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Investigating the Role of Yogic Practices in Enhancing Respiratory and Cardiovascular Function: An Intervention Study

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Abstract

Purpose. Optimal respiratory and cardiovascular health is essential for well-being. Yogic practices, through breathing and postures, show promise in enhancing these functions. Purpose: This study investigated the effects of a twelve-week structured yogic intervention on selected respiratory and cardiovascular parameters in male students.

Material & Methods. The study was conducted at Shyampahari Government Primary Teacher Training Institute, Birbhum, West Bengal, India, with 24 male participants aged 17–22. A control group (n=12) and an experimental group (n=12) were randomly assigned to the participants. The experimental group practiced an organized yogic practice that included relaxation, asanas, pranayama, and suryanamaskar. The control group, on the other hand, continued their usual activities. The following metrics were measured before and after the intervention: respiratory rate, resting pulse rate, systolic and diastolic blood pressure, positive and negative breath-holding times. Using IBM SPSS (version 25), the statistical analysis included descriptive statistics, paired t-tests for within-group differences, independent t-tests for between-group comparisons, and Shapiro-Wilk and Levene's tests for normality and variance at $\alpha=0.05$.

Results. The experimental group showed substantial improvements in all measures, including systolic and diastolic blood pressure, pulse rate, respiratory rate, and positive and negative breath-holding times, according to paired t-tests. In contrast, there were no significant changes in these parameters in the control group. Independent t-tests of pre-test showed no significant differences between the experimental and control groups across any variables. However, post-test comparisons between the groups showed significant differences in pulse rate and positive breath-holding time, favoring the experimental group, conversely, no significant differences were observed for other variables ($p>0.05$).

Conclusions. A twelve-week yogic intervention significantly enhanced respiratory and cardiovascular function in the experimental group, supporting yoga's role as a complementary practice for improving physiological health. Incorporating yogic practices into fitness programs may yield substantial benefits for young adults.

Keywords: Yogic practice, cardiovascular function, respiratory function, intervention study, physiological health.

Introduction

The human body is a complex network of systems working in harmony to ensure optimal health and functioning (Smith, 2024). Among these systems, the respiratory and cardiovascular systems are particularly pivotal in maintaining overall vitality and performance (Calderon et al., 2017). The efficient functioning of these systems is essential for the body's ability to engage in daily activities and physical exercise. However, the rise in lifestyle changes, increased access to facilities, greater consumption of junk food, and heightened stress levels, combined with air pollution, expose individuals to fine particles that penetrate both the lungs and the cardiovascular system. This has notably increased the risk of various health conditions such as cardiovascular diseases, stroke, lung cancer, chronic obstructive pulmonary diseases, and respiratory infections (Pandya et al., 2020; WHO, n.d.). A key contributor to these risks is the growing prevalence of sedentary behavior, especially among adolescents and young adults. The rising academic demands and pervasive use of technology have led to a significant increase in sedentary lifestyles and low-intensity activities, which contribute to negative health outcomes (Zhu, 2021). In response to these challenges, yoga has been recognized as an effective approach for improving respiratory function and strengthening the immune system. Yoga's potential benefits in counteracting environmental stressors are supported by research highlighting its impact on respiratory and cardiovascular health (Balaguru et al., 2022). Originating in ancient India, yoga is a comprehensive discipline that integrates the body, mind, and spirit. The term "yoga," derived from the Sanskrit word meaning "to unite" or "to join" (Miller, 2023), has gained recognition for its ability to enhance both respiratory and cardiovascular function. Practices such as controlled breathing techniques (pranayama) and physical postures (asanas) have been shown to improve respiratory function, lung capacity, and oxygen delivery to muscles during exercise (Santaella et al., 2011; Beutler et al., 2016; Kothari et al., 2023; Seltmann et al., 2020). This enhanced oxygenation not only supports cardiorespiratory fitness but also optimizes brain function and reduces stress on the cardiovascular system (Kothari et al., 2023).

Blood pressure (BP), which is the force exerted by circulating blood on the walls of blood vessels, is quantified by two parameters: systolic blood pressure (SBP), representing the pressure during cardiac contraction, and diastolic blood pressure (DBP), reflecting the pressure during the cardiac resting phase (Shahoud et al., 2023). In addition to its well-known link to coronary heart disease and stroke, numerous cohort studies have demonstrated that high blood pressure is a significant risk factor for chronic kidney disease, heart valve disorders, aortic syndromes, heart failure, atrial fibrillation, and dementia (Fuchs & Whelton, 2020). Hypertension is categorized into primary hypertension, which accounts for about 90 to 95% of cases, and secondary hypertension, resulting from renal, endocrine, or nervous system diseases, making its management a significant public health challenge (Tiwari & Pal, 2017). In Southeast Asia, hypertension affects over 36% of the adult population, leading to 9.4 million premature deaths and 64 million disability-adjusted life years annually (Tiwari & Pal, 2017; World Health Organization, 2007), and it is predicted that by 2025, the number of adults with hypertension will rise by approximately 60%, totaling 1.56 billion individuals (Kearney et al., 2005). Recent evidence suggests that regular yoga practice may have a beneficial effect on both systolic and diastolic BP, with a systematic review indicating a reduction of systolic BP by 4.17 mmHg and diastolic BP by 3.62 mmHg (Hagins et al., 2013). This reduction is largely attributed to the stress-reducing properties of yoga, which influence autonomic nervous system functioning, thereby improving cardiovascular regulation.

Pulse rate, defined as the number of palpable arterial pulsations per minute, is a fundamental physiological parameter reflecting the rhythmic expansion and recoil of arterial walls due to blood ejection by the heart (Moran, 1990). As a vital indicator of cardiovascular function and autonomic regulation, pulse rate offers valuable insights into cardiovascular health and overall physiological status (Gordan et al., 2015; Hajar, 2018; Sapra et al., 2023). Beyond its numeric value, pulse rate is assessed for its rhythm, volume, amplitude, and symmetry, making it a multifaceted diagnostic tool (Sapra et al., 2023). Resting pulse rate has been found to be an independent predictor of cardiovascular morbidity and mortality, making it a critical prognostic indicator in medical conditions. An increased risk of heart failure, atherosclerosis, and hypertension has been associated with elevated pulse rates (Arnold et al., 2008). Furthermore, physical activity, stress, hydration, temperature, and autonomic nervous system activity are some of the variables that affect pulse rate, which is a dynamic parameter (Kitajima et al., 2021; White & Raven, 2014; Shinde et al., 2015; Heal et al., 2022; Porto et al., 2023). Notably, yogic practices have demonstrated significant physiological effects on cardiovascular function, particularly in modulating pulse rate. For instance, a study on medical students revealed a statistically significant reduction in resting pulse rate following regular yoga practice, with the mean decreasing from 80.6 to 76.34 beats per minute ($p<0.001$) (Pandya et al., 2020).

The respiratory rate, which measures the number of breaths taken per minute, is an essential health indicator, with normal rates for adults typically ranging between 12 and 20 breaths per minute, while rates for children vary based on age (Lockett, 2022; Rowden, 2023). This rate is closely linked to both respiratory function and physical and mental states (Nicolò et al., 2020). A reduced respiratory rate is often associated with improved autonomic balance, parasympathetic dominance, and a state of relaxation (Valenza et al., 2018). Age, degree of activity, and environmental factors can all affect this rate, which can also increase as a result of fever, anxiety, allergic reactions, or heart problems (Rowden, 2023) Studies indicate that regular yoga practice can significantly decrease respiratory rate, largely due to enhanced respiratory muscle strength, increased lung capacity, and the calming effects of controlled breathing (Susmitha & Sowmya, 2022). The beneficial effects of yoga practices on lowering the respiratory rate were demonstrated in a study that was published in the International Journal of Applied Biology and Pharmaceutical Technology (Manaspure et al., 2011).

Positive breath-holding time (PBHT) and negative breath-holding time (NBHT) assess the duration of breath retention following inhalation and exhalation, respectively (Pramanik et al., 2024), providing valuable insights into respiratory function and individual health characteristics (Karunarathne et al., 2023). According to research by Ideguchi et al. (2021) and Hedhli et al. (2021), people with chronic obstructive pulmonary disease (COPD) typically have shorter breath-holding times than people in good health. Additionally, studies like Yildiz et al. (2020) have used breath-holding time as a tool to examine how aging and stroke affect pulmonary function. Furthermore, breath-holding exercises have drawn interest as a possible way to improve oxygen efficiency and respiratory function, which is particularly advantageous for endurance athletes participating in sports like swimming, cycling, or running (McKeown, 2023; Fernández et al., 2022). Notably, studies have demonstrated that yogic practices, especially Pranayama, greatly increase one's ability to hold breath (Joshi et al., 1992).

The increasing recognition of yoga as a holistic approach to health and well-being has been supported by a growing body of research. Nevertheless, there are still few studies explicitly looking at how it affects college students' cardiovascular and respiratory systems. Given the potential of yoga as an affordable, non-invasive intervention for promoting health in this population, this gap in the literature is significant. A structured yoga program's effects on a few respiratory and cardiovascular metrics, such as systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse rate (PR), respiratory rate (RR), positive breath-holding time (PBHT), and negative breath-holding time (NBHT), are the focus of this study. The research efforts to clarify the physiological advantages of yoga and evaluate its suitability as a preventive and therapeutic approach for young adults by methodically examining these factors. The findings are anticipated to enhance the understanding of yoga's role in improving overall health and may provide a foundation for integrating yoga into health promotion programs targeting this demographic.

Material and Methods

The published articles were located using several search engines, including MEDLINE, EMBASE, Scopus, Science Direct, the Directory of Open Access Journals (DOAJ), PubMed, and Google Scholar. Key search terms included "Yoga," "Systolic Blood Pressure," "Diastolic Blood Pressure," "Pulse Rate," "Respiratory Rate," "Positive Breath-Holding Times" and "Negative Breath-Holding Times," along with the conjunctions "OR" and "AND." All searches were conducted in English, focusing specifically on studies that examine the impact of yogic practices on respiratory and cardiovascular variables for the literature review.

Participants

The study was conducted at Shyampahari Govt. Primary Teacher Training Institute, Birbhum, West Bengal, India, involving 24 male students aged 17 to 22 years. These participants, all of whom had normal vision, were randomly assigned to either a control group or an experimental group, with 12 students in each group. In this study, none of the participants smoked, consumed alcohol, had acute or chronic diseases, or were on any medication. Table 1 presents the baseline characteristics of the experimental and control groups, along with the p-values from Levene's test for homogeneity, indicating whether the variances between the groups are homogeneous. All participants were examined by a qualified physician and deemed fit to take part in this study. All participants gave their informed consent, confirming their voluntary participation and comprehension of the research procedures.

Table 1. Baseline characteristics of the participants

Variables	Experimental		Control		P-value
	Mean	SD	Mean	SD	
Age (years)	19.92	.90	20.42	1.17	.134
BMI (kg/m^2)	20.40	2.31	24.68	3.61	.105
WHR	.85	.13	.86	.07	.305

Academic status – UG level; Primary language – Bengali; Occupation – Student; Marital Status – Unmarried; Diet (self-declared) – Veg and non-veg both; Socio-economic status – Lower middle class

Study organization

This research adopted an experimental approach, using a two-group pre-test and post-test design. The aim was to determine if a twelve-week yogic intervention could significantly improve selected physiological parameters. Probability sampling methods were used to select participants from among the students.

Experimental protocol

The participants in the experimental group followed a structured yoga regimen consisting of suryanamaskar, asanas, pranayama techniques,

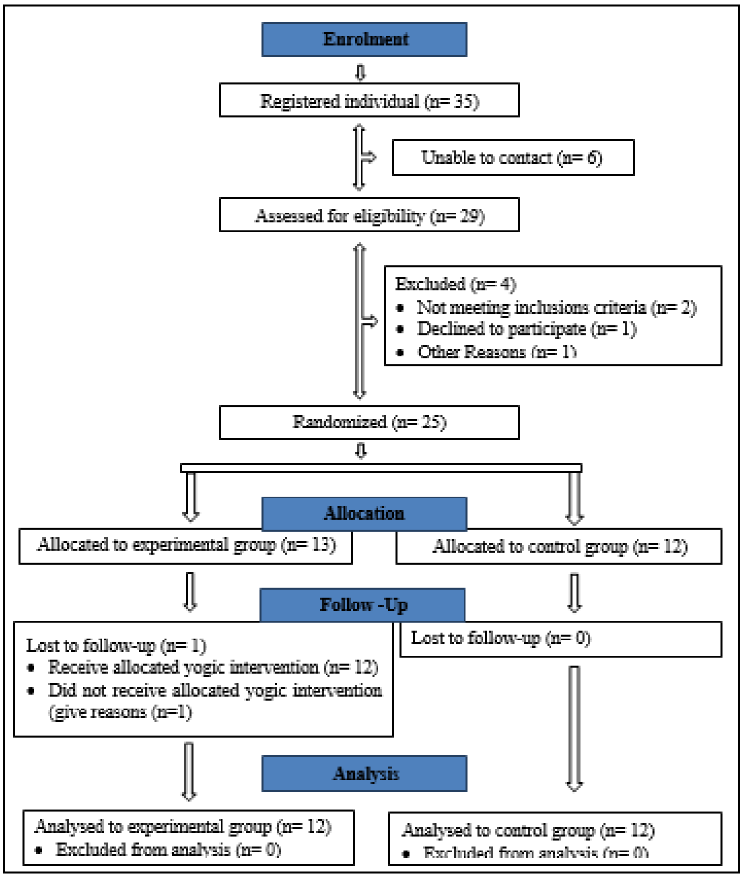

Figure 1. **Participations selection consort flow chart**

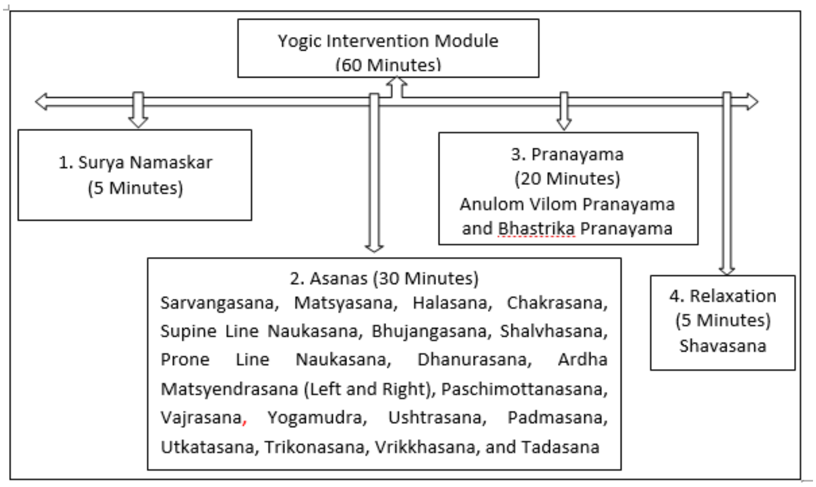

Figure 2. **Yogic intervention module**

and relaxation. These sessions were conducted from 8:00 to 9:00 AM, Monday through Saturday, at the Shyampahari Government Primary Teacher Training Institute ground in Birbhum, West Bengal, India, under the supervision of the investigator. In contrast, the control group maintained their usual daily routines without any additional interventions. All participants underwent assessments both before and after the twelve-week period. Figure 2 shows a summary of the intervention.

Instrument and Tools

Systolic and diastolic blood pressures were measured using the Omron HEM 7156 T automatic digital monitor, with readings recorded in millimetres of mercury (mmHg) following standard clinical procedures. The pulse rate, which refers to the number of pulse beats per minute, was measured using a stopwatch, with the number of beats counted over a 60-second interval to ensure precision. Respiratory rate, defined as the number of abdominal movements (up and down) per minute, was similarly measured using a stopwatch, with the cycle counted over one minute to ensure accuracy. Using a stopwatch, the breath-holding time – which included the positive breath-hold time during inhalation and the negative breath-hold time during exhalation – was timed to the closest second. All measurements were conducted in accordance with recognized standards to ensure consistency, accuracy, and reliability.

Statistical Analysis

Data distribution normality was examined using the Shapiro-Wilk test (Shapiro & Wilk, 1965), and the homogeneity of variances was assessed through Levene's test. Descriptive statistics were computed to provide a summary of the data, while paired t-tests were used for within-group differences and independent samples t-tests for between-group comparisons. All analyses were carried out using IBM SPSS software (version 25) at a significance level of 0.05.

Results

The findings of the present study, as presented in Table 2, reveal meaningful differences in cardiovascular and respiratory parameters between the experimental group (EG) and the control group (CG) following the intervention. Regarding systolic blood pressure, the EG demonstrated a reduction of 1.74%, with the mean decreasing from 124.08 mmHg (SD=4.27) in the pre-test to 121.92 mmHg (SD=2.43) in the post-test. In contrast, the CG exhibited a marginal increase of 0.40%, from 123.75 mmHg (SD=4.35) to 124.25 mmHg (SD=4.14). A similar trend was observed in diastolic blood pressure, wherein the EG showed a decline of 1.43%, from 82.00 mmHg (SD=2.49) to 80.83 mmHg (SD=1.64), while the CG recorded a slight increase of 0.84%, from 80.08 mmHg (SD=3.15) to 80.75 mmHg (SD=2.49). The resting pulse rate in the EG decreased by 4.59%, from a pre-test mean of 74.33 (SD=3.77) to a post-test mean of 70.92 (SD=3.75), indicating enhanced cardiovascular efficiency. Conversely, the CG exhibited an increase of 1.55%, from 75.50 (SD=3.75) to 76.67 (SD=4.31). In terms of respiratory rate, a substantial reduction of 15.50% was noted in the EG, from 23.67 breaths/min (SD=4.34) to 20.00 breaths/min (SD=7.29), while the CG showed a decrease of 11.28%, from 25.17 breaths/min (SD=3.83) to 22.33 breaths/min (SD=6.08). Breath-holding capacities showed notable improvements in the EG. Positive Breath Holding Time increased by 21.78%, rising from a pre-test mean of 68.50 seconds (SD=27.23) to 83.42 seconds (SD=15.53), whereas the CG demonstrated a lesser improvement of 15.92%, from 50.25 seconds (SD=24.26) to 58.25 seconds (SD=22.37). Similarly, Negative Breath Holding Time in the EG improved by 30.34%,

Table 2. Descriptive statistics

Variables	Group	Test	n	Mean	Std. Deviation	Std. Error Mean	% Change
Systolic Blood Pressure (mmHg)	EG	Pre-test	12	124.08	4.27	1.23	−1.74
		Post-test	12	121.92	2.43	.70	
	CG	Pre-test	12	123.75	4.35	1.26	.40
		Post-test	12	124.25	4.14	1.19	
Diastolic Blood Pressure (mmHg)	EG	Pre-test	12	82.00	2.49	.72	−1.43
		Post-test	12	80.83	1.64	.47	
	CG	Pre-test	12	80.08	3.15	.91	.84
		Post-test	12	80.75	2.49	.72	
Resting Pulse Rate (Number)	EG	Pre-test	12	74.33	3.77	1.09	−4.59
		Post-test	12	70.92	3.75	1.08	
	CG	Pre-test	12	75.50	3.75	1.08	1.55
		Post-test	12	76.67	4.31	1.25	
Respiratory Rate (Number)	EG	Pre-test	12	23.67	4.34	1.25	−15.50
		Post-test	12	20.00	7.29	2.10	
	CG	Pre-test	12	25.17	3.83	1.11	−11.28
		Post-test	12	22.33	6.08	1.76	
Positive Breath Holding Time (Second)	EG	Pre-test	12	68.50	27.23	7.86	21.78
		Post-test	12	83.42	15.53	4.48	
	CG	Pre-test	12	50.25	24.26	7.00	15.92
		Post-test	12	58.25	22.37	6.46	
Negative Breath Holding Time (Second)	EG	Pre-test	12	24.42	6.97	2.01	30.34
		Post-test	12	31.83	10.69	3.09	
	CG	Pre-test	12	25.75	10.24	2.96	9.40
		Post-test	12	28.17	11.45	3.31	

Table 3. **Paired t-test between the pre-test and post-test of the experimental and control groups**

Variables	Group	Test	Mean Difference	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Systolic Blood Pressure	EG	Pre-test Post-test	2.17	3.10	.90	2.42	11	.034*
	CG	Pre-test Post-test	.50	1.68	.49	1.03	11	.324
Diastolic Blood Pressure	EG	Pre-test Post-test	1.17	1.47	.42	2.76	11	.019*
	CG	Pre-test Post-test	.67	2.15	.62	1.08	11	.304
Resting Pulse Rate	EG	Pre-test Post-test	3.42	2.02	.58	5.86	11	.000*
	CG	Pre-test Post-test	1.17	1.85	.53	2.18	11	.052
Respiratory Rate	EG	Pre-test Post-test	3.67	5.03	1.45	2.52	11	.028*
	CG	Pre-test Post-test	2.83	4.88	1.41	2.01	11	.069
Positive Breath Holding Time	EG	Post-test Post-test	14.92	22.92	6.62	2.25	11	.046*
	CG	Pre-test Post-test	8.00	13.76	3.97	2.01	11	.069
Negative Breath Holding Time	EG	Pre-test Post-test	7.42	11.60	3.35	2.21	11	.049*
	CG	Pre-test Post-test Post-test	2.42	6.54	1.89	1.28	11	.227

*Significant at 0.05 level

from 24.42 seconds (SD=6.97) to 31.83 seconds (SD=10.69), while the CG showed a modest increase of 9.40%, from 25.75 seconds (SD=10.24) to 28.17 seconds (SD=11.45).

Table 3 presents the paired t-test results, indicating statistically significant improvements in various physiological parameters among participants in the experimental group (EG) following the intervention. The EG demonstrated a significant reduction in systolic blood pressure t(11)=2.42, p=.034; and diastolic blood pressure t(11)=2.76, p=.019; alongside notable improvements in resting pulse rate t(11)=5.86, p=.000; respiratory rate t(11)=2.52, p=.028; positive breath-holding time t(11)=2.25, p=.046; and negative breath-holding time t(11)=2.21, p=.049. In contrast, the control group (CG) did not exhibit statistically significant changes across these parameters: systolic blood pressure t(11)=1.03, p=.324; diastolic blood pressure t(11)=1.08, p=.305; resting pulse rate t(11)=2.18, p=.052; respiratory rate t(11)=2.01, p=.069; positive breath-holding time t(11)=2.01, p=.069; and negative breath-holding time t(11)=1.28, p=.227.

These results strongly suggest that the intervention significantly enhanced cardiovascular and respiratory parameters within the experimental group. By contrast, the absence of significant improvements in the control group underscores the specificity and efficacy of the intervention. This analysis provides compelling evidence supporting the role of the intervention in improving key physiological outcomes.

Table 4 presents the independent t-test results comparing pre-test and post-test scores between the experimental group (EG) and control group (CG) across physiological variables: systolic blood pressure, diastolic blood pressure, resting pulse rate, respiratory rate, positive breath-holding time, and negative breath-holding time.

The pre-test results indicated no statistically significant differences between the two groups in the measured variables. Specifically, for systolic blood pressure, t(22)=0.19, p=.852; diastolic blood pressure, t(22)=1.66, p=.112; resting pulse rate, t(22)=0.76, p=.456; respiratory rate, t(22)=0.90, p=.379; positive breath-holding time, t(22)=1.73, p=.097; and negative breath-holding time, t(22)=0.37, p=.713. These findings suggest that the two groups were comparable at baseline across all physiological parameters. In contrast, the post-test results revealed

Table 4. Independent t-test of pre-test and post-test between experimental and control groups

Variables	Tests	Experimental		Control		t	P-value
		Mean	SD	Mean	SD		
Systolic Blood Pressure	Pre-test	124.08	4.27	123.75	4.35	.19	.852
	Post-test	121.92	2.43	124.25	4.14	1.69	.106
Diastolic Blood Pressure	Pre-test	82.00	2.49	80.08	3.15	1.66	.112
	Post-test	80.83	1.64	80.75	2.49	.097	.924
Resting Pulse Rate	Pre-test	74.33	3.77	75.50	3.75	.76	.456
	Post-test	70.92	3.75	76.67	4.31	3.48	.002*
Respiratory Rate	Pre-test	23.67	4.34	25.17	3.83	.90	.379
	Post-test	20.00	7.29	22.33	6.08	.85	.404
Positive Breath Holding Time	Pre-test	68.50	27.23	50.25	24.26	1.73	.097
	Post-test	83.42	15.53	58.25	22.37	3.20	.004*
Negative Breath Holding Time	Pre-test	24.42	6.97	25.75	10.24	.37	.713
	Post-test	31.83	10.69	28.17	11.45	.81	.426

*Significant at 0.05 level

significant improvements in select variables within the experimental group. The Resting pulse rate significantly reduced, t(22)=3.48, p=.002, and positive breath-holding time showed a significant increase, t(22)=3.20, p=.004, favoring the experimental group. Other variables, including systolic blood pressure, t(22)=1.69, p=.106; diastolic blood pressure, t(22)=0.097, p=.924; respiratory rate, t(22)=0.85, p=.404; and negative breath-holding time, t(22)=0.81, p=.426, did not exhibit statistically significant differences between the two groups in the post-test.

These findings indicate that the intervention implemented in the experimental group led to significant enhancements in resting pulse rate and positive breath-holding time. However, other physiological variables did not demonstrate significant changes, suggesting a selective impact of the intervention on specific parameters.

Discussions

The data presented in Table 3 show a significant reduction in systolic blood pressure following the intervention involving yogic practices, particularly in the experimental group (EG), observed during both the pre-test and post-test phases. This finding is consistent with a growing body of research supporting the effectiveness of yogic practices in lowering systolic blood pressure. For example, Milli and Srinivasa (2022) found that yogic practices can reduce the risk of cardiovascular diseases by lowering systolic blood pressure and promoting healthier lifestyles. Similarly, a trial by Telles et al. (2013) showed that practices like anuloma-viloma pranayama and breath awareness significantly decreased blood pressure. A meta-analysis by Cramer et al. (2014) further supports this, demonstrating that yoga interventions lasting at least eight weeks resulted in an average reduction of 9.65 mmHg in systolic blood pressure. The mechanisms behind yogic practices ability to lower systolic blood pressure (SBP) include reducing stress (Joshi et al., 2024; Rajagopalan et al., 2023), activating the parasympathetic nervous system through pranayama techniques (Tripathy & Sahu, 2019), enhancing baroreceptor sensitivity (Tyagi & Cohen, 2014; Pramanik et al., 2009), and improving sleep quality (Bathgate & Fernandez-Mendoza, 2018; Rajagopalan et al., 2023). These factors together contribute to the observed decrease in blood pressure.

Similarly, the present study highlights that the yoga intervention significantly improved diastolic blood pressure in the experimental group (EG) compared to the control group (CG). These findings align with prior research on the impact of yogic practices on diastolic blood pressure. For instance, a multicenter trial documented a reduction of 3.86 mmHg in diastolic blood pressure following a structured yoga program, corroborating the results of other studies (Dhungana et al., 2021). Likewise, a systematic review revealed that yoga therapy effectively lowers diastolic blood pressure, demonstrating comparable efficacy to other lifestyle changes such as exercise and dietary adjustments (Khandekar et al., 2021). Additionally, research has suggested that yoga, particularly breathing exercises, contributes to a marked decrease in diastolic blood pressure (Cramer et al., 2014). The consistent practice of yoga lowers diastolic blood pressure (DBP) through a combination of physiological and psychological mechanisms, as it alleviates stress by reducing sustained muscle contraction and relaxing blood vessels, thereby decreasing diastolic blood pressure (Joshi et al., 2024; Rajagopalan et al., 2023). Moreover, pranayama, or controlled breathing, activates the parasympathetic nervous system, which further enhances cardiovascular health (Tripathy & Sahu, 2019). Various yogic techniques, including slow breathing, have been shown to reduce chemoreceptor activity and improve baroreceptor sensitivity, which play a role in normalizing blood pressure (Tyagi & Cohen, 2014; Pramanik et al., 2009). Additionally, a connection between insomnia and elevated blood pressure has been established, with research indicating that individuals suffering from insomnia are at greater risk of hypertension. Yoga has been shown to enhance sleep quality in individuals with chronic insomnia, which, in turn, contributes to the reduction of blood pressure (Bathgate & Fernandez-Mendoza, 2018; Rajagopalan et al., 2023). These interconnected mechanisms together support cardiovascular health and contribute to improved overall well-being.

The positive impact of yogic practices extends beyond blood pressure regulation. Numerous studies consistently demonstrate the effectiveness of yogic interventions in promoting cardiovascular health by reducing pulse rate among college students. For example, research conducted over a six-week period revealed a notable reduction in pulse rate, concluding that yoga therapy enhances overall quality of life (Shrivastava & Fatima, 2023). Similarly, another study found that individuals who practice yoga have significantly lower pulse rates compared to non-practitioners, further supporting the recommendation of yoga for cardiovascular health benefits (Samuel, 2020). This relationship is strengthened by findings showing that engaging in regular yogic practice for 12 weeks significantly decreases resting pulse rates through various mechanisms. Specifically, yoga promotes slow, deep, and rhythmic breathing, which activates the vagus nerve, inducing relaxation and lowering the heart rate. This practice enhances respiratory sinus arrhythmia, where the heart rate varies with the breathing cycle, contributing to a reduced resting pulse rate (Papp et al., 2013; Raghavendra et al., 2013). Moreover, long-term yogic practice has been found to decrease sympathetic nervous system activity, which is associated with the "fight or flight" response, thereby lowering the resting pulse rate (Krishna et al., 2014; Pandya et al., 2020). At the same time, yoga enhances parasympathetic nervous system activity, leading to a calmer physiological state and a reduced pulse rate (Shobana et al., 2022). Additionally, evidence suggests that individuals experiencing chronic stress tend to have higher resting pulse rates, while regular yoga practice has been shown to alleviate stress, resulting in a significant decrease in resting pulse rates (Zhang et al., 2016; Shohani et al., 2018). Collectively, these findings underscore the potential of yoga as a holistic practice to support cardiovascular health and improve overall well-being.

Participants who underwent a yoga-based intervention in the current study demonstrated significant improvements in respiratory rate compared to those in the control group, aligning with findings from prior research. For example, Manaspure and Gowda (2011) and Susmitha and Sowmya (2022) both reported a significant reduction in respiratory rate following yoga practice, reinforcing the current study's results. Similarly, Ruprai et al. (2013) observed a substantial decrease in respiratory rate after a 12-week yoga program ($p<0.001$). This reduction can be attributed to several physiological mechanisms associated with yoga, such as enhanced parasympathetic activity, as noted by Bezerra et al. (2014) in their 12-week yoga regimen. Additionally, Bernardi et al. (2002) proposed that slow breathing could improve baroreflex sensitivity, potentially contributing to the observed adaptation. Moreover, the reduction in respiratory rate during yoga breathing is likely due to increased vagal activity, suppressed sympathetic activity, and a diminished chemoreflex response to hypoxia, which may improve tissue oxygen delivery, as suggested by Aktar et al. (2013).

Further linking the present findings to previous research, the positive impact of yoga on breath-holding times – both Positive Breath-Holding Time (PBHT) and Negative Breath-Holding Time (NBHT) – was evident in the experimental group, which exhibited significant improvements compared to the control group. These results align with multiple studies supporting the effectiveness of yoga in enhancing breath-holding capacity. For instance, a study by Sivapriya and Veerapandian (2017) demonstrated a significant increase in breath-holding time in participants who practiced Pranayama for 45 minutes, five days a week, over six weeks. Similarly, Pietrangelo (2022) found that AnulomVilom improved lung function and endurance in competitive swimmers, contributing to enhanced breath-holding ability. Furthermore, research by Baghel and Shamkuwar (2017) highlighted the benefits of yogic breathing exercises, such as Pranayama, in improving negative breath-holding time, particularly in individuals with chronic respiratory conditions.

In summary, the results of this study provide compelling evidence for the beneficial effects of yogic practices on several critical physiological variables, including systolic blood pressure, diastolic blood pressure, resting pulse rate, respiratory rate, positive breath-holding time, and negative breath-holding time. These findings contribute to the existing body of literature, reinforcing the role of yogic practices as a valuable intervention for improving cardiovascular and respiratory function. Moreover, they underscore the potential of these practices as a holistic approach to enhancing overall physical health and well-being, further supporting their integration into health promotion strategies.

Conclusions

Based on the findings, the twelve-week yogic practices intervention resulted in significant improvements in key physiological variables – systolic blood pressure, diastolic blood pressure, resting pulse rate, respiratory rate, positive breath holding time, and negative breath holding time – within the experimental group, with no significant changes observed in the control group. These results suggest that the observed enhancements are directly attributable to the intervention, highlighting the potential effectiveness of yogic practices for improving cardiovascular and respiratory health. The lack of change in the control group reinforces the specificity of the intervention's impact. The implications of these findings are significant for integrating yogic practices into health and wellness programs, particularly for improving key physiological parameters. Future research should explore the long-term sustainability of these improvements and the potential for optimizing the intervention by varying its intensity or duration. Additionally, studies could examine the underlying mechanisms that drive the observed physiological changes and assess the broader applicability of yogic practices across different populations.

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