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Effect of aerobic training versus core circuit exercises on cardiovascular risk in metabolic syndrome

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Abstract:
Purpose: To compare effect of aerobic training and circuit exercises on cardiovascular risk in metabolic syndrome.
Methods: Forty metabolic syndrome participants of both sexes (14 females and 26 males) were randomly selected and divided into two groups. Group (A) received aerobic training (treadmill march walking) in addition to medical treatment. Group (B) received core circuit exercise in addition to medical treatment. Both groups were evaluated by waist-hip ratio, lipid profile, blood pressure, and fasting blood glucose before and after the 8-week study period.
Results: The results showed that there was a significant difference in all variables in both groups; the most significant improvement was in the aerobic training group. The level of improvement was at a 0.73 ±0.04 mean value for waist to hip ratio R, 137.15 ±6.48 for systolic blood pressure, 81.7 ±7.17 for diastolic blood pressure, 45.75 ±5.00for high-density lipoprotein, 133.8 ±8.11low density lipoprotein, 142.4 ±3.66 for triglyceride, and 95.8 ±4.42 fasting blood glucose with p-value <0.0001 for all.
Conclusion: Both aerobic training and core circuit exercises were effective methods for reducing cardiovascular risk in metabolic syndrome with more improvement in aerobic training.
Key words: Metabolic syndrome, aerobic training, cardiovascular risk, core circuit exercises.

1. Introduction:

The most common characteristics of metabolic syndrome include high blood pressure, abnormality in blood lipid profile, diabetes mellitus, insulin resistance, and central obesity. Metabolic syndrome is a group of risk factors for cardiac diseases rather than actual disease. (1) In the Middle East region, obesity is prevalent, especially central obesity. According to a recent study, 29% of Egyptians were centrally obese, with a more significant number among females than males. (2) The tendency of developing cardiovascular diseases rises to up to 31.2% in subjects with two metabolic syndrome criteria and up to 40.8% in subjects with four to five criteria (3).

It has been documented that metabolic syndrome individuals are prone to develop cardiovascular diseases due to several risk factors, including endothelial dysfunction, prothrombotic abnormality, high levels of pro-inflammatory markers, and atherogenic dyslipidemia. (4,5) Moderate-intensity aerobic exercise for 120 to 150 minutes a week may help reduce the risk of metabolic syndrome. People who already have metabolic syndrome exhibit a significantly reduced (by around 50%) chance of getting coronary heart disease when they engage in physical activity and regular aerobic training programs. (6) Moreover, researchers believe that the rising incidence of metabolic syndrome is linked to

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rising rates of obesity. Even though metabolic syndrome is a dangerous condition, one can significantly lower chances of developing it by eating a heart-healthy diet high in whole grains, fruits, vegetables, and fish, exercising more, losing weight, and working with the healthcare team to monitor and control blood pressure, blood glucose, and cholesterol level. (7) Aerobic training can help minimize the side effects of metabolic syndrome mainly through enhancing weight loss, decreasing body fat, enhancing lean body mass, and controlling blood sugar (8).

Circuit exercise training has a low risk of injury and provides enjoyable workouts without regional or financial constraints. It is a beneficial method for improving cardiovascular and muscular functions (9). It has a positive effect on reducing vascular inflammatory markers, positive impact on Insulin-like Growth Factor-1 (IGF-1), improving endothelium function, elevating levels of serum antioxidants, regulating blood pressure, and controlling diabetic mellitus and insulin resistance (10).

Despite many studies on evaluating the effects of aerobic exercise training on metabolic syndrome for the protection against cardiovascular problems, few studies have been conducted to determine the effect of a circuit training exercise on cardiovascular risk. Thus, this study aims to determine which type of exercise program was more effective in lowering the risk of cardiovascular diseases in the future for metabolic syndrome subjects.

2. Patients and Methods:

2.1. Study Design:

The study was designed as a randomized controlled trial with a pre-test and post-test design for two groups. Participants were randomly chosen from the outpatient clinic of Pharos University, and pt. Private clinic. An ethical approval (No: PUA 0320239243133) was obtained for this study from the Unit of the Research Ethics Approval Committee at Pharos University in Alexandria before the initiating the study. The study`s protocol was elucidated to each patient, and an informed consent was acquired before participation. The study was carried out from March 2022 till February 2023

2.2. Participants

Forty subjects of both genders (14 females,26 males) participated in the study. Their ages ranged from 40 to 50 and had body mass index (BMI) between 30-34.9 kg/m2, waist to hip ratio between(0.81to 1.0) with metabolic syndrome according to the World Health Organization's metabolic syndrome criteria 2020 (high-density protein less than 40, low-density lipoprotein more than 130 mg/dl, Hg, and triglyceride more 150 mg/dl, blood pressure more than 130/85 mm, fasting blood glucose in between 100 to 125 mg/dL). Exclusion criteria included: metabolic syndrome subjects with a previous history of (cardiac or chest diseases, renal, vascular, hepatic, autonomic neuropathy, lower limb arthritis or any orthopedic problem that will hinder the training, uncontrolled hypertension BP >160/90 mm Hg, fasting blood glucose of more than 125 mg/dL in addition to subjects having reduced exercise tolerance as a result of using β-adrenergic blocker medications).

2.3. Randomization:

Participants were allocated randomly to two equally sized groups (referred to as Group A (aerobic training) and Group B (core circuit exercises) using a computer-based randomization program. No subject dropouts were observed following the randomization process.

2.4. Interventions:

2.4.1-Group A (aerobic training): Participants in this group engaged in aerobic training in addition to their medical treatment, which included 45 minutes of march walking on a treadmill three times a week for two months. The workouts began with a warm-up on a treadmill lasting five to ten minutes and concluded with a cool-down of the same length. A collective exercise session time of 35 minutes with moderate exercise intensity, in between (60-75% of heart rate reserve), was used according to the Karvonen formula. (11).

2.4.2- Group B (Core circuit exercise): Participants in this group (group B) received core circuit exercises for 45 minutes session time, three times per week for two months in addition to their medical treatment, moderate exercise intensity in-between (60-75% of heart rate reserve)was used according to Karvonen formula .(11) starting by 5-10 minutes of aerobic warm-up performed on a treadmill and ending with 5-10 minutes of cooling down. The following sequences were used in the core circuit training: crunches on the abdomen and reverse crunches came first, followed by bridge exercises, single-leg bridges, and planks. Each exercise in the circuit was performed for several sets with repetitions (10–15 repetitions) for three sets, with a three-minute rest between each set (12).

2.5. Outcome measures:

2.5.1- Waist-to-hip ratio (WHR): Plastic tap measurement was used to assess the waist-to-hip ratio for both groups (A & B) throughout the study before and after treatment. It is a quick, easy, and reliable way. It was calculated by dividing the waist circumference (above the umbilicus level) by the hip circumference (at the widest point of the glutes) (13).

2.5.2- Lipid profile and fasting blood glucose laboratory test: Fasting blood glucose and lipid profile (HDL, LDL, TG) were assessed in both groups (A and

B) before and after the study period. The Cholestech LDXTM Analyzer is designed to provide dependable, accessible, actionable, and accurate results. It was used to evaluate both of them. Participants' fasting blood samples were taken from antecubital veins for at least eight hours to twelve before the results were analyzed. (14).

2.5.3- Blood pressure measurement: In both groups (A, B), blood pressure was measured before and after the study using portable Konuest equipment with digital monitors (Medline MDS4001 Automatic Digital). The subject was sitting with his arm comfortably resting at heart level. Once the potable cuff size was selected, the device turned on and began to record the systolic and diastolic blood pressure (15).

3. Data analysis:

SPSS for Windows, version 27, was used. The data were checked for extreme scores, homogeneity of variance, and normalcy assumption before the final analysis. This exploration was done as a pre-requisite for parametric calculations of the difference analysis. Data for all measured variables was not normally distributed, according to preliminary assumption checks. as assessed by the Shapiro-Wilk test ($p < 0.05$). Variances ($p > 0.05$) and covariances ($p > 0.05$) were homogeneous, as assessed by Levene's test of homogeneity of variances. Accordingly, non-parametric statistics were used. The Mann-Whitney U test was employed to determine if the dependent variable differed between the two independent groups. Wilcoxon test was used to determine whether differences existed within the same group. The two study groups' pretreatment demographics were compared using an unpaired t-test to see if there was a difference. The alpha level was set at 0.05.

4.Results:

Between-group comparison: Before the treatment, there was a significant difference in gender distribution with a P value of 1 **Figure (1), Table (1).** Group A included 7 females with a percentage of 35% and 13 males with a percentage of 65%. Group B included 7 females with a percentage of 35% and 13 males with a percentage of 65%. The non-significant difference in age, waist-hip ratio, systolic blood pressure, diastolic blood pressure, high-density lipoproteins, low-density lipoproteins, triglyceride, and fasting blood glucose between the two groups with P. value of 0.65, 0.86, 0.72, 0.87, 0.89, 0.28, 0.71,0.40 respectively **Table (2),** while after treatment, there was significant in all outcome variables between the two groups in favor of group A with P. value < 0.001 as shown in **Table (2).**

Within group comparison: Both groups showed a significant difference in all outcome variables posttreatment in contrast to pretreatment in both groups ($P < 0.001$) as shown in **Table (2).**

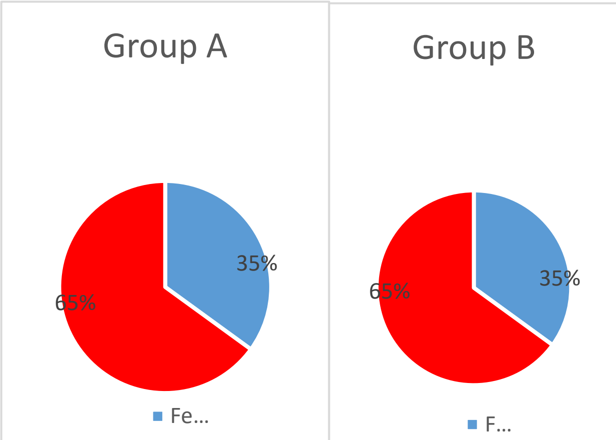

Figure (1): Gender distribution of both groups

Table (1): Frequency distribution and chi squared test for comparison of gender distribution.

Gender	Group A	Group B	χ2 value	P. value
Female	**7**	**7**	**0**	**1**
Males	**13**	**13**		**(S)**

5. Discussion:

People with metabolic syndrome have been linked to cardiovascular diseases because of many risk factors, such as atherogenic dyslipidemia, pro-thrombotic abnormalities, high levels of pro-inflammatory markers, hypertension, obesity endothelial dysfunction and diabetes mellitus (4, 5) Individuals with metabolic syndrome have a 50% lower risk of developing coronary heart disease and cardiac risk when they participate in regular aerobic training and physical activity. (6). Furthermore, scientists think that rising obesity rates and physical inactivity are connected to increasing metabolic syndrome incidence (6, 7).

To reduce the morbidity and mortality rate from CVD disease in metabolic syndrome, exercise is an essential component as a protective mechanism. In agreement with our study, meta-analyses and comprehensive reviews examined moderate-intensity aerobic training effects on metabolic syndrome and various cardiovascular risk factors. They reported a significant reduction in blood pressure, an increase in high-density lipoprotein cholesterol (HDL-C), and a decrease in low-density lipoproteins (LDL-C), triglycerides, and fasting plasma glucose (16).

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Table (2): Descriptive statistics and comparison of all dependent variables at different measuring periods among groups.

Dependent Variables		Group (A) (n = 20)	Group (B) (n = 20)	Group A Vs. B P. value*
Age (years)		44 ±3.08	43.35 ±3.14	0.65 NS
Waist to hip ratio	Pre treatment	0.89 ±0.48	0.88 ±0.48	0.8667 NS
	Post treatment	0.73 ±0.04	0.818 ±0.045	<0.0001 S
	P. value**	<0.0001 S	<0.0001 S	
Systolic blood pressure (mmhg)	Pre treatment	148.35 ±0.07	151.35 ±0.07	0.7228 NS
	Post treatment	137.15 ±6.48	142.45 ±6.18	0.039 S
	P. value**	<0.0001 S	<0.0001 S	
Diastolic blood pressure (mmhg)	Pre treatment	92.56 ±8.07	94.55 ±7.26	0.8788 NS
	Post treatment	81.7 ±7.17	88.3 ±7.43	0.0034 S
	P. value**	<0.0001 S	<0.0001 S	
High density lipoprotein (mg/dl)	Pre treatment	34.7 ±5.61	34.5 ±6.86	0.894 NS
	Post treatment	45.75 ±5.00	41.4 ±5.09	0.0017 S
	P. value**	<0.0001 S	<0.0001 S	
Low density lipoprotein (mg/dl)	Pre treatment	158.1 ±3.56	155.3 ±3.63	0.2897 NS
	Post treatment	133.8 ±8.11	144.4 ±8.11	0.0002 S
	P. value**	<0.0001 S	<0.0001 S	
Triglycerid e (mg/dl)	Pre treatment	156.15 ±7.45	155.7 ±5.18	0.7116 NS
	Post treatment	142.4 ±3.66	147.5 ±3.79	0.0026 S
	P. value**	<0.0001 S	<0.0001 S	
Fasting blood glucose (mg/dl)	Pre treatment	113 ±3.66	111.05 ±3.77	0.4049 NS
	Post treatment	95.8 ±4.42	101.4 ±4.42	0.0273 S
	P. value**	<0.0001 S	<0.0001 S	

*** Inter-group comparison; ** intra-group comparison of the results pre- and post-treatment. Data expressed by mean ± SD, NS p > 0.05 = non-significant, S p < 0.05 = significant, p = Probability.**

According to most researches, aerobic exercise reduces stress and pro-inflammatory mediators in individuals with metabolic syndrome, improving cardiovascular indices. However, a slight rise in plasma reactive oxygen species (ROS) is considered beneficial and essential for cellular adaptation to training. Exercise stimulates the sympathetic nervous system and will induce an integrated response from the body. This response maintains an appropriate level of homeostasis for the increased demand in physical, metabolic, respiratory, and cardiovascular efforts (17).

Additionally, there is a correlation between aerobic training activity and changes in the release of Orexin A (hypocretin-1), a pleiotropic neuropeptide generated by neurons in the periphery of the lateral hypothalamic region (LHA) (17, 18). The primary role of orexin is to modulate many physiological processes in various ways. For example, a variety of physiological processes, such as the regulation of food intake, arousal, metabolism, cardiovascular, and respiratory function, are all enhanced by aerobic exercise training (18).

Another possible reason for the improvement in cardiac function with aerobic training in metabolic syndrome individuals is the changing in the activity of tissue inhibitors of MMP (TIMP) and matrix metalloproteinases (MMP), which play an essential role in vascular remodeling and formation through degrading vascular basement membrane and ECM proteins and modifying cytokines and angiogenic growth factors. In addition, anti-inflammatory and oxidative stress responses to exercises can improve arterial health and endothelial function directly or indirectly (19).

The results agreed with another study, which reported that circuit training exercises of moderate intensity for obese metabolic females, as the sequence of push-ups, squats, crunches, lunges, and Superman exercises for forty minutes three times a week have significantly improved in cardiopulmonary fitness compared to the non-exercised group by decreasing body weight, % body fat, BMI, waist circumference, TG, and control leptin level as well as increased health-related physical fitness and muscle power (20).

The study results concur with other studies that reported that individuals with metabolic syndrome who performed circuit training exercises three times a week for four weeks experienced significant improvements in their vascular health. Pre- and post-intervention arterial endothelium function, pulse pressure (PP), brachial and central blood pressure (BP), augmentation index, carotid artery intima-media thickness (IMT), brachial artery flow-mediated dilation (FMD), and fitness were assessed. They reported significant improvements overall due to the circuit exercise training. (21) It was recognized that there had been few studies on the effect of circuit training exercises on cardiovascular risk, and additional trials using varying exercise intensities, and more time study periods are needed in future research.

Conclusion:

Individuals who have metabolic syndrome are more likely to develop diabetes, heart diseases, stroke, and arterial atherosclerosis. The findings demonstrated significant differences in all variables between the two groups, with the aerobic training group showing the most significant improvement. Further research is necessary to fully understand the impact of circuit exercise training on several additional systems, including the immune system, blood coagulation, and endothelium function.

Ethical approval:

Ethical approval was obtained from the unit of research ethics approval committee, at Pharos University in Alexandria. (No.: PUA 0320239243133)

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Declaration of interest:

The study was not specifically funded by public, private, or nonprofit organizations, hence the authors do not declare any conflicts of interest.

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