and Human Performance* 86.5 (2015): 452-457. <https://pubmed.ncbi.nlm.nih.gov/25945662/>
5. Dhawan A., *et al.* “Effectiveness of yogic breathing intervention on quality of life of opioid-dependent users”. *International Journal of Yoga* 8.2 (2015): 144-147. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4479894/>
6. Brown RP and Gerbarg PL. “Sudarshan Kriya Yogic breathing in the treatment of stress, anxiety, and depression. Part II--clinical applications and guidelines”. *Journal of Alternative and Complementary Medicine* 11.4 (2005): 711-717. <https://pubmed.ncbi.nlm.nih.gov/16131297/>
7. Chang SB., *et al.* “Effects of Abdominal Breathing on Anxiety, Blood Pressure, Peripheral Skin Temperature and Saturation Oxygen of Pregnant Women in Preterm Labor”. *Korean Journal of Women Health Nursing* 15.1 (2009): 32. <https://www.kjwhn.org/m/makeCookie.php?url=/m/journal/view.php?number=468>
8. Yu WJ and Song JE. “[Effects of abdominal breathing on state anxiety, stress, and tocolytic dosage for pregnant women in preterm labor]”. *Journal of Korean Academy of Nursing* 40.3 (2010): 442-452. <https://pubmed.ncbi.nlm.nih.gov/20634635/>
9. Salyers MP., *et al.* “BREATHE: a pilot study of a one-day retreat to reduce burnout among mental health professionals”. *Psychiatric Services* 62.2 (2011): 214-217. <https://pubmed.ncbi.nlm.nih.gov/21285102/>
10. Tekur P., *et al.* “A comprehensive yoga programs improve pain, anxiety, and depression in chronic low back pain patients more than exercise: an RCT”. *Complementary Therapies in Medicine* 20.3 (2012): 107-118. <https://pubmed.ncbi.nlm.nih.gov/22500659/>

11. Breathing Exercises | American Lung Association (2021). <https://www.lung.org/lung-health-diseases/wellness/breathing-exercises>
12. Sapra A., et al. “Vital Sign Assessment. Stat Pearls (2021). <https://www.ncbi.nlm.nih.gov/books/NBK553213/>
13. Holland AE., et al. “Breathing exercises for chronic obstructive pulmonary disease”. *Cochrane Database of Systematic Reviews* 10 (2012). <https://pubmed.ncbi.nlm.nih.gov/23076942/>
14. Russo MA., et al. “The physiological effects of slow breathing in the healthy human”. *Breathe* 13.4 (2017): 298. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5709795/>
15. Ma X., et al. “The Effect of Diaphragmatic Breathing on Attention, Negative Affect and Stress in Healthy Adults”. *Frontiers in Psychology* 8 (2017): 874. <https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00874/full>
16. Klein P., et al. “Meditative Movement, Energetic, and Physical Analyses of Three Qigong Exercises: Unification of Eastern and Western Mechanistic Exercise Theory”. *Medicines* 4.4 (2017): 69. <https://pubmed.ncbi.nlm.nih.gov/28946612/>
17. Ohnishi ST and Ohnishi T. “The Nishino Breathing Method and Ki-energy (Life-energy): A Challenge to Traditional Scientific Thinking”. *Evidence-based Complementary and Alternative Medicine* 3.2 (2006): 191. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1475930/>
18. Saoji AA., et al. “Effects of yogic breath regulation: A narrative review of scientific evidence”. *Journal of Ayurveda and Integrative Medicine* 10.1 (2019): 50-58. <https://pubmed.ncbi.nlm.nih.gov/29395894/>
19. Srinivasan TM. “PRANAYAMA AND BRAIN CORRELATES”. *Ancient Science of Life* 11.1-2 (1991): 2. <https://pubmed.ncbi.nlm.nih.gov/22556548/>
20. Stancák A., et al. “Kapalabhati--yogic cleansing exercise”. *II. EEG topography analysis. Homeostasis in Health and Disease: International Journal Devoted to Integrative Brain Functions and Homeostatic Systems* 33.4 (1991): 182-189. <https://pubmed.ncbi.nlm.nih.gov/1818666/>
21. Telles S., et al. “Reaction time following yoga bellows-type breathing and breath awareness”. *Perceptual and Motor Skills* 117.1 (2013): 89-98. <https://journals.sagepub.com/doi/10.2466/22.25.PMS.117x10z4>
22. Bhavanani AB and Udupa K. “Acute effect of Mukh bhastrika (a yogic bellows-type breathing) on reaction time (2021). <http://icyer.com/documents/19.pdf>
23. Pharmacol MRIJP. “Immediate effect of mukha bhastrika (a bellows-type pranayama) on reaction time in mentally challenged adolescents (2021). <https://pubmed.ncbi.nlm.nih.gov/23387247/>
24. Nemati A. “The effect of pranayama on test anxiety and test performance”. *International Journal of Yoga* 6.1(2013): 55-60. <https://pubmed.ncbi.nlm.nih.gov/23439436/>
25. Jerath R., et al. “Self-regulation of breathing as a primary treatment for anxiety”. *Applied Psychophysiology and Biofeedback* 40.2 (2015): 107-115. <https://pubmed.ncbi.nlm.nih.gov/25869930/>
26. Tsang HWH., et al. “Effect of a qigong exercise program on elderly with depression”. *International Journal of Geriatric Psychiatry* 21.9 (2006): 890-897. https://www.researchgate.net/publication/6835633_Effect_of_a_Qigong_exercise_programme_on_elderly_with_depression
27. Influence of Yoga and Ayurveda on self-rated sleep in a geriatric population (2021). <https://pubmed.ncbi.nlm.nih.gov/15937373/>
28. Descilo T., et al. “Effects of a yoga breath intervention alone and in combination with an exposure therapy for post-traumatic stress disorder and depression in survivors of the 2004 South-East Asia tsunami”. *Acta Psychiatrica Scandinavica* 121.4 (2010): 289-300. <https://pubmed.ncbi.nlm.nih.gov/19694633/>

29. Seppälä EM., *et al.* “Breathing-Based Meditation Decreases Posttraumatic Stress Disorder Symptoms in US Military Veterans: A Randomized Controlled Longitudinal Study”. *Journal of Traumatic Stress* 27.4 (2014): 397. <https://pubmed.ncbi.nlm.nih.gov/25158633/>
30. Herbert A and Esparham A. “Mind-Body Therapy for Children with Attention-Deficit/Hyperactivity Disorder”. *Children* 4.5 (2017): 31. <https://pubmed.ncbi.nlm.nih.gov/28441363/>
31. Pelham WE., *et al.* “Treatment Sequencing for Childhood ADHD: A Multiple-Randomization Study of Adaptive Medication and Behavioral Interventions”. *Journal of clinical child and adolescent psychology: The Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division* 45.4 (2016): 396-415. <https://pubmed.ncbi.nlm.nih.gov/26882332/>
32. Harrison LJ., *et al.* “Sahaja Yoga Meditation as a Family Treatment Programme for Children with Attention Deficit-Hyperactivity Disorder”. *Clinical Child Psychology and Psychiatry* 9.4 (2004): 479-497. <https://journals.sagepub.com/doi/10.1177/1359104504046155>
33. Sathyanarayanan G., *et al.* “Role of Yoga and Mindfulness in Severe Mental Illnesses: A Narrative Review”. *International Journal of Yoga* 12.1 (2019): 3. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6329226/>
34. Hearing CM., *et al.* “Physical Exercise for Treatment of Mood Disorders: A Critical Review”. *Current Behavioral Neuroscience Reports* 3.4 (2016): 350. <https://pubmed.ncbi.nlm.nih.gov/28503402/>
35. Zaccaro A., *et al.* “How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing”. *Frontiers in Human Neuroscience* 12 (2018): 353. <https://www.frontiersin.org/articles/10.3389/fnhum.2018.00353/full>
36. Sharma VK., *et al.* “Effect of fast and slow pranayama on perceived stress and cardiovascular parameters in young health-care students”. *International Journal of Yoga* 6.2 (2013): 104. <https://pubmed.ncbi.nlm.nih.gov/23930028/>
37. Bellissimo G., *et al.* “The Effects of Fast and Slow Yoga Breathing on Cerebral and Central Hemodynamics”. *International Journal of Yoga* 13.3 (2020): 207. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7735505/>
38. Lewis LK., *et al.* “Short-term effects on outcomes related to the mechanism of intervention and physiological outcomes but insufficient evidence of clinical benefits for breathing control: a systematic review”. *The Australian Journal of Physiotherapy* 53.4 (2007): 219-227. <https://pubmed.ncbi.nlm.nih.gov/18047456/>
39. Grams ST., *et al.* “Breathing exercises in upper abdominal surgery: a systematic review and meta-analysis”. *Revista Brasileira de Fisioterapia* 16.5 (2012): 345-353. <https://pubmed.ncbi.nlm.nih.gov/23060237/>
40. Joshi L and Joshi V. “Effect of forced breathing on ventilatory functions of the lung”. *Journal of Postgraduate Medicine* 44.3 (1998): 67. <https://pubmed.ncbi.nlm.nih.gov/10703574/>
41. Wang TJ., *et al.* “PM and R and Pulmonary Rehabilitation for COVID-19”. *American Journal of Physical Medicine and Rehabilitation* 99.9 (2020): 769-774. <https://pubmed.ncbi.nlm.nih.gov/32541352/>
42. Hamzelou J. “Can breathing exercises help protect you from covid-19?” *New Scientist* (1971) 246.3279 (2020): 10. <https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/coronavirus-recovery-breathing-exercises>
43. Rain M., *et al.* “Can Yogic Breathing Techniques Like Simha Kriya and Isha Kriya Regulate COVID-19-Related Stress?” *Frontiers in Psychology* 12 (2021): 1297. <https://pubmed.ncbi.nlm.nih.gov/33935886/>
44. Lavretsky H and Feldman PhD JL. “Precision Medicine for Breath-Focused Mind-Body Therapies for Stress and Anxiety: Are We Ready Yet?” *Global Advances in Health and Medicine* (2021): 10. <https://pubmed.ncbi.nlm.nih.gov/33489480/>
45. Stephens I. “Medical Yoga Therapy”. *Children* 4.2 (2017): 12. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5332914/>
46. Gilbert C. “Hyperventilation and the body”. *Accident and Emergency Nursing* 7.3 (1999): 130-140. <https://pubmed.ncbi.nlm.nih.gov/10693382/>

47. Acevedo BP, *et al.* “The Neural Mechanisms of Meditative Practices: Novel Approaches for Healthy Aging”. *Current Behavioral Neuroscience Reports* 3.4 (2016): 328-339. <https://pubmed.ncbi.nlm.nih.gov/27909646/>
48. Michelis E de. “A History of Modern Yoga: Patanjali and Western Esotericism” (2005).
49. Naik GS, *et al.* “Effect of Modified Slow Breathing Exercise on Perceived Stress and Basal Cardiovascular Parameters”. *International Journal of Yoga* 11.1 (2018): 53. <https://www.semanticscholar.org/paper/Effect-of-Modified-Slow-Breathing-Exercise-on-and-Naik-Gaur/13162cd85a454cc3395b516d68a6e54dd1256ec9>

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