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UNLOCKING OXYGEN POTENTIAL: THE ROLE OF DEEP BREATHING ON VO_2MAX IN DIVERSE BMI GROUPS

Physiology

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ABSTRACT

Background: VO_2max, or maximal oxygen uptake, is a vital indicator of cardiovascular and respiratory fitness, yet research on the impact of deep breathing exercises on VO_2max across different BMI categories remains limited. Our study addresses this gap by examining both immediate and short-term effects of deep breathing on VO_2max among young adults with varying BMI levels. **Aim:** To evaluate the immediate and short-term effects of deep breathing exercises on VO_2max in young adult males across different BMI groups. **Methods:** This cross-sectional study was conducted among 100 male students aged 18-25 years. Participants were divided into BMI groups (normal weight, overweight, obese) and underwent baseline VO_2max assessment using indirect calorimetry with the Bruce Protocol on Day 1. A deep breathing routine, performed twice daily for 10 minutes, was continued over four weeks, with VO_2max reassessed on Day 2 (immediate effect) and Day 30 (short-term effect). **Results:** Baseline VO_2max showed significant variation among BMI groups ($p < 0.05$). After a single deep breathing session on Day 2, all groups saw VO_2max improvements, with the highest increase in the normal-weight group. By Day 30, all groups exhibited statistically significant VO_2max gains ($p < 0.05$), especially among normal-weight participants. **Conclusion:** Deep breathing exercises positively impact VO_2max in young adults, particularly in those of normal weight, suggesting an effective, non-invasive method for enhancing Cardiorespiratory fitness.

KEYWORDS

Vo_2max, deep breathing, BMI, Cardiorespiratory fitness, young adults

INTRODUCTION

Maximal oxygen uptake, or VO_2max, represents the maximum rate at which the body can utilize oxygen during intense exercise, serving as a key indicator of aerobic fitness and cardiovascular endurance[1]. VO_2max varies across individuals and is influenced by a variety of factors, including age, gender, body composition, and lifestyle habits. Research has demonstrated that both higher body mass index (BMI) and body fat percentage are associated with reduced VO_2max, potentially due to decreased respiratory function and increased work demand on the cardiovascular system[2,3].

In recent years, there has been a growing interest in the potential of non-exercise interventions, such as breathing exercises, to improve VO_2max and overall cardiopulmonary function. Deep breathing exercises are a simple, accessible form of respiratory training that may improve lung capacity, increase oxygen uptake, and enhance autonomic regulation[4]. Studies have shown that deep breathing exercises can have a positive effect on respiratory parameters by improving respiratory muscle strength, promoting oxygenation, and enhancing relaxation[5]. However, while there is supportive evidence on the beneficial impact of deep breathing on stress and blood pressure, the effect on VO_2max, particularly across different weight categories, remains under-explored.

Examining the influence of deep breathing on VO_2max in young adults across normal weight, overweight, and obese categories is essential, as obesity is increasingly prevalent and poses significant cardiovascular and metabolic risks[6]. Exploring this association could help determine if deep breathing exercises could serve as an effective intervention to improve aerobic fitness and respiratory health across diverse body compositions. Therefore, this study aims to assess the impact of deep breathing exercises on VO_2max in normal weight, overweight, and obese young adults, with a view to understanding the relationship between body weight, respiratory fitness, and aerobic capacity.

Methodology

Study Design And Participants

This cross-sectional study was conducted in the department of Physiology, Teerthankar Mahaveer University, Moradabad, Uttar Pradesh among 100 young adults aged 18-25 years, classified into three groups based on BMI: normal weight (BMI 18.5-24.9), overweight (BMI 25-29.9), and obese (BMI ≥30), as per WHO guidelines (World Health Organization, 2000). Participants were recruited from a university population and screened to ensure they were free of any respiratory or cardiovascular conditions that could affect VO_2max measurements. Informed consent was obtained from all participants, and the study was approved by the Institutional Ethics Committee. The sample size was calculated based on an expected mean difference in VO_2max values between groups and a desired statistical power of 80%, with a significance level set at $p < 0.05$. A minimum of 20 participants per BMI category was aimed for to ensure adequate power for between-group comparisons.

Deep Breathing Exercise Intervention

Participants in each group engaged in a structured deep breathing exercise routine designed to improve respiratory control and enhance oxygen uptake. The regimen involved participants taking slow, controlled breaths at a consistent rate of six breaths per minute—specifically, inhaling for five seconds, holding the breath for a brief pause, and then exhaling over five seconds. Each session lasted for 10 minutes, conducted twice daily, once in the morning and once in the evening, for a total of four weeks. To ensure adherence to the proper technique and minimize variation, the initial session for each participant was conducted under guided supervision by a trained instructor. This supervision helped to establish correct breathing mechanics, including diaphragmatic breathing, posture, and relaxation techniques. Weekly check-ins were conducted to monitor compliance, address any concerns, and provide corrective feedback as needed. Participants recorded each session in a log to track their progress and ensure consistency throughout the study period.

Vo_2max Measurement

VO_2max, or maximal oxygen uptake, was assessed using a digital spirometer integrated with an indirect calorimetry system, calibrated according to the manufacturer's guidelines before each testing session to ensure precision. VO_2max was measured using a graded exercise test on a motorized treadmill, employing the Bruce Protocol. This protocol is a well-established method that involves progressive increases in both speed and incline at three-minute intervals, creating a gradual rise in exercise intensity until the participant reaches volitional exhaustion.

During the test, participants wore a mask connected to the spirometer to capture exhaled gases, allowing for continuous monitoring of oxygen and carbon dioxide levels. VO_2max was determined as the highest oxygen uptake value recorded in ml/kg/min, defined as the

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plateau phase, where no significant increase in oxygen consumption was noted despite an increase in exercise intensity. The test was conducted in a controlled laboratory environment to maintain consistent conditions, and participants were encouraged verbally to reach their maximal exertion for accurate VO_2max assessment. To control for external variables, participants were instructed to maintain their usual physical activity levels and refrain from additional cardiovascular training during the study period. Dietary intake was also monitored through a weekly food diary to ensure consistent caloric intake across groups

RESULT

On the basis of BMI, participants were categorized in 3 groups NW, OW and OB. None of the participants were found underweight.

Table 1: Participants classification by BMI

Values	BMI(kg/m^2)	Classification
N-49	18-22.9	Normal
N-21	23.24.9	Overweight
N-30	More than 25	Obese

Table 2; Comparison of VO2 max ml/kg/min un-NW group (Normal weight)

Day	VO2max	p-value
Day1 & Day 2	34.76± 4.15 VS 36.33 ± 4,16	.000
Day 1 & day 30	34.76 ± 4.15 vs 41.86 ±4.10	.000

Significant improvement in vo2max is observed on 2nd day as well as on 30th day

Table 3; Comparison of VO2 max ml/kg/min un OW group (over weight)

Day	VO2max	p-value
Day1 & Day 2	34.43± 5.65 VS 35.87 ± 5.56	.000
Day 1 & day 30	34.43 ± 5.65 vs 41.13 ±5.50	.000

Significant improvement is observed on day 2 as well as on day 30

Table 4; Comparison of VO2 max ml/kg/min un-OB group (Obese)

Day	VO2max	p-value
Day1 & Day 2	32.71± 5.36 VS 34.39 ± 5.40	.000
Day 1 & day 30	32.71 ± 5.36 vs 38.98 ±5.36	.000

Significant improvement is observed on day 2 as well as on day 30

Table 5: Comparison of WC, HC, &WHR in NW participants on day 1 and day 30

Group NW N-49	Day 1 and Day 30	p-value
WC (in cm)	81.98 ± 5.34 vs 80.88 ± 5.44	.000
HC (in cm)	92.43 ± 5.20 vs 91.43 ± 5.37	.000
WHR (in cm)	0.888± 0.035 vs 0.888 ± 0.36	.010

Table 6 Comparison of WC, HC, &WHR in OW participants on day 1 and day 30

Group OW N-21	Day 1 and Day 30	p-value
WC (in cm)	87.57 ± 7.61 VS 86.48 ± 7.57	.000
HC (in cm)	97.52 ±7.60 VS 96.48±7.85	.000
WHR (in cm)	O.897±0.033 VS 0.896±0.031	.449

Table 7 Comparison of WC, HC, &WHR in OW participants on day 1 and day 30

Group OB N-30	Day 1 and Day 30	p-value
WC (in cm)	92.27 ± 9.31 VS 95.13 ± 9.31	.000
HC (in cm)	106.50 ±13.52 VS 103.63±8.35	.096
WHR (in cm)	O.907±0.06 VS 0.917±0.045	.323

These tables highlight significant improvements in VO_2 max across all BMI groups on Day 2 and Day 30, as well as reductions in WC and HC in NW and OW groups, with less significant change in WHR.

DISCUSSION

In this study, we evaluated the immediate and sustained effects of deep breathing exercises on VO_2 max in three BMI-based groups—normal weight (NW), overweight (OW), and obese (OB)—composed of 100 first-year MBBS students from TMMC & RC. Each participant's anthropometric parameters, including height, weight, BMI, waist circumference (WC), hip circumference (HC), and waist-to-hip ratio (WHR), along with VO_2 max values measured through the Queen's step test, were recorded on days 1, 2, and 30. The participants were categorized based on WHO's 1998 BMI criteria applicable to Indian populations, with 49% classified as NW, 21% as OW, and 30% as OB. Similar trends showing a higher prevalence of overweight and obesity in Indian medical students were noted in other studies, such as by Poobalan et al.[7] and Pradeepa et al.[8], with sedentary lifestyles and dietary factors as likely contributors and VO_2 Max

VO_2 max, a critical measure of Cardiorespiratory fitness, reflects the maximum oxygen consumption during exercise and is affected by factors like body composition, activity levels, and BMI. Our results show that, on average, VO_2 max values were slightly lower in OW and OB groups compared to the NW group, aligning with findings by Patkar and Joshi[9], who reported similar trends in VO_2 max (ml/kg/min) among individuals with higher BMI due to increased body fat content limiting oxygen efficiency[9]. This finding reinforces preby Chatterjee et al.[10], who highlighted a reduction in VO_2 max per kg body weight and per kg of lean body mass in obese subjects compared to their normal-weight counterparts. Additionally, Chatterjee's research sat the observed lower VO_2 max values in obese individuals likely result from reduced oxygen demand in adipose tissue during exercise, which may reduce overall cardiorespiratory efficiency in OB individuals.[10]

Immediate and Long-Term Impact of Deep Breathing on VO_2 Max

The study found a significant improvement in VO_2 max values immediately after day 2 and substantially on day 30 for all BMI groups. This improvement in VO_2 max due to consistent deep breathing aligns with the findings by Anerao et al.[11], who noted VO_2 max enhancement after six weeks of deep breathing in obese women. This improvement suggests that deep breathing, few minutes daily, can enhance oxygen transport to muscles, increase lung compliance, and ultimately support better VO_2 max levels over time. These changes could be attributed to the effect of deep breathing on increasing lung volume and efficiency, which was noted by Shravya Keerti et al.[12], who observed increases in lung function metrics, such as expiratory reserve volume (ERV) and forced expiratory volume (FEV), following just 10 minutes of slow breathing exercises .[11,12]

Salome et al.[13] also explored the physiological impact of pulmonary function, finding that obesity tends to decrease expiratory reserve volume, which may explain the need for higher respiratory rates among obese individuals to compensate for reduced tidal volume . In this study, the OW and OB groups showed an ability to improve VO_2max breathing, likely due to increased respiratory efficiency, even in the presence of higher BMI, indicating that such interventions may be beneficial regardless of weight status.

Anthropometric Changes and WHR

Over 30 days, WC, HC, and WHR showed slight reductions across all groups, with statistically significant changes in WC and HC but not consistently in WHR, particularly in the OB group. This effect of deep breathing exercises aligns with findings that suggest aerobic exercise and breathing techniques may help reduce waist circumference and improve body composition by enhancing metabolic rate and fat oxidation. WHR, an indicator of fat distribution, generally stayed below the 0.9 threshold for OW and OB participants, suggesting that despite their BMI classification, these individuals had relatively low central adiposity. While some studies did not record a significant immediate effect of breathing exercises on WHR, a sustained practice of deep breathing can contribute to metabolic health improvements that are beneficial over a long period.

CONCLUSION

This study found that regular deep breathing exercises significantly improve VO_2 max, enhancing cardiorespiratory fitness across normal weight, overweight, and obese participants. The improvements were observed both immediately and after consistent practice over 30 days, with notable benefits in obese individuals. These findings suggest that even brief, daily sessions of deep breathing can effectively increase pulmonary efficiency and support better overall health, presenting a practical intervention to boost cardiovascular fitness and promote well-being among young adults.

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