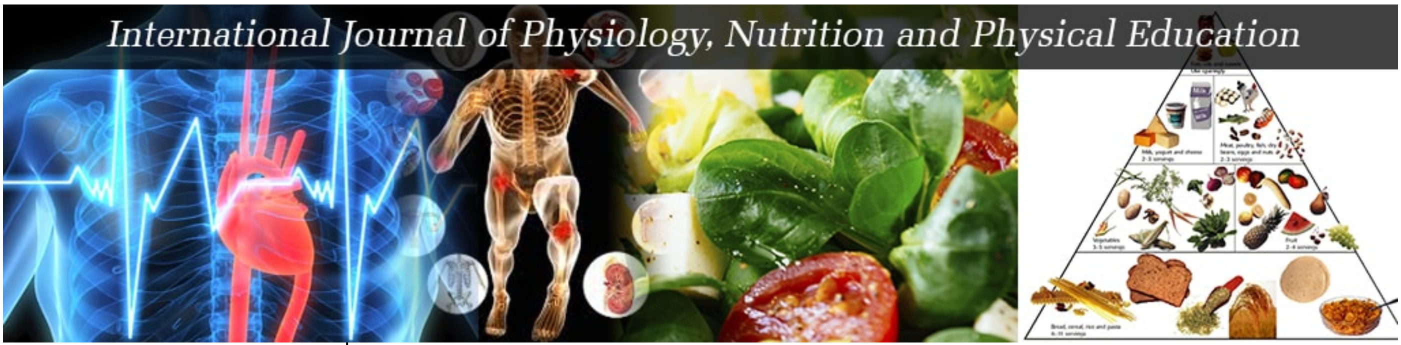

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Combined effect of aerobic and strength training with and without lifestyle modification on selected cardiopulmonary parameters among overweight men

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Abstract
Aerobic and strength training with lifestyle modification can significantly improve cardiopulmonary health in overweight men. Adding a dietary component as a lifestyle modification enhances the positive effects on weight loss and cardiorespiratory fitness (CRF). Lifestyle modification may further amplify these adaptations, yet comparative evidence in overweight Indian men remains limited. The purpose study was to examine the Combined Effect of Aerobic and Strength Training with and without Lifestyle Modification on Selected Cardiopulmonary Parameters among Overweight Men.
Methods: Sixty overweight men aged 30-35 years (BMI 25-29.9 kg/m²) were randomly divided into three groups: Group I - Combined Aerobic and Strength Training with Lifestyle Modification (n=20); Group II - Combined Aerobic and Strength Training without Lifestyle Modification (n=20); and Group III - Control (n=20). The experimental groups underwent a structured 12-week program (5 sessions/week: 3 aerobic, 2 strength). Cardiopulmonary parameters such as Respiratory Exchange Ratio (RER), Total Lung Capacity (TLC), and Breath Frequency (BF) were assessed pre- and post-intervention using a Metalyzer-B Cardiopulmonary Analyzer. Data were analyzed using paired 't' tests and between-group differences were assessed using analysis of covariance (ANCOVA).
Results: The results proved that there was significant improvements ($p<0.05$) were observed in both experimental groups, with Group I showing greater enhancement across all parameters. Respiratory Exchange Ratio (RER) decreased by 7.67% and 4.07% respectively, reflecting improved fat oxidation. Total Lung Capacity (TLC), increased by 2.63% (G I) AND 1.73% (G II), and Breath Frequency (BF) by 17.29% and 14.77%. The control group showed no significant change.
Conclusion: Twelve weeks of combined aerobic and strength training effectively improved cardiopulmonary parameters among overweight men. Lifestyle modification further amplified these adaptations, highlighting the value of integrated interventions for optimizing health.

Keywords: Aerobic training, Strength training, Lifestyle modification, Respiratory Exchange Ratio (RER), Total Lung Capacity (TLC), and Breath Frequency (BF)

Introduction

Overweight and obesity are major public health challenges worldwide, associated with increased risk of cardiovascular disease, metabolic disorders, respiratory dysfunction, and reduced physical fitness. Men with overweight often exhibit compromised cardiopulmonary parameters, including elevated blood pressure, impaired lung function, and suboptimal cardiovascular risk profiles. Interventions that can improve these parameters are therefore of high clinical and public health importance.

Physical exercise is well recognized for its beneficial effects on cardiovascular and respiratory health. Two major forms of exercise- aerobic training (such as walking, running, cycling) and strength (or resistance) training, each bring unique benefits. Aerobic training tends to improve cardiorespiratory fitness, enhance oxygen uptake, reduce resting heart rate and blood pressure, and promote fat loss. Resistance training improves muscular strength, preserves or increases lean mass, and contributes to metabolic health by improving insulin sensitivity. Combined aerobic and strength training may synergize these benefits.

Lifestyle modification which generally includes dietary changes (caloric restriction or healthier food choices), behavior counseling, sleep hygiene, reducing sedentary time, and other health-promoting behaviors adds another layer of intervention that may magnify or sustain improvements obtained through exercise alone. Although there is growing evidence that combined aerobic + strength training has advantages over either modality alone in reducing weight, fat mass, improving lipid profiles, and cardiorespiratory fitness, the incremental benefit of adding lifestyle modification (beyond exercise) specifically for cardiopulmonary parameters (ventilatory thresholds, lung function measures, pulmonary mechanics, etc.) among overweight men is less well defined.

Several randomized controlled trials have shown that combined training over periods of 8-12 weeks or more improves lowers blood pressure, improves arterial stiffness, reduces body fat percentage, and improves metabolic markers in overweight and obese men. Additional studies indicate that when lifestyle modification (especially diet) is added, effects on weight loss, lipid profile, systemic inflammation, and glucose metabolism are greater. However, less is known about how lifestyle changes interact with combined training to affect pulmonary function (airway mechanics, lung volumes), ventilatory efficiency, and other cardiopulmonary outcomes specifically in overweight men. Thus, the present topic aims to examine and compare the effects of combined aerobic and strength training with versus without lifestyle modification on cardiopulmonary parameters in overweight men.

Materials and Methods

This study employed a randomized controlled trial (RCT) design to evaluate the impact of combined aerobic and strength training, with and without lifestyle modification, on cardiopulmonary parameters in overweight men. The trial was conducted over a 12-week period and adhered to ethical guidelines approved by an institutional review board. In this study, 60 sedentary male, aged between 30-35 years, with Body Mass Index (BMI) between 25 and 29.9 kg/m², were divided at random between three Groups: Group 1 (n = 20) engaged in aerobic exercise and strength training with lifestyle modification, Group 2 (n = 20) engaged in aerobic exercise and strength training without lifestyle modification, and Group 3 (n = 20) control group no intervention; participants were advised to maintain their usual lifestyle.

Combined Training Protocol: Aerobic Exercise: 3 sessions per week, 45 minutes each, at 60-75% of maximal heart rate. Activities included treadmill walking and stationary cycling. Strength Training: 2 sessions per week, 30 minutes each, focusing on major muscle groups using resistance machines and free weights. Exercises included leg press, chest press, lat pulldown, and bicep curls.

Lifestyle Modification Program: Dietary Counselling: Weekly sessions focusing on caloric restriction, balanced macronutrient intake, and portion control. Behavioural Strategies: Techniques such as goal setting, self-monitoring, and stress management.

Cardiopulmonary parameters such as Respiratory Exchange Ratio (RER), Total Lung Capacity (TLC), and Breath Frequency (BF) were assessed pre- and post-intervention using a Metalyzer-B Cardiopulmonary Analyzer.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Descriptive statistics were computed for baseline characteristics. Between-group differences were assessed using analysis of covariance (ANCOVA), with baseline values as covariates. Post-hoc analyses were conducted using Tukey's test for pairwise comparisons. A p-value of <0.05 was considered statistically significant.

Results

Table 1 presents the pre- and post-test mean values (±SD) and percentage changes in cardiopulmonary and metabolic parameters among the three groups, namely Aerobic exercise and strength training with lifestyle modification Group, Aerobic exercise and strength training without lifestyle modification Group and Control group (no intervention). Both intervention groups demonstrated reductions in Respiratory Exchange Ratio (RER), with Group I showing a 4.07% decrease and Group II a larger 7.67% decrease, indicating improved metabolic efficiency and enhanced fat oxidation. In contrast, the control group recorded a 1.80% increase, suggesting no improvement in metabolic substrate utilization.

Total Lung Capacity (TLC) increased modestly in Group I (+1.73%) and Group II (+2.63%), while it slightly declined in the control group (-0.98%). The improvement was more pronounced in Group II, suggesting that consistent training enhanced pulmonary expansion and ventilation. Both training groups showed marked increases in Breathing Frequency (BF), +14.77% in Group I and +17.29% in Group II, whereas the control group increased only +2.57%**.** This indicates improved ventilatory response and respiratory endurance resulting from aerobic and strength exercise.

Table 1: Mean ± SD and % Changes in Cardiopulmonary and Metabolic Parameters

Parameter	Group I (aerobic exercise and strength training with lifestyle modification)	Group II (aerobic exercise and strength training without lifestyle modification)	Group III Control Group
RER	1.042±0.080 → 0.962±0.064 (-7.67%	1.03±0.042 → 0.988±0.033 (-4.07%)	1.025±0.018 → 1.044±0.038 (+1.80%)
TLC (L)	6.075±0.160 → 6.235±0.127 (+2.63%)	5.94±0.103 → 6.05±0.204 (+1.73%)	6.085±0.060 → 6.025±0.104 (-0.98%)
BF (breaths/min)	34.40±5.95 → 40.35±2.16 (+17.29%)	33.85±5.00 → 38.85±0.917 (+14.77%)	35.00±0.90 → 35.90±1.37 (+2.57%)

Table II presents the analysis of covariance (ANCOVA) comparing the effects of aerobic exercise and strength training with and without lifestyle modification on selected cardiopulmonary and metabolic parameters, relative to a control group. Baseline values across all variables showed no significant differences among groups, confirming homogeneity prior to intervention. However, the adjusted final means revealed statistically significant differences ($p < 0.05$) for all variables, indicating that the exercise interventions produced measurable physiological adaptations.

Table 2: Computation of Analysis of Covariance of Experimental and Control Group

Variable	Test	Group I (aerobic exercise and strength training with lifestyle modification)	Group II (aerobic exercise and strength training without lifestyle modification)	Control Group	F-Value
RER	Baseline	1.04	1.03	1.03	1.88
	Final	0.96	0.99	1.04	31.76*
	Adjusted Final	0.96	0.99	1.04	28.20*
TLC	Baseline	6.08	5.95	6.09	1.30
	Final	6.24	6.05	6.03	3.12
	Adjusted Final	6.20	6.12	5.98	11.71*
BF	Baseline	33.85	34.40	35.00	1.41
	Final	38.85	40.35	35.90	23.48*
	Adjusted Final	39.25	40.36	35.49	60.67*

At baseline, Respiratory Exchange Ratio (RER) values were similar across groups (F = 1.88, ns). Post-intervention, Respiratory Exchange Ratio (RER) decreased to 0.99 in the lifestyle-modification group and 0.96 in the non-modification group, while the control group slightly increased to 1.04. The adjusted F-value of 28.20* indicates a significant group effect, reflecting improved metabolic efficiency and greater fat oxidation in the exercise groups. Baseline Total Lung Capacity (TLC) values did not differ significantly (F = 1.30). Following the intervention, Total Lung Capacity (TLC) rose in both experimental groups (6.05 L and 6.24 L) but declined slightly in the control (6.03 L). The adjusted F-value (11.71*) demonstrated significant improvements in pulmonary function among the exercise participants, with the greatest increase in the group without lifestyle modification.

Initial Breathing Frequency (BF) values were comparable (F = 1.41). After training, mean Breathing Frequency (BF) rose to 38.85 and 40.35 breaths/min in the two experimental groups versus 35.90 breaths/min in the control. The adjusted F-value (60.67*) revealed highly significant differences, confirming the strong impact of combined aerobic and strength training on ventilatory performance.

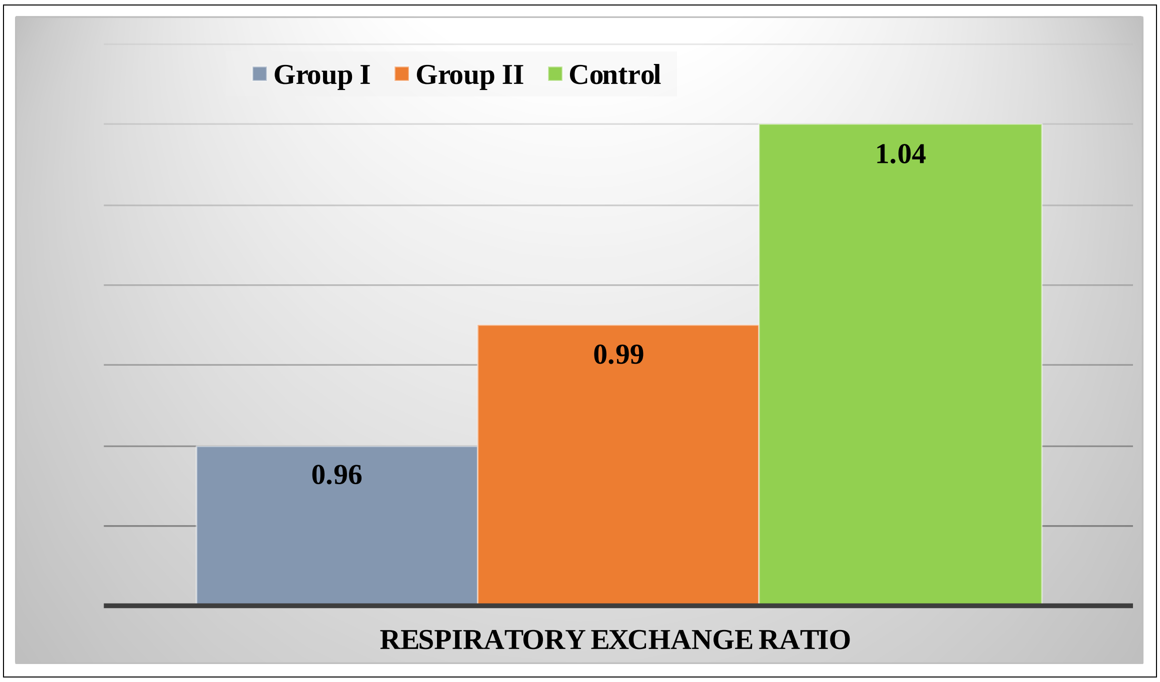

Fig 1: Bar Diagram Showing Adjusted Post-Test Values of Respiratory Exchange Ratio (RER) among the Three Groups

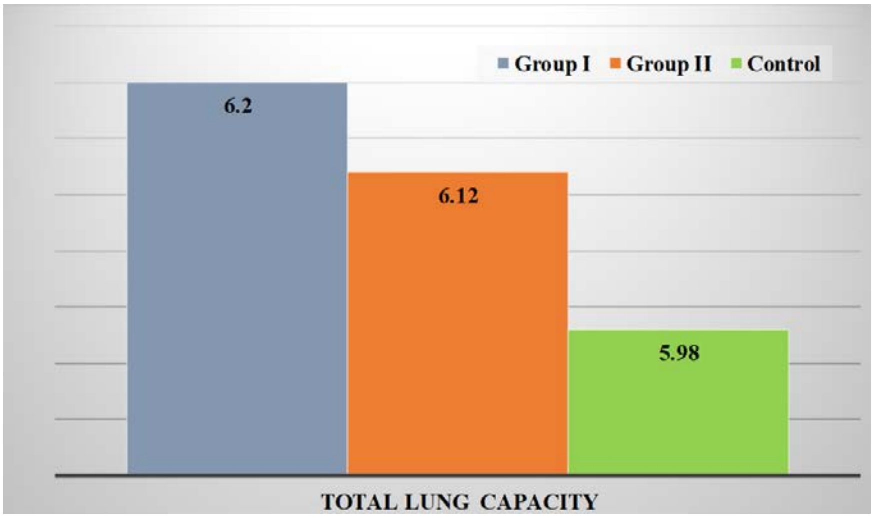

Fig 2: Bar Diagram Showing Adjusted Post-Test of Total Lung Capacity (TLC) among the Three Groups

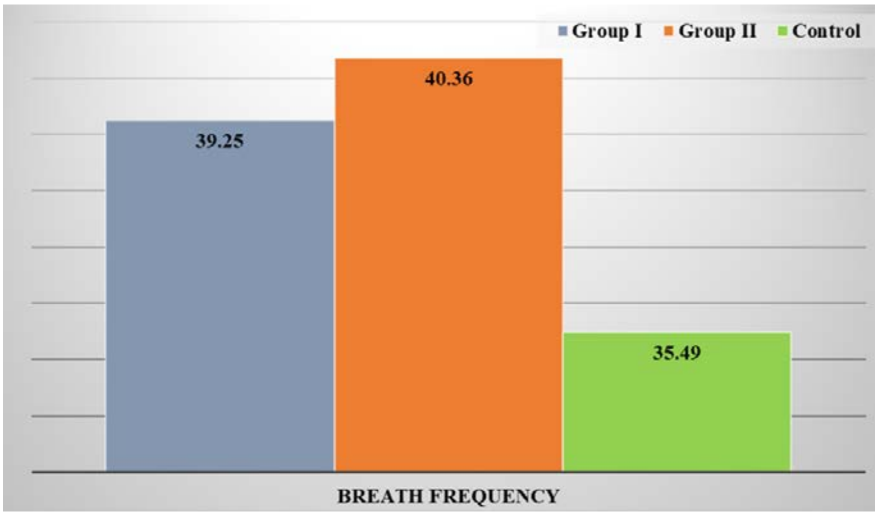

Fig 3: Bar Diagram Showing Adjusted Post-Test Values of Breath Frequency (BF) among the Three Groups

Findings

All adjusted final means differed significantly among groups for Respiratory Exchange Ratio (RER), Total Lung Capacity (TLC), and Breath Frequency (BF) ($p < 0.05$), confirming the effectiveness of the interventions. Both exercise programs, with and without lifestyle modification, produced marked improvements in cardiopulmonary efficiency and metabolic performance compared with the control group. The largest decreases in Respiratory Exchange Ratio (RER) were observed in the exercise groups, indicating a shift toward enhanced fat oxidation and aerobic metabolism. Significant increases in Total Lung Capacity (TLC) and Breath Frequency (BF) were also recorded in the experimental groups, demonstrating improved pulmonary capacity, respiratory endurance, and metabolic activation.

The control group exhibited negligible changes, underscoring that observed effects resulted directly from the interventions. While both experimental groups improved, the lifestyle-modification group showed slightly better efficiency in metabolic adaptation Respiratory Exchange Ratio (RER), whereas the non-modification group recorded marginally higher increases in pulmonary and energy-related parameters.

Discussion

The ANCOVA results reveal that aerobic and strength training interventions significantly enhanced cardiopulmonary and metabolic function compared to no intervention. Reductions in Respiratory Exchange Ratio (RER) in both experimental groups indicate a shift from carbohydrate-dominant to fat-dominant energy metabolism, demonstrating improved aerobic efficiency and mitochondrial capacity. This supports the role of combined training in enhancing substrate utilization and energy conservation during rest and exercise.

Notably, the non-modification group exhibited the largest decline in RER, which may reflect either a physiological response to the training protocol itself or unmeasured behavioral or metabolic adaptations occurring during the study period.

A significant reduction in RER following the 12-week intervention reflects improved substrate utilization, indicating greater reliance on fat oxidation and enhanced metabolic flexibility. This outcome aligns with findings by Venables *et al*. and Jeukendrup & Wallis, who reported that regular endurance-based training enhances lipid metabolism and reduces carbohydrate dependency during submaximal exercise. The greater reduction observed in Group II suggests that the inclusion of dietary and lifestyle adjustments—such as improved nutrition and recovery habits—further supports the efficiency of aerobic metabolism.

The observed increases in Total Lung Capacity (TLC) and Breathing Frequency (BF) signify improvements in pulmonary elasticity, respiratory muscle strength, and ventilatory adaptation. Regular aerobic and resistance training is known to stimulate lung expansion, increase tidal volume, and strengthen accessory respiratory muscles, thereby enhancing oxygen exchange efficiency. The improvement in TLC indicates enhanced pulmonary function and respiratory compliance. Aerobic and resistance exercise promote thoracic expansion, strengthen inspiratory and expiratory muscles, and increase alveolar ventilation, which together contribute to more efficient gas exchange and oxygen delivery (Romer & McConnell, 2004; Powers & Howley, 2018).

The higher adjusted post-test means observed in Group II suggest that combining exercise training with lifestyle modification augments these respiratory adaptations more effectively than exercise alone. A significant increase in BF was also recorded, reflecting better ventilatory control and respiratory endurance. This improvement is consistent with neuromuscular adaptations of the respiratory muscles, allowing more efficient ventilation during physical exertion (Gosselink *et al.*, 2011). The enhanced BF response in the lifestyle-modified group further suggests improved breathing economy, which may be associated with increased lung elasticity and greater oxygen uptake capacity.

Between the two intervention groups, the inclusion of lifestyle modification which may involve dietary regulation, sleep hygiene, and stress management appears to further enhance metabolic efficiency Respiratory Exchange Ratio (RER), while consistent training alone (without lifestyle modification) produced slightly higher absolute energy and pulmonary gains. This suggests a complementary interaction between structured exercise and behavioral factors in optimizing physiological performance. Overall, the results affirm that aerobic exercise and strength training, particularly when integrated with lifestyle modification, produce significant improvements in cardiopulmonary and metabolic parameters. These findings highlight the importance of comprehensive exercise-based interventions in promoting metabolic health, respiratory efficiency, and overall functional capacity.

Conclusion

The study concludes that aerobic exercise and strength training, with or without lifestyle modification, significantly enhance respiratory efficiency, metabolic rate, and energy expenditure. However, the integration of lifestyle modification yields the most favourable outcomes, particularly in metabolic efficiency Respiratory Exchange Ratio (lower RER) and energy regulation. These findings highlight that structured exercise programs combined with healthy lifestyle practices represent an effective strategy for improving overall cardiopulmonary health, metabolic performance, and physiological well-being. It is recommended that future studies explore the long-term sustainability of these effects and the specific contributions of individual lifestyle factors (such as diet, sleep, and stress management) to the overall outcomes.

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