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Effect of pilates exercise on cardio metabolic risk factors in women patients with metabolic syndrome

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Abstract--Background: With the aid of the DASH diet, which is used to lower blood pressure, Pilates exercise helps to improve cardiometabolic risk factors in women with metabolic syndrome. Aim of the study: This study was conducted to determine how Pilates workouts affected the cardiometabolic risk variables in female patients with metabolic syndrome. Materials and Methods: 60 obese adult women, aged 45 to 55, who were randomly chosen from Elkalioubia governorate's outpatient internal medicine clinics, took part in the study. The internal medicine doctor recommended these. They were divided into two equal groups at random. Group A, which included 30 subjects, got DASH diet, three sessions of 60 minutes each, three sets per session of pilates exercise, and medical care for twelve weeks. Group B, which included 30 patients, got DASH diet and medical care for a total of twelve weeks. Blood analysis was measured before and after 12 weeks of training for (fasting blood sugar, post-prandial blood sugar, glycosylated hemoglobin, total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides) and Borg scale. Results: Statistical analysis using MANOVA between pre and post treatment showed that groups A and B revealed a significant decrease in FBS, PPBS, HbA1c in group A was 24.71, 28.25 and 12.36% while

that in group B was 14.61, 13.21 and 5.03% respectively. The percent of change in TC, LDL, HDL and TG in group A was 23.1, 26.61, 26.21 and 31.75% while that in group B was 12.6, 10.75, 14.08 and 13.07% respectively. Comparing the results among the two tested groups, there was a significant difference within the post testing mean value of FBS, PPBS, HBA1C, TC, LDL, HDL, and TG of -20.04, -42.4, -0.79, -28.77, -30.57, 6.17, and -47.27 respectively. Conclusion: The findings of the current study assure and confirm the significance of combining a DASH diet with Pilates exercise to reduce cardiometabolic risk factors in women with metabolic syndrome.

Keywords---Pilates exercise, DASH diet, cardiometabolic risk factors, and metabolic syndrome.

Introduction

Joseph H. Pilates is credited with creating Pilates, which is based on the eight principles of movement, breathing, range of motion, precision, stability, and opposition (1). There was no gender or geographic preference in the prevalence of the metabolic syndrome among healthy Egyptian adolescents aged 10 to 18; it was 7.4% overall. Results showed that, with the exception of systolic blood pressure, where they were 42 percent, and TG, where they were 31 percent, teenagers with the full criteria of metabolic syndrome made up roughly one-fourth of those exhibiting high levels of various components. The likelihood of developing MS was considerably raised by inactivity and family history of obesity and diabetes mellitus (2).

Central obesity, high blood pressure, high blood sugar, high serum triglycerides, and low serum high-density lipoprotein (HDL) are the five medical disorders that make up metabolic syndrome (3). The pathophysiology is incredibly complicated and has only been partially understood. The majority of those who suffer from the ailment are older, obese, overweight, and to some extent, insulin resistant. Another contributing factor can be stress. Diet (especially the intake of sugar-sweetened beverages), heredity, aging, sedentary lifestyles or low levels of physical activity, disturbed chronobiology/sleep, mood disorders/psychotropic medication usage, and excessive alcohol use are the main risk factors (4).

Joseph Pilates developed the Pilates method, a healthy lifestyle strategy combining exercise/movement, philosophy, gymnastics, martial arts, and dance. The six guiding concepts of this mind-body fitness regimen are centering, focus, control, precision, flow, and breath (5). Dietary habits are essential to older persons' quality of life and survival because they significantly impact the development of cardiometabolic illness (6). An effective set of dietary guidelines for preventing and managing high blood pressure is the Dietary Approaches to Stop Hypertension (DASH) diet. (7).

The DASH trial, which is a diet high in fruits, vegetables, and low-fat dairy foods, has been found to lower blood pressure and have appropriate effects on blood lipids, according to the Dietary Approaches to Stop Hypertension (DASH) research

group (8). A set of metabolic abnormalities known as metabolic syndrome (MetS) raises the risk of developing type 2 diabetes mellitus (T2D) and cardiovascular problems (CVD). The key identifying features are hyperglycemia, increased blood pressure, elevated triglyceride levels, low HDL cholesterol levels, and obesity (particularly central adiposity). Since Reaven originally referred to it as "Syndrome X" in 1988 (9).

A group of modifiable risk factors, such as hypertension, abdominal adiposity, dyslipidemia, and elevated fasting glucose and triglycerides, are collectively referred to as cardiometabolic diseases. These risk factors raise a person's risk of developing cardiovascular disease, type-2 diabetes, and metabolic syndrome. The older adult population is especially prone to cardiometabolic disease since co-existing risk factors are more common in this group. Currently, 80 percent of Americans 65 and over who are adults have at least one chronic condition related to cardiometabolic disease, and 41 percent of them are obese.

Furthermore, by 2060, 98 million more elderly adults are expected to be living in the world. It is critical to start implementing targeted intervention strategies that reduce risk factors for cardiometabolic disease, which will, in turn, lead to a decrease in cardiovascular disease and type-2 diabetes in older adults, with 47 million Americans suffering from cardiometabolic disorders and the health risks associated with the growing older adult population (10).

The objective was to investigate the simultaneous effects of pilates exercise and the DASH diet on cardiometabolic risk factors in women patients with metabolic syndrome, despite the fact that it is believed that both can have an impact on these risk variables. MetS's complicated pathogenic processes are not being fully understood. It is still unclear if each MetS component represents a unique pathology or the presentation of a single pathogenic process. The significant geographic range in the prevalence of MetS and the recent "catch up" in the developing world highlight the significance of environmental and lifestyle variables, including excessive calorie consumption and inactivity, as major causes.

The notability of a high caloric intake as a major causal component is emphasized by the fact that visceral obesity has been shown to be a fundamental trigger for the majority of the pathways involved in MetS. Initiation, progression, and transition from MetS to CVD appear to be primarily mediated by insulin resistance, neurohormonal activation, and chronic inflammation, among all other postulated pathways (11).

Based on the research framework, the increased consumption of foods that are unsuitable for humans biochemically in the Western diet is a contributing element in the development of metabolic syndrome. The metabolic syndrome is correlated with weight gain. The primary metabolic problem is insulin resistance, although visceral and/or ectopic fat i.e., fat in organs not intended for fat storage is the key clinical component of the syndrome rather than total adiposity. A backlog of the byproducts of mitochondrial oxidation is produced when the constant supply of energy from dietary carbohydrate, lipid, and protein fuels is not matched by physical activity or energy demand. This process is linked to

developing mitochondrial malfunction and insulin resistance (12).

Subjects and Methods

This study, which was randomized and controlled, involved 60 obese adult women aged 45 to 55. They had a body mass index of 30 to 39.9 kg/m on average, a waist circumference of 88 cm, blood pressure of 130/85 mm Hg for the past five years, levels of hemoglobin A1c1 between 5.7 percent and 6.4 percent, fasting plasma glucose of 100 mg/dl or known type 2 diabetes for the past five years, dyslipidemia, and all four of these

Neuropsychiatric disorders and those with orthopedic or neurological issues that interfere with activities were the exclusion criteria. Other diabetic microvascular problems (such as diabetic retinopathy) in the previous three months, involvement in other clinical studies in the previous three months, anemia patients, and Type 1 diabetic patients were also excluded from this investigation. Internal medicine outpatient clinics in Elkalioubia Governorate recruited the patients. in the time frame of March 2020 through December 2021.

The cases were categorized randomly into two groups of equal number, Group (A) The trial group included 30 patients who got DASH diet, medical treatment, and three sessions of 60 minutes each of Pilates exercise three times per week for twelve weeks. Group (B) The control group included 30 patients who got both their medical care and the DASH diet for a total of twelve weeks. The Cairo University faculty of physical therapy's ethical committee gave the current study their stamp of approval in 2022. P.T. Rec. No. 012/ 002767

Methods: Before and after 12 weeks of training, blood analysis for (FBS, PPBS, HBA1C, TC, LDL, and HDL) and Borg scale were measured.

Group A: The exercise group completed a 10-minute warm-up that included gentle breathing and stretching exercises, a 30-minute Pilates session, and a 10-minute cool-down. Every three weeks, the exercise time was gradually increased.

Group B: DASH DIET for group A and group B: was adopted as the background diet for the two groups.

Statistical analysis

The comparison of subject characteristics between groups was done using an unpaired t-test. Shapiro-Wilk test was used to determine whether the data had a normal distribution. To ensure group homogeneity, Levene's test for homogeneity of variances was run. To examine how therapy affected FBS, PPBS, HbA1c, and lipid profile, mixed MANOVA was used. For further multiple comparisons, post-hoc testing employing the Bonferroni correction was conducted. All statistical tests had a significance threshold of $p < 0.05$. The statistical program for social studies (SPSS) version 25 for Windows was used for all statistical analysis (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics:

The subject characteristics for groups A and B were displayed in Table 1. The mean age, weight, height, and BMI for the two groups did not significantly differ from one another ($p > 0.05$).

Table 1. Comparison of subject characteristics between groups A and B

	Group A	Group B	MD	t-value	p-value
	Mean \pm SD	Mean \pm SD			
Age (years)	48.36 \pm 2.55	48.13 \pm 2.23	0.23	0.37	0.71
Weight (kg)	90.56 \pm 6.94	89.4 \pm 6.96	1.16	0.65	0.51
Height (cm)	161.96 \pm 2.94	161.9 \pm 3.53	0.06	0.08	0.93
BMI (kg/m ²)	34.49 \pm 1.94	34.11 \pm 2.57	0.38	0.65	0.51

SD, Standard deviation; MD, Mean difference; p-value, Probability value

Effect of treatment on FBS, PPBS, HbA1c and lipid profile:

A significant interaction between treatment and time was found by mixed MANOVA ($F = 19.66$, $p = 0.001$). ($F = 158.33$, $p = 0.001$) There was a crystal-clear main impact of time. ($F = 2.74$, $p = 0.001$) There was a significant main effect of therapy.

Within group comparison:

FBS, PPBS, and HbA1c noticeably decreased in groups A and B post-treatment compared to pre-treatment levels ($p > 0.01$). FBS, PPBS, and HbA1c change percentages in group A were 24.71, 28.25, and 12.36 percent, respectively, while they were 14.61, 13.21, and 5.03 percent in group B. (Table 2). In comparison to before the therapy process, there was a clear drop in TC, LDL, HDL, and TG in groups A and B ($p > 0.001$). In group A, TC, LDL, HDL, and TG changed by 23.1, 26.61, 26.21, and 31.75 percent, respectively, while in group B, they changed by 12.6, 10.75, 14.08, and 13.07 percent. (Table 3).

Between groups comparison:

All factors between groups did not differ prior to treatment ($p > 0.05$). Following therapy, a comparison between the two groups showed a clearly lower FBS, PPBS, and HbA1c in group A than in group B ($p < 0.001$). Additionally, there was a statistically noticeable difference between groups A and B in terms of TC, LDL, HDL, and TG ($p < 0.001$). (Table 2).

Table 2. Mean FBS, PPBS, HbA1c, TC, LDL, HDL and TG pre and post treatment of the group A and B

	Pre treatment Mean \pm SD	Post treatment Mean \pm SD	MD	% of change	p value
FBS (mg/dl)					
Group A	165.3 \pm 26.32	124.46 \pm 14.15	40.84	24.71	0.001
Group B	169.23 \pm 24.97	144.5 \pm 16.95	24.73	14.61	0.001
MD	-3.93	-20.04			
	<i>p</i> = 0.41	<i>p</i> = 0.001			
PPBS (mg/dl)					
Group A	269.83 \pm 45.75	193.6 \pm 25.79	76.23	28.25	0.001
Group B	271.93 \pm 50.97	236 \pm 30.17	35.93	13.21	0.001
MD	-2.1	-42.2			
	<i>p</i> = 0.86	<i>p</i> = 0.001			
HbA1c (%)					
Group A	7.93 \pm 0.83	6.95 \pm 0.79	0.98	12.36	0.001
Group B	8.15 \pm 0.92	7.74 \pm 0.78	0.41	5.03	0.003
MD	-0.22	-0.79			
	<i>p</i> = 0.33	<i>p</i> = 0.001			
TC (mg/dl)					
Group A	221.4 \pm 21.89	170.26 \pm 32.31	51.14	23.1	0.001
Group B	227.73 \pm 27.35	199.03 \pm 26.47	28.7	12.6	0.001
MD	-6.33	-28.77			
	<i>p</i> = 0.32	<i>p</i> = 0.001			
LDL (mg/dl)					
Group A	168.82 \pm 25.02	123.89 \pm 24.45	44.93	26.61	0.001
Group B	173.06 \pm 27.27	154.46 \pm 25.42	18.6	10.75	0.001
MD	-4.24	-30.57			
	<i>p</i> = 0.53	<i>p</i> = 0.001			
HDL (mg/dl)					
Group A	40.83 \pm 7.24	51.53 \pm 4.32	-10.7	26.21	0.001
Group B	39.76 \pm 7.55	45.36 \pm 4.16	-5.6	14.08	0.001
MD	1.07	6.17			
	<i>p</i> = 0.58	<i>p</i> = 0.001			
TG (mg/dl)					
Group A	238.73 \pm 29.67	162.93 \pm 25.35	75.8	31.75	0.001
Group B	241.8 \pm 24.55	210.2 \pm 30.92	31.6	13.07	0.001
MD	-3.07	-47.27			
	<i>p</i> = 0.66	<i>p</i> = 0.001			

SD, Standard deviation; MD, Mean difference; p value, Probability value

Discussion

In this study, women with metabolic syndrome ranging in age from 45 to 55 were examined to determine the simultaneous effects of pilates exercise and the DASH diet on cardiometabolic risk variables. They were divided equally into two groups. Group (A) The trial group consisted of 30 patients who got DASH diet, medical treatment, and three sessions of 60 minutes each of Pilates exercise three times per week for twelve weeks. Group (B) The control group included 30 patients who

got both their medical care and the DASH diet for a total of twelve weeks. Before and after 12 weeks of training, blood analysis for (FBS, PPBS, HBA1C, TC, LDL, and HDL) and Borg scale was measured.

For the Pilates group (group A):

The findings of this study corroborated those of **Sassen et al.**, who had previously shown that metabolic disorders had been demonstrated to cluster when physical activity and physical fitness are low. (13) The findings of this study supported those of **Abd El-Moniem et al.**, who conducted research on 40 women with type 2 diabetes who were randomly divided into two groups and had been diagnosed with the disease for 5-7 years prior. Pilates exercises were given to (Group A), while (Group B) merely received their prescribed medication.

For a total of 12 weeks, each patient had 3 sessions per week. After twelve weeks, the outcome measurements were taken. According to the study, there was a significant drop in HbA1c (8.35%), TC (10.57%), TG (11.98%), and TG/HDL ratio (17.96%) in both groups. There was also a significant drop in LDL (17.03) and a significant rise in HDL (7.96%) in the study group.

Non-significant variance in LDL (1.24%) and HDL (1.17%) in the controlled group, with a significant difference in lipid profiles between the two groups. 14) In addition, **Hagner-Derengowska et al.** evaluated the effects of walking and pilates workouts on 196 overweight or obese women and discovered that the former had a better impact on HDL and LDL than the latter. (15)

There were significant differences in HbA1c, pain, fatigue, mental health-related QOL, anxiety, depression, and fasting blood glucose after 12 weeks of PBME, according to **Hulya and Omer's** findings, which supported the recommendation of PBME for women with T2D as a component of a therapy program. (16)

The findings of this investigation corroborate those of **Zehua et al.**, who discovered that 15 randomized controlled trials (RCTs) with a total of 587 individuals were included in the analysis after meeting the inclusion and exclusion criteria. Overall, the post-meal blood glucose was considerably lower in the Pilates group (PG) than in the control group (CG). (17)

The findings of this study were consistent with those of **Melo et al.**, who conducted a study on 22 T2D patients who were randomly assigned to either a control group (CONTROL; age: 67.5 years; height: 154.7 cm; weight: 73.5 kg) or a Pilates group (PILATES; age: 65.5 years; height: 155.0 cm; weight: 66.2 kg). Both groups participated in three 60-minute sessions per week for a period of 12 weeks.

Blood sugar levels were checked before and after Pilates sessions, as well as before and after rest periods, 4, 8, and 12 weeks into the PILATES and CONTROL interventions. Before and after the intervention's 12-week period, the amount of glycated haemoglobin (HbA1c) was assessed. For older T2D patients, a battery of testing yielded the general index of the FC (GIFC). It is found that 12 weeks of the Pilates approach produces improvement and a link in the FC and glyceimic

control in older women with T2D. Analysis of variance revealed variations in the GIFIC for PILATES vs. CONTROL. (18)

The current study's findings did not agree with those of **Zehua et al.**, who found no significant differences in fasting blood glucose (MD = 7.04 mg/dL, 95 percent, I2 = 93 percent) or high-density lipoprotein cholesterol (MD = 2.68 mg/dL, 95 percent) between the two groups (Pilates group and control group). (17)

By subgroup analysis, **Zehua et al.** discovered that while the Pilates group did not significantly improve blood glucose and cholesterol levels compared to the control group for non-diabetics, it significantly reduced post-prandial blood glucose, TC, TG, and LDL-C for diabetic patients.

Notably, for diabetic cases, combining Pilates with medication treatments did not significantly lower fasting blood glucose (MD = 7.00 mg/dL, 95%) or HbA1c (MD = 0.23 percent, 95%) compared to medication treatment used alone, and combining Pilates with medications and dietary treatments did not significantly improve fasting blood glucose (MD = 10.90 mg/dL, 95%). (17)

The ongoing study also showed that the DASH diet group (group B) experienced statistical improvements in FBS with a percentage decrease of about 14.61 percent, as well as PPBS with a percentage decrease of about 13.21 percent, the HBA1C with a percentage decrease of about 5.03 percent, the TC with a percentage decrease of about 12.6%, the LDL with a percentage decrease of about 10.75 percent, and the HDL with a percentage increase of about 1.

For DASH diet group (Group B):

The findings of this study are consistent with those of **Asghari et al.**, who found that among 425 healthy children and adolescents aged 6 to 18 years, stronger DASH diet adherence was linked to a 64 percent decreased incidence of MetS. The investigators also noted negative correlations between abdominal obesity, fasting plasma glucose levels, and DASH diet adherence. (19)

The current study's findings concur with those of **Akhlaghi et al.**, who indicate that the nutritional quality and distribution of the DASH diet are likely to be responsible for the diet's health advantages. The DASH diet is heavy in fruits and vegetables, which translates into high intakes of potassium, magnesium, and fibre. These nutrients have been found to play a role in blood pressure regulation, glucose metabolism, and insulin response. Additionally, fruits and vegetables are the primary food sources of polyphenols and antioxidants, which have been associated with improved blood levels of insulin and glucose. In addition, it is low in sodium and fat, especially saturated fatty acids (SFA), which are directly linked to cardiovascular disease (CVD). (20)

The findings of this study were in line with a cross-sectional study published by **Phillips et al.**, which found that among 1493 adults, higher DASH diet adherence was associated with a 48 percent lower risk of developing MetS, while BMI, waist circumference, pro-inflammatory markers, and adiposity measures were significantly lower in those who adhered to the diet more strictly (21)

In contrast, a research by **Siervo et al.** found no significant variations in HDL-c and triglyceride levels, despite improvements in total cholesterol and LDL-c levels following the DASH intervention. (7)

These outcomes back up the findings of a study conducted by **Siervo et al.** who showed a meta-analysis of 1917 participants with some CVD risk factors and noticed a decrease in total cholesterol and LDL-c levels after the DASH intervention (mean differences: 0.20 mmol/L (95 percent) and 0.10 mmol/L (95 percent), respectively) (7). Related findings were attained in a published controlled trial by **Asghari et al.**, who achieved a substantial reduction in triglycerides, total cholesterol, and very-low-density lipoproteins with both dietary treatments (19)

According to the latest research, DASH considerably raises blood lipoprotein levels. Ge et al. could not find any significant variations in HDL-c or low-density lipoprotein-cholesterol (LDL-c) levels following a DASH dietary intervention compared to usual diet, which contradicts the findings of this study (22)

Subsequently, this study found that women with metabolic syndrome benefitted noticeably more from both the DASH diet and pilates workouts in terms of lowering blood sugar levels, post-meal glucose levels, glycosylated haemoglobin, and lipid profiles. According to these findings, Pilates exercise combined with DASH did enhance cardio-metabolic risk variables more than DASH alone. This may be because Pilates exercises directly impact body parts, flexibility, mobility, and even mood. Pilates also has the benefit of reducing stress, which may impact blood pressure, glucose levels, insulin resistance, and lipid profiles.

Conclusion

It has been demonstrated that DASH eating habits and Pilates exercise significantly enhance lipid profiles and HBA1C in women with metabolic syndrome. Pilates and DASH applications can enable patients with metabolic syndrome to improve cardiometabolic risk factors, enhance their quality of life, and lessen the financial burden of its maintenance. Pilates and DASH application improve lipid profile more than application of DASH diet alone.

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