International Journal of Healthcare and Medical Sciences
ISSN(e): 2414-2999, ISSN(p): 2415-5233
Vol. 10, Issue. 3, pp: 20-26, 2024
URL: https://arpgweb.com/journal/journal/13
DOI: https://doi.org/10.32861/ijhms.103.20.26

Academic Research Publishing Group

Original Research **Open Access**

The Effects of a Novel Deep Breathing Program for Weight Reduction and Cholesterol Metabolism

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Article History
Received: 18 May, 2024
Revised: 21 June, 2024
Accepted: 25 July, 2024
Published: 31 July, 2024

Abstract

Background: Previous studies have demonstrated the positive impact of yoga and deep breathing exercises on overall physical wellness. The effects of deep breathing alone on metabolic rate, weight, and cholesterol management have not been studied well. Objective: This study assessed changes in weight and metabolic markers following a 30-day intervention of a 12-minute deep breathing program. Methods: Sixty-six participants with a BMI >27 kg/m2 and 18-70 years were enrolled in this study. Participants were assigned to either the control or intervention group in a single-blinded manner. The intervention group followed the novel deep breathing program, while the control group did not modify their lifestyle or exercise. Anthropometric measurements and metabolic markers were evaluated and compared between the two groups after 30 days. Results: After 30 days, the control group exhibited no significant change in mean weight. The intervention group showed a significant mean weight reduction of 1.3 kg. The intervention group experienced a remarkable average decrease of 22.53 mg/dL in cholesterol levels, while the control group had an increase of 7.2 mg/dL. The 12-minute deep breathing sessions were associated with a significant increase in growth hormone and lung function. It was also associated with decreased glycosylated haemoglobin, creatine, inflammatory markers, and cholesterol levels. Conclusion: A guided deep breathing program can lead to reductions in markers of obesity among clinically overweight patients, even without additional lifestyle modifications. Further investigations are warranted to explore the effects of novel deep breathing programs on metabolic markers and elucidate the underlying mechanisms of weight loss.

Keywords: Deep breathing; Weight loss; Metabolic markers; Obesity; Randomized controlled trial.

1. Introduction

The global prevalence of obesity has significantly increased, with the number of overweight or obese adults reaching 1.9 billion in 2016 [1]. Obesity-related diseases contribute to millions of deaths and disabilities annually. Studies indicate that individuals with obesity incur higher medical care expenses, ranging from 30% more to a significant portion of a country's healthcare costs [2]. Traditional weight management approaches typically involve modifications in dietary habits, physical activity, and behavior [3]. However, exploring additional adjunctive interventions, such as deep breathing exercises, to enhance weight loss outcomes has garnered scientific interest. Deep breathing exercises are structured practices aimed at promoting relaxation, reducing stress, and improving overall well-being [4]. These programs emphasize the power of conscious breathing and teach individuals how to utilize their breath as a tool to manage their physical and mental states effectively. Deep breathing has been used for centuries in various cultures and is a fundamental component of practices like yoga, meditation, and mindfulness [5]. Mindful meditation and deep breathing exercises have been shown to improve the quality of life of individuals [6]. Deep breathing exercises encompass various techniques that emphasize diaphragmatic breathing, leading to increased oxygen intake and relaxation responses [7]. They have gained significant attention as a complementary approach to promote overall well-being and improve various aspects of health. While primarily recognized for their relaxation and stress-reducing benefits, deep breathing exercises have also been suggested to influence weight loss.

The fundamental principle behind deep breathing programs is to engage in slow, deliberate, and controlled breaths, focusing on the inhalation and exhalation processes. By breathing deeply, individuals increase the intake of oxygen, which can have a range of positive effects on the body and mind [8]. Deep breathing stimulates the parasympathetic nervous system, responsible for the body's rest-and-digest response, leading to a cascade of physiological changes that promote relaxation and stress reduction [9].

Common deep breathing techniques that are often incorporated into deep breathing programs include diaphragmatic breathing, box breathing and 4-7-8 breathing among many other techniques [10-12]. Deep breathing programs can be practiced in various settings and formats, including individual sessions, group classes, online courses, or guided meditation apps [13]. These programs typically provide instructions on how to perform the techniques correctly and offer guidance on incorporating deep breathing into daily routines. They may also incorporate other elements such as visualization, body scan exercises, or progressive muscle relaxation to enhance the overall relaxation experience.

Research has shown that regular deep breathing practice can have numerous benefits, including stress reduction, improved emotional well-being, enhanced focus and concentration, lowered blood pressure and better sleep [14]. A literature review examined the effects of diaphragmatic breathing on physiological and psychological measures in individuals with prehypertension or hypertension and demonstrated that voluntary diaphragmatic deep breathing led to decreased blood pressure, reduced heart rate, relaxation, and decreased anxiety. The review concluded that diaphragmatic breathing at a rate of less than 10 or 6 breaths per minute for 10 minutes, twice a day, over duration of 4 weeks, produced positive outcomes [15]. In a quasi-experimental study, the effectiveness of the DanJeon Breathing Exercise Program (DJBEP) as a nursing intervention for improving the quality of life in kidney transplant recipients was examined. The results indicated that the DJBEP reduced stress and uncertainty in kidney transplant recipients. Additionally, it showed positive effects on serum cholesterol and serum creatinine levels [16]. Another study examined the effectiveness of yoga and breathing exercises on antioxidant enzyme levels (superoxide dismutase), glycosylated hemoglobin (HbA1c), and fasting blood glucose levels in individuals with diabetes. The results indicated that the exercises increased superoxide dismutase levels and decreased glycosylated Hb and glucose levels in the experimental group compared to the control group. These findings suggest that yoga enhances the body's antioxidant defence mechanism and reduces oxidative stress in individuals with diabetes [17]. Chaya et al. investigated the overall change in the basal metabolic rate (BMR) of individuals practicing a combination of yoga practices (asana, meditation, and pranayama) for at least six months [18]. The results showed that the BMR of the yoga practitioners was significantly lower compared to the control group. The reduction in BMR was around 13%, and this difference was more pronounced in women compared to men. Another quasi-interventional study investigated the impact of breathing exercises using an Incentive Spirometer (IS) on C-reactive protein (CRP) levels (a marker of systemic inflammation) and lipid ratios in individuals with chronic spinal cord injury. The results indicated that although the exercises improved lung function and the LDL/HDL ratio, they did not decrease systemic inflammation levels (CRP) in the patients [19]. While most of these studies indicate the positive effect on the overall health of individuals who practice yoga and breathing exercises, there is little evidence to support that deep breathing can aid in weight loss and management.

Herein, we report a randomized controlled single-blind study aimed to investigate the impact of a 12-minute deep breathing program on body weight, anthropometric parameters, concentration of blood metabolites and respiratory outcomes in overweight patients. The study seeks to contribute to the scientific understanding of the effects of deep breathing exercises on metabolic and cholesterol management. The findings of this research will help in integrating deep breathing exercises as adjunctive activities to promote a healthy lifestyle.

2. Methods

2.1. Study Design

This study employed a single-blinded randomized controlled trial design to evaluate the effects of a novel 12-minute deep breathing program on weight and metabolic changes in participants over a period of 30 days.

2.2. Participants

A total of 66 volunteers, 30 in intervention group and 36 in control group, were recruited for the study. Participants who had a BMI greater than 27 and fell within the age range 18-70 years were selected for the study. The participants were randomly assigned to either the control group or the intervention group.

2.3. Exclusion Criteria

- BMI < 27
- Age below 18 and above 70
- Patients with weight fluctuations over the last three months
- Patients with participation in weight loss program over past three months
- Patients with pacemakers or those taking Beta blocking medication

2.4. Randomization

The participants were randomly assigned to either the intervention group or the control group. A block randomization process was employed to maintain balance and prevent any statistical differences between the groups in terms of gender, age, and BMI. This process involved dividing the participants into blocks based on these variables. Within each block, an equal number of participants were allocated to the intervention and control groups. The allocation sequence was generated using a computer-generated random number sequence.

2.5. Blinding Protocol

A blinding protocol was implemented to ensure that the technicians performing measurements on the subjects remained unaware of which subjects belonged to the active group and which belonged to the control group. This blinding aimed to minimize potential biases during the measurement process. To maintain technician blinding, specific procedures were followed. Separate stations were established for subject check-in, which were physically separated from the measurement stations. This separation helped prevent the technicians from identifying the group allocation of the subjects while performing measurements.

2.6. Intervention

The intervention group was instructed to participate in a 12-minute deep breathing program for duration of 30 days. The deep breathing exercises were administered through a website, requiring participants to log in three times daily. The participants were provided with guided breathing exercises to follow during each session. The intervention group in this study followed a daily mind/body program that consisted of three short bouts of deep breathing and yoga poses performed daily during the entire study period. The first bout of deep breathing was a 12-minute duration performed in the morning before breakfast. The other two bouts were one minute each in duration, performed one before lunch and one before dinner. The participants received instructions for the deep breathing and yoga poses through pre-recorded video workout sessions accessible via an online mobile-friendly website. In addition to performing the three short bouts of deep breathing each day, the participants were instructed to stay well hydrated by consuming six 8-ounce glasses of water per day.

At the start of the program, the active group participants were provided login access to the website, which contained the deep breathing videos. Each participant had an individual account on the website used to intake initial survey questions and subject data integral to the intervention program. The website also logged the completed videos for each subject. The website was also used by the participants to log their water intake and provide input to additional survey questions prompted by the website while viewing the daily videos. They were instructed not to change other aspects of their lifestyle, including nutrition, eating habits, exercise, or other physical activities, to avoid confounding the benefits of the deep breathing program. The control group did not participate in the deep breathing program and maintained their usual lifestyle without any modifications to their diet or exercise behaviours during the trial period.

2.7. Data Collection

Anthropometric measurements were taken by technicians in a consistent manner using a scientific tape measure with a tensiometer. The tensiometer ensured that the measurements were taken at a consistent tension. Specifically, a Gulich tape measure was used for this purpose. To maintain consistency and minimize measurement variability, the same technician performed all measurements for all subjects throughout the entire measurement intervals. The technician ensured that the tape was placed consistently relative to body markers and horizontal levelness. Additionally, a second technician was present during the measurement process to observe and ensure the consistent placement of the tape to maintain accuracy and reliability in the measurement procedure. Weight measurements were recorded for all participants at the beginning of the study (day 0) and at the end of the 30-day trial period (day 30). The measurements were taken using standardized weighing scales.

Blood samples were collected on day 0 (baseline), day 10, and day 30 and analysis were conducted to evaluate metabolite concentrations including human growth hormone (HGH), total cholesterol, HDL, LDL, creatine, glucose, C-reactive protein (CRP), white blood cell (WBC) count, hemoglobin (HGB), glycosylated hemoglobin A1C (HbA1C), blood CO_2 and mean corpuscular hemoglobin (MCHC).

Respiratory outcomes were measured using New Diagnostic Design (NDC) easy one diagnostic spirometer which evaluated the parameters including ratio of tidal volume to slow vital capacity (V_T/SVC), forced vital capacity (FVC), ratio of Forced expiratory volume in one second to forced vital capacity (FEV_1/FVC), ratio of forced expiratory flow at the mid-portion of forced vital capacity to forced vital capacity (FEF_{25-75}/FVC), average rate of absorbance of oxygen (VO_{2Avg}), average respiratory frequency (RF_{Avg}), average tidal volume (TV_{Avg}) and average expiratory oxygen concentration (FeO_{2Avg}).

2.8. Statistical Analysis

All statistical analysis was carried out using R version 4.1.1, with linear mixed modeling completed using the package *lme4* (v1.1-31, [20]), and post-hoc testing using package *emmeans* (v1.8.5, [21]). Participants were categorized according to group (intervention vs. control) and time point (baseline, ten days, and thirty days following the intervention). Time was modeled as a continuous variable (number of days), with three time points per participant. Covariates included participant age, sex, and baseline BMI. Models included a random effect of participant to correct for repeated measures and allow intercept variability. The variance inflation factor (VIF) was calculated to ensure multicollinearity was negligible. For each model, residuals were tested using the Kolmogorov-Shapiro test for normality, as well as visually using QQ plots. In each outcome measure, outliers were removed at three standard deviations beyond the mean on a per-trial basis. One model was created per outcome measure, with FDR-adjusted *p*-values reported to correct for multiple comparisons. Post-hoc testing was completed to test the significance of changes over time for each group in outcomes with a significant group by time interaction. P value less than 0.05 was considered significant.

3. Results

The sample included 30 and 36 participants in the intervention and control groups, respectively. All sample characteristics are outlined in Table 1. There was no significant difference between the age, sex ratio, height, and other blood metabolite parameters of the participants between the two groups. The sample included 36.4% males, and had a mean age of 39±14.5 years. Notably, the intervention group had a significantly higher average BMI (35.4) at baseline than the control group (31.8), and so baseline BMI was controlled in all models. A comparison between the intervention and control groups revealed significant differences in the weight, BMI and HbA1C levels of the participants. While the control group had an average weight of 90.39±18.29 kg, average BMI of 31.82±5.86, and average HbA1C level of 5.49± 0.65%, the intervention group had an average weight of 100.87kg±17.63 kg, BMI of 221.92±38.79 and HbA1C of 5.98±0.73%. Two-tailed pairwise t-tests showed that these differences were significant with a p-value of 0.024, 0.020, and 0.006 for weight, BMI and HbA1C levels, respectively.

Table-1. Sample characteristics by group at baseline, with p-values reported using two-tailed pairwise t-tests, and significance shown

	Overall	Control	Intervention	Difference
Sample size	66	36	30	p
Age (Years)	39.03 (14.45)	37.47 (13.89)	40.90 (15.11)	0.341
Sex - M (%)	24 (36.4)	14 (38.9)	10 (33.3)	0.833
Height - Mean (SD) in inches	66.35 (3.51)	66.24 (3.58)	66.48 (3.49)	0.781
Weight - Mean (SD) in pounds	209.15 (41.19)	198.86 (40.67)	221.92 (38.79)	0.024*
BMI - Mean (SD)	33.40 (6.17)	31.82 (5.86)	35.37 (6.08)	0.020*
HGH - Mean (SD) ng/ml	6.19 (1.92)	6.02 (2.08)	6.39 (1.73)	0.447
HbA1C - Mean (SD)	5.72 (0.72)	5.49 (0.65)	5.98 (0.73)	0.006*
Cholesterol - Mean (SD) mg/dl	217.89 (46.49)	209.54 (45.53)	227.63 (46.43)	0.119
Creatine - Mean (SD) mg/dl	0.53 (0.26)	0.59 (0.29)	0.47 (0.20)	0.074
Glucose - Mean (SD)	104.40 (23.64)	101.83 (17.25)	107.40 (29.44)	0.347
HDL - Mean (SD) mg/dL	47.18 (15.28)	46.97 (14.68)	47.43 (16.21)	0.904
CO_2 - Mean (SD)	15.55 (4.47)	16.37 (4.83)	14.60 (3.87)	0.112
LDL - Mean (SD) mg/dl	156.22 (40.89)	149.03 (39.43)	164.60 (41.62)	0.127
CRP - Mean (SD) mg/L	9.71 (9.18)	8.85 (7.53)	10.70 (10.85)	0.423
WBC - Mean (SD)	3.68 (2.49)	3.80 (2.61)	3.55 (2.37)	0.687
HGB - Mean (SD) g/dL	14.69 (3.46)	14.62 (1.85)	14.76 (4.77)	0.873
MCHC - Mean (SD)	29.12 (2.13)	29.12 (2.02)	29.13 (2.29)	0.985

(*represents significant $p < 0.05$)

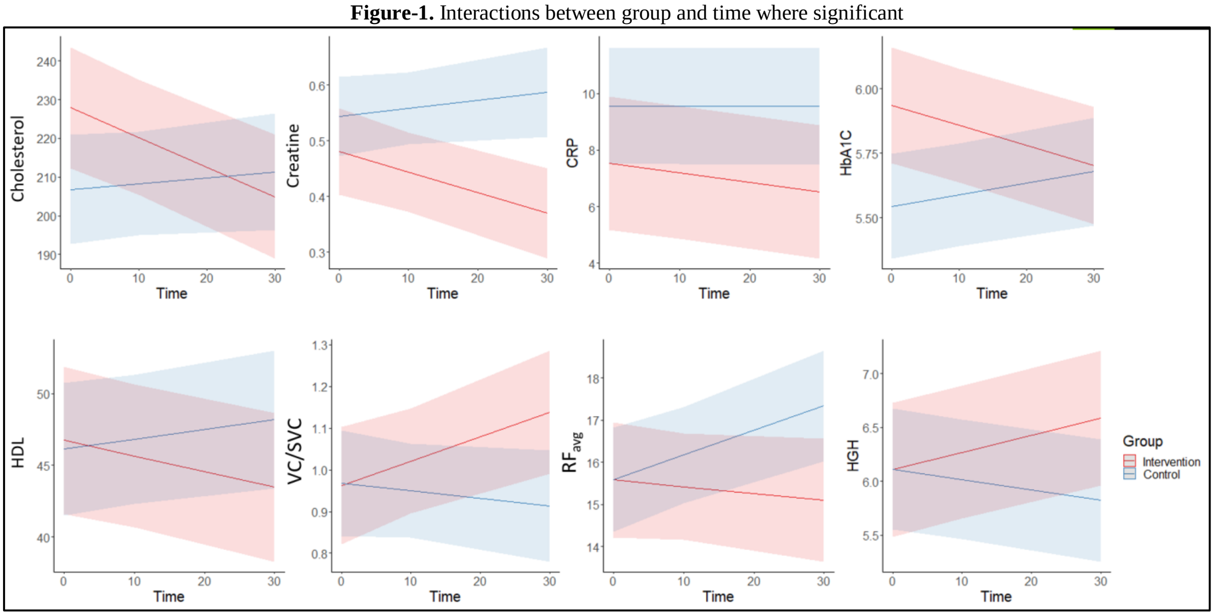
After 30 days, the intervention group reported to have lost an average 1.3 kg while the control group did not report to have lost any weight. In addition, the intervention group demonstrated a substantial average reduction of 22.53 mg/dL in their cholesterol levels, whereas the control group experienced an increase of 7.2 mg/dL. Primary focus was given on models that demonstrated a noteworthy interaction between group and time, as this would suggest a potential influence of the intervention on changes over time. To maintain conciseness, significant main effects of group were not presented (average group differences without changes over time), time (changes experienced by all participants over time), and covariates (such as age, sex, and baseline BMI) in the findings. In the intervention group, significant time interactions were observed for several outcome measures. Post-hoc testing was conducted to examine the significance of changes over time in each outcome for this group. The findings revealed that HGH levels significantly increased over time, while HbA1C and cholesterol levels showed significant decreases. Creatine levels also decreased significantly, indicating an intervention effect. However, HDL levels decreased significantly over time. CRP levels significantly decreased, indicating a positive response to the intervention. VT/SVC also increased significantly, which might suggest improved pulmonary function. However, there were no significant changes in CO_2, $FEF_{25\text{-}75}$/FVC ratio, FEV_1/ FVC ratio, and RF_{Avg} values. These results demonstrate the effectiveness of the deep breathing intervention program in influencing various outcome measures within the intervention group over time. On the other hand, no significant changes were found in cholesterol, creatine, HDL, blood CO_2, CRP, ratios of VT/SVC, $FEF_{25\text{-}75}$/FVC, and FEV_1/FVC. However, significant time interactions were observed for HGH and HbA1C levels, where a decrease in HGH and an increase in HbA1C% were observed over time. Notably, the control group also demonstrated a significant increase in RF_{Avg} over time. While the two groups significantly differed between one another in their changes over time for blood CO_2, $FEF_{25\text{-}75}$/FVC, and FEV_1/FVC, neither group showed statistically significant changes over time in isolation for these measures. These relationships are shown in Table 2 and Figure 1.

Table-2. Group by time interactions in outcome measures where significant, with post-hoc testing to demonstrate the significance of changes over time in each outcome for each group

		Intervention		Controls	
	Interaction	**Change per month**	**Significance**	**Change per month**	**Significance**
HGH ng/ml	F(1, 112)= 26.66, p < 0.001	0.48 (0.01)	t(112)= 4.60, p < 0.001*	-0.29 (0.01)	t(112= -2.72, p= 0.008*
HbA1C %	F(1, 111)= 25.42, p < 0.001	-0.23 (0.01)	t(111)= -4.53, p < 0.001*	0.13 (0.01)	t(112)= 2.6, p= 0.011*
Cholesterol mg/dL	F(1, 113)= 11.69, p= 0.003	-22.93 (0.19)	t(113)= -4.06, p < 0.001*	4.52 (0.19)	t(115)= 0.79, p= 0.431
Creatine mg/dL	F(1, 110)= 8.27, p= 0.015	-0.11 (0.01)	t(104)= -3.02, p= 0.003*	0.04 (0.01)	t(110)= 1.11, p= 0.268
HDL mg/dL	F(1, 113)= 7.25, p= 0.020	-3.28 (0.05)	t(112)= -2.35, p= 0.020*	2.07 (0.05)	t(113)= 1.46, p= 0.147
CO_2 mmol/L	F(1, 113)= 5.24, p= 0.041	-1.12 (0.02)	t(112)= -1.88, p= 0.062	0.82 (0.02)	t(114)= 1.36, p= 0.177
CRP mg/L	F(1, 108)= 6.39, p= 0.026	-1.01 (0.01)	t(108)= -3.56, p= 0.001*	-0.01 (0.01)	t(108)= -0.02, p= 0.984
VT/SVC	F(1, 120)= 5.41, p= 0.045	0.18 (0.01)	t(116)= 2.40, p= 0.018*	-0.05 (0.01)	t(117)= -0.82, p= 0.415
FEF_{25-75}/FVC	F(1, 123)= 5.00, p= 0.045	-0.24 (0.01)	t(122)= -1.69, p= 0.094	0.19 (0.01)	t(122)= 1.47, p= 0.144
FEV_1/FVC	F(1, 122)= 5.28, p= 0.045	-0.02 (0.01)	t(117)= -1.74, p= 0.085	0.02 (0.01)	t(119)= 1.51, p= 0.134
RF_{Avg}	F(1, 113)= 6.44, p= 0.050	-0.48 (0.02)	t(112)= -0.74, p= 0.458	1.75 (0.02)	t(113)= 2.94, p= 0.004*

Significant post-hoc tests are indicated (*represents significant p < 0.05). Outcomes with no significant interaction are not shown. Model-estimated change per month (mean and standard error) is shown for each group in each measure.

Figure-1. Interactions between group and time where significant



4. Discussion

This study aimed to investigate the effects of a novel 12-minute deep breathing program on weight reduction and cholesterol metabolism in overweight patients. The results showed promising outcomes, suggesting that guided deep breathing can decrease certain markers of obesity in clinically overweight patients, even in the absence of other lifestyle modifications. The results demonstrate that participants in the intervention group experienced a mean weight reduction of 1.3 kg over the course of 30 days, while the control group showed no significant change. This suggests that the deep breathing program had a positive impact on weight reduction. Furthermore, the intervention group exhibited a significant average decrease of 22.53 mg/dL in their cholesterol levels, while their counterparts in the control group showed an increase of 7.2 mg/dL. It indicates that the deep breathing program had a favorable effect on cholesterol metabolism. This also aligns with significant changes in metabolic markers including decrease in HbA1C, creatine, CRP levels and increase in HGH and VT/SVC in the intervention group.

These results align with previous studies that have shown the potential of deep breathing exercises, along with diet and exercise modifications, to increase the basal metabolic rate and promote weight loss in obese patients [22, 23]. Furthermore, lowering cholesterol levels is crucial for reducing the risk of cardiovascular diseases, which are often associated with obesity [24]. The findings of this study suggest that deep breathing exercises may contribute to cholesterol management in overweight individuals.

The observed effects of the deep breathing program on weight and cholesterol metabolism may be attributed to several mechanisms. Deep breathing exercises stimulate the parasympathetic nervous system, leading to relaxation responses and decreased stress levels [25]. Stress has been linked to weight gain and poor cholesterol metabolism [26]. By reducing stress through deep breathing, individuals may experience improved weight control and cholesterol regulation. In addition, deep breathing exercises increase oxygen intake, which can have positive effects on various physiological processes. Increased oxygenation may enhance metabolism, leading to weight reduction [27]. Moreover, deep breathing has been associated with improved respiratory function, which could contribute to better overall health and metabolic outcomes [28].

The results of this study support the integration of deep breathing exercises as adjunctive activities to promote a healthy lifestyle and aid in weight reduction and cholesterol management. Deep breathing programs are accessible, cost-effective, and can be easily incorporated into daily routines. They offer a non-invasive and non-pharmacological approach to addressing the global health issue of obesity.

4.1. Limitations of the Study

Several limitations should be considered when interpreting the results of this study. First, the study employed a single-blinded design, which may introduce bias. Although efforts were made to ensure blinding of the technicians performing measurements, it was not possible to blind the participants themselves. This may have influenced their perception and reporting of outcomes. Future studies could consider implementing a double-blinded design to minimize bias. Second, the study had a relatively short intervention period of 30 days. Longer-term studies are needed to assess the sustainability of the observed effects and determine whether the benefits of the deep breathing program persist over time. Third, the study focused on overweight participants with a BMI of 27 or higher. Further research is needed to explore the effects of deep breathing exercises on individuals with different levels of obesity and in diverse populations. Lastly, the study did not investigate the underlying mechanisms through which deep breathing exercises affect weight and cholesterol metabolism. Future studies could include assessments of biomarkers, hormone levels, and physiological responses to provide a deeper understanding of the mechanisms involved.

5. Conclusion

The study aimed to investigate the effects of a 12-minute deep breathing program on weight reduction and cholesterol metabolism in overweight patients. The results indicated that the deep breathing program had positive outcomes, demonstrating its potential to decrease markers of obesity and contribute to cholesterol management in overweight individuals. The intervention group, who participated in the deep breathing program, experienced a significant weight reduction over a 30-day period, while the control group showed no significant change in weight. Furthermore, the intervention group exhibited a significant average decrease in cholesterol levels. Lowering cholesterol levels is important for reducing the risk of cardiovascular diseases associated with obesity. This study suggests that guided deep breathing exercises have the potential to contribute to weight reduction and cholesterol management in overweight individuals, even in the absence of other lifestyle modifications. Future studies should address the limitations of this research by implementing a double-blinded design, conducting longer-term investigations, examining a broader range of BMI categories, and exploring the underlying mechanisms. By doing so, the effects of deep breathing exercises on weight reduction and cholesterol metabolism can be better understood, paving the way for more targeted and effective interventions in the future.

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