The Healing Power of Pranayama: Exploring Medicinal Significance in Health Care


[1] Department of Electronics & Communication Engineering, ATME College of Engineering, Mysuru, Karnataka, INDIA
[2] Department of Chemistry, ATME College of Engineering, Mysuru, Karnataka, INDIA

Abstract: This review provides an overview of the medical implications of pranayama in healthcare applications. Yoga originated in India 1000 years ago and is now gaining a lot of attention as a natural remedy for health issues. Pranayama, a key component of yoga, involves regulating breathing and has been scientifically proven to effectively improve health and manage diseases. Ongoing scientific research is further exploring the therapeutic benefits of yoga. Yoga offers numerous benefits, such as reducing stress, managing anxiety, improving autonomic nervous function, and suppressing sympathetic nervous activity. Recent research studies showed that yoga and pranayama could potentially have beneficial impacts on the physical well-being of cancer patients, especially in the treatment of respiratory diseases. Additionally, the global recognition of yoga demonstrates India's increasing cultural influence. This review highlights the significance of pranayama in healthcare and emphasizes the need for further research to explore its medicinal value. Pranayama, through the practice of regulating breath, has the potential to greatly enhance overall health and assist in the treatment of various medical conditions.

Keywords: Yoga, Pranayama, Breathing techniques, Health care, Diabetes mellitus, cardiorespiratory efficiency, Hypertension

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1. Introduction

Yoga, which originated in India 1,000 years ago, is a comprehensive practice that has evolved into various forms practiced globally [1]. Yoga traditionally consists of eight components, known as the limbs of yoga: ethical principles (yama), self-discipline (niyama), physical poses (asanas), breath control (pranayama), sensory withdrawal (pratyahara), concentration (dharana), meditation (dhyana), and transcendence of self (samadhi)[2]. Many contemporary forms of yoga primarily focus on postures (asanas), often accompanied by breath control (pranayama). Some styles or schools of yoga also incorporate elements of concentration or meditation, although this can vary depending on the region and purpose of practice [3,4].

In the past few decades, yoga has become increasingly popular worldwide, extending beyond its origins in India. According to the National Health Interview Survey in 2017, approximately 14.3% of adults in the United States (around 35.2 million people) have engaged in yoga within the last year[5]. Similarly, in Australia, the estimated rate of yoga practice is 12%[6], while in Germany, recent studies suggest that 15.1% of the population has tried yoga at some point in their lives[7]. Although specific prevalence rates may vary across countries and time periods, research consistently shows a growing trend in the adoption of yoga. The scope of
yoga research is increasing along with its popularity [8,9]. The global yoga journal publication count has seen a significant increase, showing a compound annual growth rate (CAGR) of 7.79% during the period 2008 to 2016[10]. While many people practice yoga for general health and wellness, approximately 18% of practitioners use it to address specific health issues [11]. Yoga is believed to offer therapeutic benefits, such as reducing anxiety or depression, reducing pain, improving physical performance, and improving overall quality of life in a variety of medical problems [12].

Numerous randomized controlled trials (RCTs) have been performed to examine the potential advantages and risks of yoga for various health conditions [13]. A systematic review, considered a comprehensive and objective source of data, reveals the efficacy of yoga as a therapeutic practice. The publication in 2013 provided an overview of the evidence supporting systematic reviews of yoga [14]. However, considering the increasing popularity and utilization of yoga as a therapeutic method, it is probable that more recent systematic reviews have been published. These reviews offer in-depth information about the origins and qualities of evidence that support the potential benefits of yoga for improving health [15]. Research investigations have demonstrated the advantages of pranayama in improving overall well-being and combating various health problems. According to research studies, practicing pranayama regularly helps treat breathing diseases like asthma and chronic obstructive pulmonary disease (COPD) by reducing stress and anxiety, enhancing autonomic function, enhancing lung capacity, and improving autonomic functioning. The controlled breathing techniques in pranayama activate the parasympathetic nervous system, leading to relaxation and a reduction in the sympathetic “fight-or-flight” response [16–20].

Although the advantages of pranayama are becoming more acknowledged, there are still obstacles to integrating it into healthcare [21]. A major difficulty is the absence of uniformity, as various yoga schools and practitioners may teach and prioritize different pranayama techniques. This variation makes it challenging to establish consistent guidelines for its therapeutic use [22]. Additionally, the need for scientific validation to establish evidence-based recommendations poses another hurdle. Individual variations in physiology and capacity to perform pranayama further complicate its widespread adoption [23]. Limited accessibility to trained instructors and the integration of pranayama into conventional healthcare systems also present barriers. In order to protect the health and safety of practitioners, it is vital to recognize and address any potential dangers that may result from improper practice [24].

To overcome the challenges associated with pranayama's health care applications, concerted efforts are required [25][26]. Further research studies on pranayama’s physiological effects and its impact on specific health conditions are necessary to build a robust body of evidence [27]. Collaboration between yoga practitioners, medical professionals, and researchers can help bridge the gap between traditional wisdom and contemporary scientific understanding [28,29]. Standardization of pranayama techniques and guidelines is crucial to ensure consistency and safety. Increasing awareness about the benefits of pranayama and training more healthcare professionals in its practice can help improve accessibility and integration into modern healthcare systems [30,31]. The global recognition and adoption of yoga, including pranayama, signify its cultural influence and the growing acceptance of its potential benefits [32].

Pranayama scientific studies emphasize its importance in enhancing overall health and addressing different medical conditions [33]. However, challenges such as lack of standardization, scientific validation, individual variations, limited accessibility, integration into conventional healthcare, and safety considerations must be addressed to fully harness its potential [34]. By furthering research, encouraging collaboration, promoting standardization, and increasing awareness, pranayama can be integrated into modern healthcare practices, showcasing the synergy between traditional wisdom and contemporary advancements [35,36].

In this comprehensive review, we will explore the medical implications of pranayama in healthcare applications. By studying its historical background, theoretical basis, and recent studies, we hope to discover the potential advantages and future prospects of pranayama in healthcare. Through this investigation, we aim to contribute to the expanding knowledge about pranayama and its role in improving overall health and wellness.

2. Artificial Intelligence in Yoga and Pranayama

In recent years, artificial intelligence (AI) has caused notable transformations in different aspects of human life, including sectors like medicine, transportation, healthcare, and retail. Furthermore, it has also had an
impact on the fitness industry [37]. While many associate fitness with concepts like diet, cardio, and gym workouts, yoga has emerged as a highly popular option. Yoga is not only favored by young adults but also by people of all ages, including the elderly. To further enhance accessibility to yoga, Prana breath, an application, has incorporated AI technology to assist individuals in accurately performing yoga asanas (postures)[38]. Unlike traditional fitness applications that rely on video guides, Prana Breath offers personalized monitoring and guidance. While following instructional videos can be challenging, especially for beginners, they often lack the ability to assess and correct posture and breathing techniques [39]. Pranayama, a breathing exercise technique practiced worldwide, is believed to have transformative effects on one's life. It promotes personal growth, strengthens the body-mental-emotional immunity, and aids in dissolving the ego. Pranayama is highly recommended by sportspersons, yogis, self-help gurus, and medical professionals, all of whom have experienced the numerous benefits it offers [40].

By integrating AI technology into yoga and pranayama practices, applications like Prana Breath aim to make these exercises more accessible, accurate, and beneficial for individuals of all ages and fitness levels. By incorporating AI technology, people can benefit from personalized guidance, track their breathing patterns, and gain a more profound comprehension of these ancient practices. This integration guarantees that individuals can fully utilize yoga and pranayama in their fitness endeavors, resulting in enhanced physical and mental health.

3. Literature review

This section explores recent progress in the advancement of various kinds of pranayama on health care applications with medicinal significance. The review aims to provide insights into the different types of pranayama and their potential impact on health. Extensively researched for its healing effects, pranayama is a yoga technique that primarily emphasizes the regulation of breathing. This practice is renowned for its diverse impacts on both the mind and body. By examining the advancements in different types of pranayama, researchers aim to understand their specific applications in health care.

The review focuses on the various types of pranayama that have been undertaken [41]. Pranayama, a practice often associated with breath awareness in yoga, goes beyond just the act of breathing [42]. It taps into the vital life-force of prana, which when low, can result in lethargy and dullness. Through yoga, prana begins to flow, releasing toxins and connecting the body and mind. Patanjali, in his yoga sutras, dedicated five sutras to breathing alone. One technique, Dirgha pranayama, also known as the three-part breath, involves a deep inhalation in three stages, expanding the abdomen, rib cage, and chest. Ujjayi pranayama, known as the "victorious breath," utilizes gentle contractions to draw breath into the thoracic cavity, producing the sound of the ocean. Nadi Shodhana, or alternate nostril breathing, involves inhaling and exhaling through different nostrils, activating or relaxing the sympathetic nervous system. Anuloma-Viloma pranayama teaches practitioners to utilize the rib cage and deep breath, while Sitali pranayama cools and refreshes the throat. Kapalabhati, or "skull shining breath," is a cleansing technique that rapidly expels air from the lungs, followed by deep, slow breaths. These various pranayama techniques offer a holistic approach to enhancing the respiratory system, improving oxygenation, and promoting overall well-being [43].

Fig 1: Benefits of practicing Yoga in everyday life of every mankind (Source: www.arhantayoga.org)
All of these different types of pranayama yoga practices are well-known for their numerous mental and physical health advantages [44]. Yoga has been demonstrated to enhance flexibility, strength, balance, and general physical fitness, as well as reduce stress, anxiety, and depression and improve sleep quality [45–50]. Yoga can benefit human health in various ways. It reduces stress by lowering stress hormone levels, improving overall mood. Yoga poses, or asanas, help stretch and lengthen muscles, improve joint range of motion, and enhance flexibility and mobility. Holding challenging positions in yoga poses helps build strength and endurance. Regularly practicing yoga poses that emphasize balance can enhance overall stability and reduce the likelihood of falls and injuries [51,52]. Moreover, engaging in yoga on a consistent basis can decrease inflammation in the body, which is linked to chronic health issues. Additionally, research has shown that practicing yoga can lower blood pressure, decrease cholesterol levels, and mitigate the risk of heart disease.

Additionally, yoga promotes relaxation and overall wellness through techniques such as deep breathing and relaxation exercises. Yoga can serve as a supplementary treatment for the management and enhancement of symptoms associated with specific illnesses. For people with arthritis, yoga can reduce pain and stiffness in the joints, increase flexibility, and improve physical functioning. Yoga has advantages for people with diabetes as it can reduce blood sugar levels, alleviate stress, and enhance overall physical and mental health. For those with heart disease, yoga can have positive effects such as reducing blood pressure and cholesterol levels, improving heart function, and alleviating stress and anxiety. People with asthma can also benefit from yoga by improving breathing techniques, reducing stress, and enhancing respiratory health. Cancer patients and survivors may experience reduced symptoms like fatigue, pain, and anxiety, as well as an improved quality of life through practicing yoga. It is crucial to understand that yoga should not be considered a substitute for medical treatment or advice. People with chronic health conditions should seek guidance from their healthcare provider before beginning a yoga practice or any other complementary therapy [53–55].

Many studies and research have explored the possibility of using yoga as a supplementary therapy for various health conditions [56,57]. A one study published in the Annals of Internal Medicine found that yoga can be a beneficial addition to standard care for individuals with chronic low back pain. This can result in significant enhancements in pain relief, functionality, and overall quality of life. Another review of 17 RCTs discovered that yoga can be a successful remedy for anxiety, specifically for generalized anxiety disorder, social anxiety disorder, and post-traumatic stress disorder. Additionally, a meta-analysis of 23 RCTs revealed that yoga can effectively alleviate depression symptoms. For cancer patients and survivors, a systematic review of 24 RCTs demonstrated that yoga can enhance quality of life and reduce fatigue. Additionally, a research article published in the European Journal of Preventive Cardiology found that engaging in yoga can effectively reduce the likelihood of developing cardiovascular disease by decreasing risk factors like hypertension and elevated cholesterol levels. These studies, indicate that yoga can serve as a beneficial supplementary treatment for different health conditions. However, more research is required to gain a comprehensive understanding of the mechanisms behind yoga’s effectiveness and to identify the most suitable types and techniques for specific health conditions [58–66].

4. Medical implications of pranayama in healthcare applications

Many people in the United States practice yoga for its health benefits, without necessarily embracing the Hindu religious beliefs that form the basis of the practice [43]. Typically, these viewpoints become more noticeable in the later stages of instruction. Basic Hatha yoga classes focus on physical exercises that involve various poses and breathing techniques. A growing body of research supports the idea that specific yoga techniques can improve physical and mental health by regulating the hypothalamo-pituitary-adrenal (HPA) axis and the sympathetic nervous system. Stress and stress-related conditions, such as high blood pressure and angina, are rapidly increasing problems in modern society. Yoga, as a holistic science, is considered the most effective approach for preventing and managing stress and stress-related disorders. Numerous studies have demonstrated that yoga has an immediate calming effect on the HPA axis responses to stress. The effectiveness of yoga in stress management has been well established [67]. The study also discovered that short yoga-based relaxation training helps restore the balance of the autonomic nervous system by moving both sympathetic and parasympathetic indicators towards the average range of reference values, which is considered more typical or normal [68]. Research indicates that practicing yoga can lead to a reduction in salivary cortisol levels [69,70],
blood glucose levels and plasma renin levels [71,72], and levels of norepinephrine and epinephrine in 24-hour urine samples [73]. Additionally, yoga has been found to significantly decrease heart rate, as well as systolic and diastolic blood pressures [73–75]. These studies suggest that yoga has an immediate calming effect on the HPA axis response to stress. While the precise mechanism of action has not been determined, it has been hypothesized that certain yoga exercises induce a shift towards parasympathetic nervous system dominance, potentially through direct vagal stimulation [76]. Shapiro et al. [77] noted significant reductions in low-frequency heart rate variability, which is a sign of sympathetic nervous system activation, in depressed patients following an 8-week yoga intervention. Regardless of the pathophysiologic pathway, yoga has been shown to have immediate psychological effects, such as reducing anxiety [78–82] and enhancing feelings of emotional, social, and spiritual well-being [83]. Several literature reviews have examined the impact of yoga on various health conditions, such as cardiovascular disease [84], metabolic syndrome [85], diabetes [86], cancer [87], and anxiety [67]. Galantino et al. [88] published a systematic review on the effects of yoga on children. These reviews have contributed to the extensive body of research evidence supporting the positive health benefits of yoga. The purpose of this article is to provide a comprehensive review of the literature on the impact of yoga on different health outcomes and conditions.

4.1 Diabetes mellitus

Yoga has been shown to be an affordable and uncomplicated therapeutic method that can be advantageous for people with non-insulin dependent diabetes mellitus. A research study was carried out on a group of individuals with diabetes who regularly engaged in yoga, and the results indicated a notable reduction in high blood sugar levels and improved management of blood sugar. This study also found that the need for oral hypoglycemic medication was reduced in those who practiced yoga [89]. Another research study was reported by Chaya et.al [90], exhibited a decrease in fasting plasma insulin levels among yoga practitioners. Long-term yoga practice was associated with increased insulin sensitivity and a less pronounced negative relationship between body weight or waist circumference and insulin sensitivity. Additionally, Manjunatha et al. [91] investigated the impact of four different sets of asanas on the sensitivity of B cells in the pancreas to the glucose signal. The asanas were performed in a random order for five consecutive days, and the researchers found that practicing asanas resulted in an enhanced sensitivity of the B cells to the glucose signal. The researchers suggested that this enhanced sensitivity may be a result of the long-term effects of practicing these poses. While the exact mechanism behind the anti-glycemic activity of yoga is not fully understood, it is possible that it involves neurohormonal modulation through insulin and glucagon activity.

4.2 Cardiorespiratory efficiency and physical fitness

A six-week yoga training program has been found to decrease sweating during a step test and increase respiratory pressures and endurance in both men and women during a 40 mmHg test which was reported by Madanmohan et al. [92]. Another study from same research group reported that 12 weeks of yoga practice resulted in significant improvements in maximum expiratory pressure, maximum inspiratory pressure, breath holding time after exhaling, breath holding time after inhaling, and hand grip strength [93]. Joshi and his colleagues [94] also demonstrated that a six-week pranayama breathing course led to improved ventilatory functions, including a decrease in respiratory rate, and increases in forced vital capacity, forced expiratory volume at the end of the first second, maximum voluntary ventilation, peak expiratory flow rate, and breath holding time. Similar positive effects were observed by Makwana et.al.,[95] after 10 weeks of yoga practice. The increase in inspiratory and expiratory pressures suggests that yoga training strengthens both the muscles used for exhaling and inhaling. Respiratory muscles, like skeletal muscles, can be strengthened through isometric contractions, which are involved in yogic techniques.

Breath holding time is influenced by initial lung volume, and greater lung volume reduces the frequency and intensity of involuntary contractions of respiratory muscles, resulting in less discomfort during breath holding. During yoga practice, individuals consciously override stimuli to respiratory centers, gaining control over respiration. This, along with improved cardiorespiratory performance, may explain why individuals trained in yoga have a longer breath holding time. Yogic techniques are known to enhance overall performance and work capacity [96], as they improve not only cardiorespiratory fitness and muscular strength but also
coordination and flexibility. In adults, low physical fitness, particularly cardiorespiratory fitness, appears to be a stronger predictor of cardiovascular and all-cause mortality than other well-established risk factors [97]. Physical fitness encompasses more than just cardiovascular fitness and muscular strength. It also includes coordination and flexibility, which can be seen as a comprehensive assessment of all the functions and structures involved in performance [98–101]. Low physical fitness, particularly cardiorespiratory fitness, appears to be a more significant indicator of cardiovascular and overall mortality in adults compared to other well-known risk factors [102]. In a study conducted by Sharma et al. [103], the researchers investigated the immediate effects of a concise lifestyle intervention focused on yoga on the well-being of both healthy individuals and those with medical conditions. The study included both healthy individuals and those with conditions such as hypertension, coronary artery disease, and diabetes. Within a span of 10 days, 77 subjects reported a significant improvement in their subjective well-being scores compared to the control group. This suggests that even a short intervention can have a meaningful impact on preventing and managing lifestyle diseases. Oken et al., [104] discovered that seniors (aged 65-85 years) who engaged in hatha yoga for a period of 6 months experienced significant improvements in their quality of life and physical measures compared to groups who participated in walking exercise or were on a wait-list.

4.3 Hypertension

It is widely recognized that many antihypertensive medications are associated with various undesirable side effects. In addition to medication, moderately intense aerobic exercise is well-known to effectively lower blood pressure. Interestingly, a randomized controlled study convincingly demonstrated that even a short period of regular yogic practice, at one hour per day, is as effective as medical therapy in controlling blood pressure in hypertensive individuals [105]. Yoga, along with relaxation techniques, biofeedback, transcendental meditation, and psychotherapy, has been found to have a significant antihypertensive effect [106]. Yoga's ability to lower blood pressure may be due to its positive influence on the function of the autonomic nervous system. Impaired baroreflex sensitivity is increasingly considered one of the major causes of essential hypertension, and the practice of yogic postures has been shown to restore baroreflex sensitivity [107]. In particular, yoga poses that imitate tilting the head up or down have been discovered to be especially advantageous in this aspect. Tests have demonstrated a progressive reduction in sympatho-adrenal and renin-angiotensin activity with regular yogic practice. By restoring baroreceptor sensitivity, yogic practice leads to a substantial reduction in blood pressure among participants [107,108]. Also, revealed to be effective in the treatment of secondary heart problems that are linked to long-term high blood pressure. Chronic hypertension leads to left ventricular hypertrophy, which is a precursor to several chronic cardiac complications including myocardial ischemia, congestive heart failure, and diastolic dysfunction. The cardiovascular response to the head-down-body-up exercise known as Sarvangasana has been discovered to have specific advantages in preventing and treating left ventricular hypertrophy and diastolic dysfunction associated with hypertension. Another study revealed that the participants who regularly performed Sarvangasana for a few weeks experienced notable decreases in their resting heart rate and left ventricular end diastolic volume, as observed through echocardiography [109]. Additionally, there was a slight decrease in left ventricular mass.

This review examines the alterations in the EEG pattern after practicing Bhramari Pranayama (BP), also known as bee-like breathing exercise. BP is known to be effective in alleviating various mental problems such as tension, stress, and hypertension, while inducing relaxation in practitioners and also observed that BP yields rapid outcomes. It has been noted that BP produces quick results. The analysis of EEG data recorded before and after BP reveals positive changes in different brainwave patterns associated with a relaxed state, both in experienced practitioners and those new to the practice. In this preliminary study, two subjects were chosen: one with four months of regular BP experience and another with no prior experience but trained in BP before the EEG recording. The subjects were selected from different cultural and ethnic backgrounds to evaluate the universality of BP's effects. The study aimed to objectify the impacts of BP by recording EEG before and after the practice, with each subject performing 15-20 rounds of BP. EEG signals were recorded from various regions of the head, including the temporal lobe, parietal lobe, and frontal lobe, as these regions are biologically connected to the pineal gland and are involved in BP concentration and the production of humming sounds. The recorded EEG data showed changes in different brainwave patterns, particularly in alpha, theta, and gamma
frequencies, which are indicative of the mental state of the subjects. Although the results presented in this review are based on only two subjects, they provide interesting trends for additional investigation of the impacts of BP. The effects of BP on theta and gamma brainwaves are particularly noteworthy, suggesting that BP is capable of producing immediate effects. The humming sound produced during BP is supposed to play a key role in achieving these results.

The objective of this review is to enhance the well-being of individuals with long-term illnesses by offering them the essential modifications in their lifestyle. The authors propose the progress of a mobile application that analyzes patient data, such as diabetes, and implements a system for diagnosing chronic diseases using machine learning methods, specifically classification algorithms. For hypertension, the Tree algorithm achieved 100% accuracy, making it the most effective algorithm. Chronic Kidney Disease (CKD) is a significant public health concern [110–116], and the authors used attributes such as specific gravity, albumin, serum creatinine, hemoglobin, packed cell volume, and hypertension to predict the presence of kidney disease. The Random Forest algorithm achieved 100% accuracy in predicting kidney disease, outperforming other algorithms. Similarly, the authors used attributes such as pregnancy, glucose, blood pressure, skin thickness, insulin, diabetes pedigree function, age, and BMI to diagnose diabetes using neural networks, which demonstrated the highest accuracy. The authors also proposed machine learning techniques, including ANN, SVM, NB, and k-NN, to accurately diagnose chronic kidney disease and reduce the number of patients and costs associated with renal replacement therapy. The experimental results showed high testing accuracy for ANN, SVM, and Naïve Bayes, while k-NN achieved a slightly lower accuracy. The authors recommend lifestyle changes for patients and involve doctors by providing notes on specific pranayama techniques, such as Kapalbhati for diabetics and Anuloma Viloma and Bhastrika for kidney and liver health. This review demonstrates the usage of machine learning classifiers to expect the probability of chronic diseases, with a focus on diabetes and kidney disease [117–120].

5. Conclusion

According to the scientific evidence presented, it can be concluded that incorporating Pranayama practices into daily life can help maintain good health and prevent psychosomatic disorders caused by psychological stress. These practices have been proven to reduce physiological arousal, improve attention, and promote relaxation and peace of mind. Pranayama has also been found to reduce stress and anxiety, improve the functioning of the autonomic and higher neural centers, and potentially enhance physical health. Although more scientific research is needed to fully understand the effects and mechanisms of yoga on the human body in different health conditions, the integration of AI technology into the wellness industry has opened up new possibilities. Startups like Pranayama are using AI and machine learning to offer virtual yoga assistance, making yoga and Pranayama more accessible and accurate for users. This combination of traditional practices and digital assistance shows promise in preventing and treating diseases.

References


