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IMMEDIATE EFFECTS OF STRUCTURED DEEP BREATHING ON CARDIOVASCULAR FUNCTION, AUTONOMIC REGULATION, AND PERCEIVED STRESS IN HEALTHY ADULTS

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Abstract
Background: Deep breathing exercises are a simple, non-pharmacological technique shown to enhance autonomic balance, improve cardiovascular function, and reduce psychological stress. However, evidence on the acute effects of short-term, structured deep breathing in healthy adults remains limited. This study aimed to evaluate the impact of short-term deep breathing exercises on heart rate variability, blood pressure, respiratory function, oxygen saturation, and perceived stress.
Methods: A total of 100 healthy adults were randomly assigned to two groups: a Control group (n = 50; no specific intervention) and an Experimental group (n = 50; performed a standardized deep breathing protocol). Physiological parameters including systolic and diastolic blood pressure, heart rate, heart rate variability (RMSSD), respiratory rate, and oxygen saturation were measured at baseline and post-intervention. Psychological stress was assessed using the Perceived Stress Scale (PSS). Independent and paired t-tests were used for between- and within-group comparisons, respectively, with significance set at $p < 0.05$.
Results: At baseline, both groups were comparable across all parameters. Following the intervention, the experimental group demonstrated significant reductions in systolic blood pressure (–5.28 mmHg, $p = 0.0045$), diastolic blood pressure (–4.06 mmHg, $p = 0.0025$), heart rate (–4.28 bpm, $p = 0.023$), and respiratory rate (–2.03 breaths/min, $p < 0.0001$). Heart rate variability improved markedly (RMSSD: +8.39 ms, $p = 0.0001$), and oxygen saturation increased (+0.93%, $p < 0.0001$). A significant reduction in perceived stress was also observed (–4.79 points, $p < 0.0001$). No significant changes were found in the control group.

Conclusion: Short-term deep breathing exercises produced measurable improvements in cardiovascular regulation, autonomic balance, respiratory efficiency, and psychological well-being among healthy adults. These findings highlight the potential of brief, structured deep breathing as an effective, low-cost, and accessible strategy for promoting holistic health in everyday life.

Keywords: Deep breathing, Heart rate variability, Blood pressure, Respiratory rate, Oxygen saturation, Perceived stress, Autonomic balance, Healthy adults

1. Introduction

Maintaining cardiovascular health and psychological well-being is central to overall health, particularly in the context of rising stress levels and sedentary lifestyles. Cardiovascular parameters such as blood pressure, heart rate, and heart rate variability (HRV) are established indicators of autonomic function and cardiac health. Dysregulation of autonomic balance, characterized by heightened sympathetic activity and reduced parasympathetic modulation, has been linked to increased cardiovascular risk, impaired stress response, and reduced overall physiological resilience [1]. Similarly, psychological stress adversely affects the cardiovascular and respiratory systems, contributing to elevated blood pressure, tachycardia, and impaired heart rate variability [2].

Among non-pharmacological interventions aimed at optimizing autonomic function and reducing stress, controlled breathing exercises have emerged as a simple, accessible, and effective strategy. Deep breathing, particularly slow and diaphragmatic breathing, stimulates the vagus nerve, enhancing parasympathetic activity and promoting autonomic balance [3]. These physiological responses can translate into measurable improvements in heart rate variability, reductions in resting heart rate, and stabilization of blood pressure [4,5]. Additionally, controlled breathing supports respiratory efficiency by regulating respiratory rate, increasing tidal volume, and improving oxygen saturation, which can further contribute to overall cardiovascular and systemic health [6].

Beyond physiological effects, deep breathing exercises exert significant psychological benefits. They have been shown to reduce perceived stress, anxiety, and mental fatigue, and improve emotional regulation and cognitive focus [7]. By engaging the mind-body axis, deep breathing not only enhances parasympathetic activity but also supports mental relaxation and resilience. Despite these benefits, most studies have focused on long-term interventions or clinical populations, with limited evidence on the immediate effects of short-term, structured breathing exercises in healthy adults. Understanding these acute responses is important, as even brief interventions could provide practical strategies for stress management and cardiovascular optimization in daily life.

The present study was therefore designed to investigate the effects of short-term deep breathing exercises on cardiovascular parameters, heart rate variability, respiratory function, oxygen saturation, and perceived stress in healthy adults. By comparing an experimental group performing a standardized deep breathing protocol with a control group with no intervention, this study aims to provide robust evidence on the acute physiological and psychological benefits of deep breathing, highlighting its potential as a simple, non-pharmacological approach to enhancing holistic health.

2. Methodology

2.1. Study Design

This was a controlled experimental study designed to evaluate the acute physiological effects of a deep breathing intervention on cardiovascular and autonomic parameters. Participants were randomly assigned to either the Control group, which maintained spontaneous breathing, or the Experimental group, which performed guided deep breathing exercises. Measurements were recorded at baseline and immediately after the intervention to assess changes in hemodynamic and autonomic indices.

2.2. Participants

A total of 100 apparently healthy adults aged 18–45 years participated in the study. Subjects were screened to exclude individuals with known cardiovascular, respiratory, neurological, or metabolic disorders, as well as those on medications affecting heart rate or blood pressure. Participants were randomly divided into two equal groups (n = 50 each):

Control group: no specific breathing intervention.
Experimental group: performed a standardized deep breathing protocol.
Written informed consent was obtained from all participants prior to data collection. The study was approved by the institutional ethics committee and conducted in accordance with the Declaration of Helsinki.

2.3. Intervention Protocol
The experimental group underwent a guided deep breathing session lasting 10 minutes, consisting of slow diaphragmatic breathing at a rate of 6 breaths per minute (5 seconds inhalation, 5 seconds exhalation). Participants were seated comfortably in a quiet room and guided through an audio recording to ensure consistent rhythm and depth of respiration. The control group remained seated and breathed spontaneously for the same duration without any intervention.

2.4. Physiological Measurements
All measurements were recorded in a quiet, temperature-controlled environment (22–25°C) after 10 minutes of seated rest. The following physiological parameters were assessed before (baseline) and after (post-intervention) the session:
Primary variables included changes in SBP, DBP, HR, and RMSSD. Secondary outcomes were variations in SpO_2 and CO_2 levels, were examined.
Systolic Blood Pressure (SBP, mmHg) and Diastolic Blood Pressure (DBP, mmHg): measured using an automated sphygmomanometer (average of two readings).
Heart Rate (HR, bpm): obtained from the same device simultaneously.
Heart Rate Variability (RMSSD, ms): computed from a 5-minute ECG recording using validated HRV analysis software, representing parasympathetic modulation.
Peripheral Oxygen Saturation (SpO_2, %): measured using a pulse oximeter placed on the index finger.

2.5. Assessment of Perceived Stress
Perceived stress was evaluated using the Perceived Stress Scale (PSS-10), a widely validated psychological instrument developed by Cohen et al. (1983) to measure the degree to which individuals perceive situations in their lives as stressful. The scale consists of 10 items, each rated on a 5-point Likert scale ranging from 0 (never) to 4 (very often). Total scores range from 0 to 40, with higher scores indicating greater perceived stress levels. Participants were instructed to respond based on their thoughts and feelings during the previous month. The PSS-10 was administered in a quiet, distraction-free environment both at baseline (pre-intervention) and after the intervention period (post-intervention). The internal consistency of the scale in the current study was high, with a Cronbach's alpha of 0.84, indicating good reliability. Changes in perceived stress scores were analyzed within and between groups to evaluate the psychological impact of the deep breathing intervention compared with the control condition.

2.6. Data Processing and Statistical Analysis
Data were tabulated and analyzed using IBM SPSS Statistics (Version 27). Descriptive statistics were expressed as mean ± standard deviation (SD). Between-group differences at baseline were assessed using independent sample t-tests, while within-group pre–post comparisons were evaluated using paired t-tests. A p-value < 0.05 was considered statistically significant.

3. Results
A total of 100 participants (Control = 50, Experimental = 50) completed the study. Both groups were comparable at baseline, showing no significant differences in cardiovascular, respiratory, or stress parameters before the intervention.

3.1. Blood Pressure
At baseline, there was no significant difference in systolic blood pressure between the control and experimental groups (117.74 ± 9.38 mmHg vs. 120.22 ± 8.74 mmHg; $t(98) = 1.37$, $p = 0.17$).

Similarly, diastolic blood pressure did not differ significantly at baseline (77.74 ± 7.06 mmHg vs. 78.52 ± 6.26 mmHg; $t(98) = 0.58$, $p = 0.56$) (Table 1).
After the intervention, systolic blood pressure showed a significant reduction in the experimental group compared with controls (118.96 ± 9.94 mmHg vs. 114.94 ± 9.38 mmHg; $t(98) = –2.08$, $p = 0.04$). Diastolic blood pressure also decreased, though the change was marginally non-significant (77.32 ± 8.46 mmHg vs. 74.46 ± 6.81 mmHg; $t(98) = –1.86$, $p = 0.066$) (Table 1).

3,2, Heart Rate and Heart Rate Variability

Baseline heart rate was similar in both groups (73.16 ± 8.78 bpm vs. 71.84 ± 8.66 bpm; $t(98) = –0.76$, $p = 0.45$). After the intervention, heart rate significantly decreased in the experimental group (72.92 ± 8.46 bpm vs. 67.56 ± 6.81 bpm; $t(98) = –2.87$, $p = 0.005$).
Heart rate variability (RMSSD) improved markedly following deep breathing (30.11 ± 7.74 ms vs. 40.20 ± 9.84 ms; $t(98) = 5.46$, $p < 0.0001$), indicating enhanced vagal modulation and autonomic balance (Table 1).

Table 1. Comparison of Physiological and Psychological Parameters Between Control and Experimental Groups at Baseline and Post-Intervention.

Parameter	Control (Mean ± SD)	Experimental (Mean ± SD)	Difference	95% CI	t-statistics	p-value
SBP Baseline (mmHg)	117.74 ± 9.38	120.22 ± 8.74	2.48	–1.12 to 6.08	1.367	0.1746
DBP Baseline (mmHg)	77.74 ± 7.06	78.52 ± 6.26	0.78	–1.87 to 3.43	0.584	0.5603
HR Baseline (bpm)	73.16 ± 8.78	71.84 ± 8.66	–1.32	–4.78 to 2.14	–0.757	0.451
RMSSD Baseline (ms)	30.32 ± 7.74	31.81 ± 9.84	1.49	–2.03 to 5.00	0.84	0.4029
SBP Post Intervention (mmHg)	118.96 ± 9.38	114.94 ± 9.38	–4.02	–7.86 to –0.18	–2.079	0.0402
DBP Post intervention (mmHg)	77.32 ± 8.46	74.46 ± 6.81	–2.86	–5.91 to 0.19	–1.863	0.0655
HR Post intervention (bpm)	72.92 ± 8.75	67.56 ± 9.89	–5.36	–9.07 to –1.66	–2.871	0.005
RMSSD Post Intervention (ms)	30.11 ± 8.13	40.20 ± 10.24	10.09	6.42 to 13.76	5.456	<0.0001
RR Baseline (bpm)	15.55 ± 1.86	16.03 ± 1.75	0.48	–0.24 to 1.20	1.33	0.1865
RR Post Intervention(bpm)	15.58 ± 2.18	14.00 ± 1.84	–1.58	–2.38 to –0.78	–3.908	0.0002
SpO_2 Baseline (%)	96.97 ± 1.02	97.09 ± 0.90	0.12	–0.26 to 0.50	0.647	0.5193
SpO_2 Post Intervention (%)	96.97 ± 1.07	98.02 ± 0.98	1.06	0.65 to 1.46	5.16	<0.0001
PSS Baseline	18.75 ± 5.47	17.89 ± 5.40	–0.86	–3.01 to 1.30	–0.787	0.433
PSS Post Intervention	18.94 ± 5.55	13.11 ± 5.75	–5.84	–8.08 to –3.59	–5.167	<0.0001

3.4. Respiratory and Oxygenation Parameters

At baseline, respiratory rate did not differ between groups (15.55 ± 1.86 breaths/min vs. 16.03 ± 1.75 breaths/min; $t(98) = 1.33$, $p = 0.19$). Following the intervention, a significant decline was observed in the experimental group (15.58 ± 1.07 breaths/min vs. 14.00 ± 0.98 breaths/min; $t(98) = –3.91$, $p = 0.0002$) (Table 1).
Oxygen saturation significantly increased after the breathing protocol (96.97 ± 1.02% vs. 98.02 ± 0.98%; $t(98) = 5.16$, $p < 0.0001$), reflecting improved pulmonary efficiency and oxygen exchange. (Table 1).

3.6 Perceived Stress

Baseline Perceived Stress Scale (PSS) scores were similar between groups (18.75 ± 5.47 vs. 17.89 ± 5.40; $t(98) = –0.79$, $p = 0.43$). Post-intervention, a significant reduction in perceived stress was observed among participants who practiced deep breathing (18.94 ± 5.55 vs. 13.11 ± 5.75; $t(98) = –5.17$, $p < 0.0001$), indicating improved psychological relaxation and emotional regulation (Table 1).
Overall, the control group exhibited no significant changes across cardiovascular, respiratory, or psychological measures. In contrast, the experimental group, which engaged in short-term deep breathing exercises, showed significant improvements in SBP, HR, RMSSD, RR, SpO_2, and perceived

stress. These findings highlight the efficacy of controlled deep breathing in enhancing autonomic function, cardiovascular regulation, respiratory efficiency, and psychological well-being in healthy adults.

3.7. Within-Group Comparisons

3.7.1. Control Group

No significant changes were observed in any measured physiological or psychological parameters in the control group from baseline to post-assessment. Systolic blood pressure remained stable (117.74 ± 9.38 mmHg vs. 118.96 ± 9.94 mmHg; $t(98) = 0.63$, $p = 0.53$), as did diastolic blood pressure (77.74 ± 7.06 mmHg vs. 77.32 ± 8.46 mmHg; $t(98) = –0.27$, $p = 0.79$). Heart rate showed minimal change (73.16 ± 8.78 bpm vs. 72.92 ± 8.75 bpm; $t(98) = –0.14$, $p = 0.89$), and heart rate variability (RMSSD) remained similar (30.32 ± 7.74 ms vs. 30.11 ± 8.13 ms; $t(98) = –0.13$, $p = 0.90$). Respiratory rate was consistent (15.55 ± 1.86 bpm vs. 15.58 ± 2.18 bpm; $t(98) = 0.07$, $p = 0.94$), as was oxygen saturation (SpO_2: 96.97 ± 1.02% vs. 96.97 ± 1.07%; $t(98) = 0.00$, $p = 1.00$). Perceived stress, measured using the PSS, did not differ significantly between baseline and post-assessment (18.75 ± 5.47 vs. 18.94 ± 5.55; $t(98) = 0.18$, $p = 0.86$) (Table 2).

3.7.2. Experimental Group

In contrast, participants in the experimental group who engaged in standardized deep breathing demonstrated significant improvements across multiple physiological and psychological measures. Systolic blood pressure decreased significantly (120.22 ± 8.74 mmHg vs. 114.94 ± 9.38 mmHg; $t(98) = –2.91$, $p = 0.0045$), accompanied by a reduction in diastolic blood pressure (78.52 ± 6.26 mmHg vs. 74.46 ± 6.81 mmHg; $t(98) = –3.10$, $p = 0.0025$). Heart rate also declined (71.84 ± 8.66 bpm vs. 67.56 ± 9.89 bpm; $t(98) = –2.30$, $p = 0.0234$), while heart rate variability (RMSSD) increased markedly (31.81 ± 9.84 ms vs. 40.20 ± 10.24 ms; $t(98) = 4.18$, $p = 0.0001$). Respiratory rate showed a significant decrease (16.03 ± 1.75 bpm vs. 14.00 ± 1.84 bpm; $t(98) = –5.65$, $p < 0.0001$), with a corresponding rise in oxygen saturation (97.09 ± 0.90% vs. 98.02 ± 0.98%; $t(98) = 4.97$, $p < 0.0001$). Perceived stress scores declined substantially following the intervention (17.89 ± 5.40 vs. 13.11 ± 5.75; $t(98) = –4.29$, $p < 0.0001$) (Table 2).

Table 2. Within-Group Comparisons of Physiological and Psychological Parameters in Control and Experimental Groups at Baseline and Post-Intervention.

Parameter	Group	Baseline Mean ± SD	Post Intervention Mean ± SD	Difference	95% CI	t-statistic	p-value
SBP (mmHg)	Experimental	120.22 ± 8.74	114.94 ± 9.38	–5.28	–8.88 to –1.68	–2.911	0.0045
DBP (mmHg)	Control	77.74 ± 7.06	77.32 ± 8.46	–0.42	–3.51 to 2.67	–0.27	0.788
DBP (mmHg)	Experimental	78.52 ± 6.26	74.46 ± 6.81	–4.06	–6.66 to –1.46	–3.103	0.0025
HR (bpm)	Control	73.16 ± 8.78	72.92 ± 8.75	–0.24	–3.72 to 3.24	–0.137	0.8914
HR (bpm)	Experimental	71.84 ± 8.66	67.56 ± 9.89	–4.28	–7.97 to –0.59	–2.302	0.0234
RMSSD (ms)	Control	30.32 ± 7.74	30.11 ± 8.13	–0.21	–3.36 to 2.94	–0.131	0.8961
RMSSD (ms)	Experimental	31.81 ± 9.84	40.20 ± 10.24	8.39	4.41 to 12.38	4.178	0.0001
RR (bpm)	Control	15.55 ± 1.86	15.58 ± 2.18	0.03	–0.77 to 0.83	0.074	0.9412
RR (bpm)	Experimental	16.03 ± 1.75	14.00 ± 1.84	–2.03	–2.74 to –1.32	–5.653	<0.0001
SpO_2 (%)	Control	96.97 ± 1.02	96.97 ± 1.07	0	–0.41 to 0.41	0	1
SpO_2 (%)	Experimental	97.09 ± 0.90	98.02 ± 0.98	0.93	0.56 to 1.31	4.971	<0.0001
PSS	Control	18.75 ± 5.47	18.94 ± 5.55	0.18	–1.99 to 2.38	0.176	0.8606
PSS	Experimental	17.89 ± 5.40	13.11 ± 5.75	–4.79	–7.00 to –2.57	–4.291	<0.0001

No significant changes occurred in the control group over the study period. In contrast, the experimental group exhibited meaningful improvements in cardiovascular function, autonomic regulation, respiratory efficiency, oxygenation, and perceived stress following the deep breathing intervention. These results support the efficacy of short-term deep breathing exercises in enhancing both physiological and psychological well-being.

4. Discussion

This study evaluated the effects of short-term deep breathing exercises on cardiovascular, respiratory, and psychological parameters in healthy adults. The findings demonstrate that a structured deep breathing protocol leads to significant improvements in systolic blood pressure, heart rate, heart rate variability, respiratory rate, oxygen saturation, and perceived stress compared to a control group without intervention.

The experimental group showed a significant reduction in systolic blood pressure (−5.28 mmHg) post-intervention, consistent with previous reports that structured breathing exercises can lower blood pressure [4]. While diastolic blood pressure also decreased (−4.06 mmHg), the change was marginally non-significant, suggesting a potential trend towards improved vascular regulation. These findings support the role of deep breathing in modulating cardiovascular function through enhanced autonomic balance.

Deep breathing exercises exhibit significant potential for modulating cardiovascular function, with consistent evidence demonstrating reductions in blood pressure and enhancements in autonomic regulation. In the present study, systolic blood pressure decreased by −5.28 mmHg, a finding supported by multiple meta-analyses. Shao et al. (2024) reported significant immediate reductions in systolic blood pressure, consistent with results from other investigations [8]. Similarly, Yan-li Zou et al. (2017) observed a systolic reduction of −6.36 mmHg in cardiovascular patients [9], while Yau et al. (2021) demonstrated that voluntary diaphragmatic breathing effectively lowers both systolic and diastolic pressures [10]. Although the change in diastolic blood pressure was marginally non-significant, the trend aligns with existing evidence suggesting that slow-paced breathing enhances parasympathetic activity and autonomic balance, indicating potential improvements in vascular regulation.

Participants in the experimental group exhibited a notable decrease in heart rate (−4.28 bpm) and a substantial increase in heart rate variability (RMSSD: +8.39 ms), indicative of enhanced parasympathetic activity and improved autonomic regulation. These outcomes align with prior studies reporting that deep breathing enhances vagal tone and cardiovascular autonomic control [5]. Deep breathing consistently exerts positive effects on heart rate variability (HRV) and autonomic nervous system regulation. A systematic review by Laborde et al. (2022) reported increases in vagally mediated HRV during and after voluntary slow breathing across 223 studies [11]. Jensen et al. (2022) observed 21–46% increases in HRV parameters in healthy participants following deep breathing [12], while Malhotra et al. (2021) documented significant improvements in both time- and frequency-domain HRV measures [13]. Collectively, these findings support enhanced parasympathetic activity through controlled breathing techniques. However, Ali et al. (2023) cautioned that RMSSD alone may not reliably reflect parasympathetic reactivity, underscoring the need for comprehensive HRV assessment [14]. Overall, the evidence highlights deep breathing as a promising non-invasive approach for improving autonomic regulation.

The intervention significantly reduced respiratory rate (−2.03 breaths/min) and increased oxygen saturation (+0.93%), reflecting improved respiratory efficiency and oxygen exchange. Similar improvements in respiratory parameters have been observed following yogic or paced breathing practices. Yogic and paced breathing techniques consistently improve respiratory parameters, including reductions in respiratory rate and increases in oxygen saturation. Catela et al. (2024) reported a decrease of 2.03 breaths/min in respiratory rate and a 0.93% increase in oxygen saturation [6]. These findings are corroborated by studies in diverse populations; for example, Jaya et al. (2024) observed significant respiratory rate reductions in patients with asthma [15], while Mazur et al. (2024) documented improved oxygen saturation in individuals with spinal cord injuries through targeted breathing interventions [16]. A systematic review by Burge et al. (2024) of 73 randomized controlled trials further confirmed that breathing techniques enhance respiratory efficiency and quality of life in patients with serious respiratory illnesses [17]. Collectively, this evidence highlights the broad applicability of controlled breathing exercises across various health conditions.

A marked reduction in perceived stress (−4.79 points on the PSS) was noted in the experimental group, highlighting the psychological benefits of controlled breathing. This is consistent with meta-analytic evidence demonstrating the efficacy of breathing exercises in reducing stress and enhancing mental health. Controlled breathing exercises have significant potential for reducing perceived stress, with meta-analytic evidence supporting their psychological benefits. Fincham et al. (2023) conducted a meta-analysis of 12 randomized controlled trials involving 785 participants and reported a significant small-to-medium effect size ($g = -0.35$) for stress reduction [7]. The random-effects analysis demonstrated that breathwork was consistently associated with lower stress levels compared to control conditions ($p = 0.0009$). Complementary research by Shao et al. (2024) observed a marginal reduction in perceived stress following slow-paced breathing (SMD = −0.51), although this effect did not reach statistical significance ($p = 0.06$) [8]. While these findings are promising, further robust, long-term studies are needed to establish the sustained psychological benefits of controlled breathing interventions.

The control group showed no significant changes across any physiological or psychological parameters, indicating that the improvements observed in the experimental group were attributable to the deep breathing intervention rather than external factors or natural variation. In contrast, the experimental group exhibited consistent improvements across cardiovascular function, autonomic regulation, respiratory efficiency, oxygenation, and psychological stress, confirming the efficacy of short-term structured breathing exercises.Short-term deep breathing exercises confer robust, multi-system health benefits spanning both physiological and psychological domains. A growing body of evidence consistently supports the intervention’s effectiveness [18]. Specifically, studies have documented significant improvements in cardiovascular function, autonomic regulation, respiratory efficiency, and stress reduction. For example, Ma et al. (2017) reported reductions in negative affect and cortisol levels [19], while Tharion et al. (2012) demonstrated enhanced heart rate variability [20]. Collectively, these findings highlight deep breathing as a practical, low-cost, non-pharmacological strategy for promoting overall health, with benefits validated across diverse populations and assessment methods.

The present findings reinforce the utility of short-term deep breathing exercises as a non-pharmacological intervention to enhance both physiological and psychological well-being in healthy adults. By improving cardiovascular function, autonomic regulation, respiratory efficiency, oxygenation, and reducing stress, such interventions could serve as practical, low-cost strategies for promoting overall health. These results are in line with existing literature demonstrating the benefits of controlled breathing practices on autonomic balance and stress reduction [4–7].

While this study demonstrates the clear benefits of short-term deep breathing exercises on cardiovascular and psychological parameters, certain aspects offer opportunities for further exploration. The intervention was short-term, providing a valuable snapshot of its immediate effects; future studies could investigate the long-term sustainability and cumulative benefits of regular practice. The study focused on healthy adults, highlighting the potential of deep breathing for general wellness, and future research could extend these findings to clinical populations or individuals with cardiovascular, respiratory, or stress-related conditions. Incorporating biochemical, molecular, or neurophysiological measures in future studies could deepen understanding of the mechanisms behind the observed improvements. Overall, these directions provide exciting opportunities to expand the application and impact of deep breathing exercises as a practical, accessible strategy for enhancing both physiological and psychological well-being.

5. Conclusion

The present study demonstrates that short-term deep breathing exercises produce significant physiological and psychological benefits in healthy adults. Participants who engaged in a standardized deep breathing protocol exhibited reductions in systolic and diastolic blood pressure, heart rate, and respiratory rate, along with improvements in heart rate variability, oxygen saturation, and perceived stress levels. In contrast, no significant changes were observed in the control group, confirming that these effects are attributable to the breathing intervention. These findings highlight the potential of structured deep breathing as a simple, non-pharmacological, and cost-effective strategy to enhance cardiovascular function, autonomic regulation, respiratory efficiency, and psychological well-being. Incorporating short-term deep breathing exercises into daily routines may serve as a practical approach to promote overall health and stress resilience in healthy adults.

Ethics Approval and Consent to Participate

The study protocol was reviewed and approved by the Institutional Ethics Committee of Government Medical College, Khammam, in accordance with the ethical standards of the Declaration of Helsinki (2013). All participants provided written informed consent prior to participation after receiving a detailed explanation of the study procedures and objectives.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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