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COMPARATIVE ANALYSIS OF CONVENTIONAL ENDURANCE TRAINING AND CIRCUIT ENDURANCE TRAINING ON CARDIO-RESPIRATORY ENDURANCE IN OVERWEIGHT YOUNG ADULTS

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Abstract

Introduction: Obesity is one of greatest health concern that is the triggering factor associated with many disease conditions commonly cardiovascular disease. By 2025, prevalence of obesity in adults globally is expected to be 18% in men and above 21% in women.

Objective: To study the effect of conventional training over circuit endurance training on cardio-respiratory endurance among young college students with overweight.

Methodology: A total of 60 Young overweight individuals both male and female with >25kg/m^{2,} were included in the study. They were randomly divided into two groups A and B. Group A performed conventional training (treadmill training) thrice a week, for 45min/day for 12 weeks and Group B performed circuit training consisting of 10 exercise 4 days a week with 50min/day for 12 weeks and assessed pre and post-test score.

Result: The p-value for the post-test score of both Harvard step test and Cooper 12-min run/walk test for both A and B group was <0.05 and both the training method has a significant impact on the cardio-respiratory endurance among overweight candidates. The VO2-max shows significant increases in post-test mean values on assessing Group-A and B, but Group B exhibited a score of 41.82 ± 7.34 compared to Group A shows 35.88 ± 5.50 and was more effective despite statically significance of $P \leq 0.05$.

Conclusion: From our analysis we would like to conclude that a circuit training program had proven to be more effective on cardio-respiratory endurance in young overweight individuals.

Keywords: Cardiorespiratory endurance training, Circuit training, overweight. Maximal oxygen uptake (Vo2 max)

INTRODUCTION

Nowadays, obesity is categorised as one the common problem related to the metabolism Worldwide and its risk affects all age group especially the adults, children, and adolescents. It is widespread affecting the developed and developing countries and in 2025 it prevalence would reach 18% in men and above 21% in women[1]. The obesity is getting epidemic in the recent decade is because of various factor like stagnant lifestyle, restless life with increasing stress, poor food habit. The common diseases associated with obesity are Type 2 diabetes mellitus, cardiovascular disease, gastrointestinal complications and Respiratory diseases.[2] cardiovascular disease is one the major contributor of mortality worldwide and accounts for approximately 400 million cases as of 2019 and in Asia it expected to rise to 91.2% from 2025 to 2050 [2,3]. Developed countries are only now beginning to recognise 18–25 year olds as a 'vulnerable group' for unhealthy lifestyles leading to overweight and obesity [4,5]. The BMI and waist measurements are easy measures and are important. Greater abdominal adiposity, as assessed by waist, is associated with greater cardio metabolic risk.

Cardiorespiratory endurance is a critical component of physical fitness, influencing an individual's ability to sustain prolonged physical activity. It is primarily determined by the efficiency of the cardiovascular and respiratory systems in delivering oxygen to working muscles. Regular endurance training has been widely acknowledged as an effective method to enhance aerobic capacity, mitigate cardiovascular disease risks, and improve metabolic efficiency (Cheng et al., 2019). In the context of increasing obesity rates, cardiorespiratory fitness is especially relevant as a preventive strategy against non-communicable diseases, including hypertension, diabetes, and metabolic syndrome (Lin & Li, 2021).

Obesity is a growing global health concern, with an estimated 39% of adults classified as overweight and 13% as obese, according to the World Health Organization (WHO, 2019). Physical inactivity is a major contributor to excessive weight gain and associated health complications. As a result, there is an urgent need to explore effective exercise interventions tailored to overweight individuals. Traditional endurance training (ET) and circuit endurance training (CET) are two widely adopted approaches for improving cardiorespiratory fitness. Conventional ET primarily involves sustained, moderate-intensity aerobic exercise, such as treadmill running, which is known to enhance cardiovascular efficiency. In contrast, CET combines multiple high-intensity exercises performed in succession, targeting both cardiovascular and muscular endurance (Ballesta-García et al., 2020).

While both training modalities have been proven effective in enhancing endurance, their comparative impact, particularly in overweight individuals, remains an area of ongoing investigation. Some studies suggest that CET induces superior cardiovascular and metabolic adaptations due to its intermittent high-intensity nature (Franceschin et al., 2020). Additionally, CET has been linked to improved mitochondrial biogenesis, greater oxygen uptake, and enhanced muscular endurance compared to steady-state endurance exercises (McCartan et al., 2020). However, conventional ET has also been shown to provide significant benefits, particularly in maintaining long-term cardiovascular health (Kandels et al., 2021).

This study aims to evaluate and compare the effects of conventional endurance training and circuit endurance training on key physiological markers, including the Harvard Step Test, the Cooper 12-Minute Run/Walk Test, and VO2 max estimation. By analysing these parameters in overweight young adults, this research provides potential insights on which mode of training modality would be more effective for improving cardiorespiratory endurance and overall fitness levels. These findings would provide valuable insights into the optimization of exercise interventions for individuals struggling with obesity-related fitness challenges.

MATERIALS AND METHODS

Study Design

This study was designed as an experimental, randomized controlled trial conducted at MAHER University. A total of 60 overweight young adults, aged 18-25 years with a BMI greater than 25kg/m², were recruited.

Participant Selection and grouping

Participants were selected based on inclusion criteria; candidate to be physically inactive for at least three months prior enrollment, the candidate should be overweight and age group of 18-25. Individuals with cardiovascular, pulmonary or musculoskeletal disorders, those who are recently hospitalized and candidate with the habit smoking or alcohol consumption were excluded. Participants were randomly assigned to two groups: Group A (n=30) receives conventional endurance training using a treadmill and Group B (n=30) receives circuit endurance training regimen.

Training Protocols

The conventional training protocol included treadmill-based exercises following the modified Bruce protocol, conducted four days per week for 12 weeks with progressive intensity increments ranging from 3.3-6.0 mph and a 1-4% inclines. Similarly the circuit training protocol involved a combination of resistance and aerobic exercises, including burpees, lunges, push-ups, planks, and jumping jacks, performed three times per week for 12 weeks. To assess the effects of training, three key outcome measures were evaluated; the Harvard Step Test for cardiovascular recovery efficiency, the Cooper 12-Minute Run/Walk Test for aerobic capacity and VO2 max estimation test.

Statistical Analysis

Data analysis was performed using SPSS 27 employing paired t-tests for within-group comparisons and independent t-tests for between-group comparisons. Statistical significance was set at $p < 0.05$.

RESULTS

The results demonstrated a significant improvement in cardiorespiratory endurance across both training groups, Group A (treadmill training) and Group B (circuit training). The results were evaluated based on various famous test assessment protocols. The Harvard Step Test exhibited a statically significant values in both groups; however, Group B showed a greater improvement of pre-test mean 64.97 ± 3.88 to a post-test mean of 72.22 ± 3.70 ($p = 0.001$) while Group A showed a value of 65.38 ± 3.04 to 68.29 ± 3.29 ($p = 0.001$) for details refer table 1. Similarly, in the Cooper 12-Minute Run/Walk Test, Group A improved from 35.33 ± 6.81 meters to 39.67 ± 9.27 meters ($p = 0.001$), while Group B showed a more pronounced improvement from 38.00 ± 7.61 meters to 45.67 ± 7.27 meters ($p = 0.001$) refer table 2 and for VO2 max score both groups showed significantly improvement while Group B showed more substantial improvement from 32.28 ± 5.71 to 41.82 ± 7.34 ($p = 0.001$) compared to the Group A improving from 32.27 ± 5.64 to 35.88 ± 5.50 ($p = 0.001$) for details refer table 3. Overall, statistical

analysis confirmed that though both training modalities improved the cardiovascular fitness greatly the circuit training showed a significant effective score in enhancing aerobic capacity endurance and VO2 max.

Table 1: Harvard Step Test Scores (Mean ± SD)

Group	Pre-Test	Post-Test	T-Value	P-Value
Group A	65.38 ± 3.04	68.29 ± 3.29	4.33	0.001*
Group B	64.97 ± 3.88	72.22 ± 3.70	4.33	0.001*

Table 2: Cooper 12-Minute Run/Walk Test (Mean ± SD)

Group	Pre-Test (m)	Post-Test (m)	T-Value	P-Value
Group A	35.33 ± 6.81	39.67 ± 9.27	2.73	0.001*
Group B	38.00 ± 7.61	45.67 ± 7.27	2.73	0.001*

Table 3: VO2 Max (Mean ± SD)

Group	Pre-Test	Post-Test	T-Value	P-Value
Group A	32.27 ± 5.64	35.88 ± 5.50	3.14	0.001*
Group B	32.28 ± 5.71	41.82 ± 7.34	3.14	0.001*

*(Significant at $p < 0.05$)

DISCUSSION

The findings of this study indicate that both conventional endurance training and circuit endurance training significantly enhance cardiorespiratory endurance in overweight young adults. However, CET demonstrated a more pronounced improvement in key physiological markers, including the Harvard Step Test, the Cooper 12-Minute Run/Walk Test, and VO2 max. These results align with previous studies that highlight the superior cardiovascular benefits of high-intensity interval-based training over steady-state endurance exercises (Shah et al., 2020; Kolahdouzi et al., 2019). A key factor underlying the greater efficacy of CET is its ability to induce greater cardiovascular stress and metabolic adaptations within a shorter period. Sonchan, W and his colleague had reported on the potential effect of CET in muscle strengthening, cardiovascular endurance and anaerobic capacity among college students. In this study no comparison was performed with the ET and the candidates involved sports students. In this study we have employed the candidate who is overweight and particularly with no prior exercise for atleast three months and hence this study would provide valuable insights with regard to cardiovascular endurance among overweight college students. Many studies are performed on the effectiveness of muscle High-intensity intermittent exercise has been shown to improve stroke volume, cardiac output, and oxygen utilization efficiency more effectively than moderate-intensity continuous training (Franceschin et al., 2020). Additionally, CET engages multiple muscle groups simultaneously, enhancing overall muscular endurance and metabolic rate, which may contribute to increased fat oxidation and weight management (McCartan et al., 2020).

Sonchan, W., Moungmee, P., & Sootmongkol, A. (2017). The effects of a circuit training program on muscle strength, agility, anaerobic performance and cardiovascular endurance. *International Journal of Medical, Health, Biomedical, Bioengineering and Pharmaceutical Engineering*, *11*(4), 170-173.

The significant improvements in VO2 max observed in the CET group suggest that this training modality facilitates greater oxygen uptake and utilization efficiency. Research has shown that high-intensity training enhances mitochondrial biogenesis, increasing the body's ability to generate energy aerobically (Kandels et al., 2021). The improvement in the Cooper 12-Minute Run/Walk Test further supports the notion that CET is more effective in boosting aerobic capacity than conventional ET. These results are consistent with studies demonstrating that interval-based training elicits greater cardiovascular adaptations compared to steady-state endurance exercises (Ballesta-García et al., 2020).

Despite the evident advantages of CET, it is important to acknowledge certain limitations of this study. The sample size was relatively small, and the intervention period was limited to 12 weeks. Long-term studies with larger cohorts are necessary to validate these findings and explore the sustainability of the observed benefits. Additionally, this study did not assess other physiological markers, such as lactate threshold and respiratory exchange ratio, which could provide deeper insights into metabolic adaptations associated with different training modalities.

Another consideration is the feasibility and adherence to CET in real-world settings. While CET is highly effective, it requires greater motivation and effort from participants compared to conventional ET. Future studies should investigate strategies to enhance adherence and explore modifications to make CET more accessible to a broader population, including individuals with lower baseline fitness levels.

CONCLUSION

This study provides compelling evidence that circuit endurance training is a more effective method for improving cardiorespiratory endurance in overweight young adults compared to conventional treadmill-based endurance training. Given its superior impact on VO2 max and aerobic capacity, CET should be considered a valuable intervention for individuals seeking to enhance cardiovascular health and overall fitness. Future research should explore long-term adherence, additional physiological benefits, and practical implementation strategies for CET in various populations.

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