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Effect of Pilates on Anxiety, Depression, and Anthropometric Indices of Women with Type 2 Diabetes

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is prevalent among overweight or obese women. Due to the chronic nature of diabetes, individuals with this condition often experience psychological complications, such as anxiety and depression. This study aimed to investigate the effects of Pilates exercises on anthropometric indices, anxiety, and depression in women with diabetes attending diabetes clinics in Zahedan, Iran.

Methods: This two-group quasi-experimental study with pre-test and post-test assessments included 60 female patients diagnosed with T2DM who attended diabetes clinics in Zahedan within March 2021 and July 2022. The participants were selected using convenience sampling and then randomly assigned to either the Pilates exercise group or the control group using a random allocation method with permutation blocks. Initially, anthropometric indices, including body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR), were measured, and the Hospital Anxiety and Depression Scale was completed by both groups. The intervention group participated in Pilates exercises three times a week for 8 weeks, with each session lasting 60 minutes and supervised by a Pilates exercise expert. The control group received routine care at the diabetes clinic, including diet counseling and medication adjustments. After 8 weeks, the data were collected again and statistically analyzed using SPSS 22 software. The significance level was set at $P < 0.05$.

Results: Significant differences were observed in anxiety scores before and after the intervention (13.33 ± 2.6 and 3.2 ± 5.41, respectively; P = 0.001), depression scores (11.9 ± 2.61 and 2.56 ± 1.85, respectively; P = 0.001), and anthropometric indices ($P < 0.05$). Waist circumference (96.20 ± 9.86 and 92.25 ± 8.56, respectively; P = 0.001), BMI (27.75 ± 1.99 and 26.67 ± 2.03, respectively; P = 0.001), and WHR (0.97 ± 0.06 and 0.93 ± 0.17, respectively; P = 0.001) all showed significant improvements.

Conclusions: Exercise is a crucial non-pharmacological intervention in the management of diabetes. The results of this study demonstrate that Pilates exercises can effectively reduce anxiety and depression while improving anthropometric indices in women with T2DM. Therefore, it is recommended to incorporate Pilates exercises as a method to reduce anxiety and depression and enhance anthropometric indicators in this population.

Keywords: Diabetes Mellitus, Pilates, Depression, Anxiety, Anthropometric Indices

1. Background

Diabetes mellitus is a metabolic disease characterized by a blood sugar level above 120 milligrams per deciliter over an extended period of time (1). The prevalence of type 2 diabetes (T2DM) has dramatically increased in all countries, regardless of income level, over the past three decades. Diabetes is more common in women than in men, and factors such as pregnancy, childbirth, hormonal changes, low physical activity, and obesity put women at a greater risk of developing diabetes (2).

The global prevalence of diabetes was reported at 8.5% in 2014, with estimates suggesting that the number of affected individuals will rise from 422 million worldwide to 642 million by 2040 (3). The Middle East region is expected to see a significant increase in diabetes

prevalence by 2030, and it is estimated that Iran will have the second-highest annual growth rate of diabetes in the region, following only Pakistan (4). By 2030, approximately 9.2 million Iranians might have diabetes. Diabetes ranks as the seventh leading cause of death in the United States and is also among the top 10 causes of death in Iran (5).

The rising prevalence of obesity, unhealthy lifestyles, low physical activity, and sedentary behavior are major contributing factors to the occurrence of T2DM and its associated complications (6). It is estimated that diabetic patients are at least twice as likely to develop depression or anxiety compared to the general population (7). Moreover, anxiety and depression in diabetic patients are linked to increased risks of comorbidities, interference with daily activities, reduced quality of life, higher healthcare costs, and a greater number of complications than non-diabetic individuals (8).

A meta-analysis of 16 studies has shown a significant association between depression and an increased risk of mortality in diabetic patients (9). Diabetic individuals generally experience higher levels of stress, anxiety, and depression than those without diabetes. The prevalence of depression and anxiety among diabetic patients has been reported at 26.6% and 40%, respectively (10, 11). Identifying and treating anxiety and depression can lead to improved clinical outcomes (12). Most diabetic patients experience moderate to severe anxiety, depression, or both following their diabetes diagnosis. Diabetic patients are also at an increased risk of anxiety if they have been hospitalized for 8 days or more and lead a physically inactive lifestyle. Therefore, diabetes specialists have recommended various strategies for preventing anxiety and depression, such as engaging in an adequate level of physical activity and maintaining social interactions (13).

General and central obesity represent the most significant risk factors for T2DM, with body mass index (BMI) being a recognized risk factor for diabetes incidence (14). Shakeri et al.'s study in 2015 demonstrated that anthropometric indices, such as BMI, waist circumference (WC), and hip circumference, can influence the development of diabetes. In essence, as an individual's weight increases, their likelihood of developing diabetes also rises. Genetics and obesity are identified as the most significant risk factors for diabetes, emphasizing the vital role of lifestyle control and management in preventing the onset of this disease, particularly through the regulation of obesity and other anthropometric indices (15). Allenberg further affirmed that WC is the most accurate measure for predicting diabetes (16).

Considering the observed decline in physical activity in societies and its correlation with the rising prevalence of T2DM, regular exercise is deemed beneficial for managing the treatment of this disease and plays an influential role in its primary prevention (17). Exercise typically stands as one of the initial management strategies recommended for individuals recently diagnosed with T2DM (18). Contemporary international guidelines advocate for various types of exercise, including aerobic, resistance, and combined exercises, to control T2DM (19).

Pilates exercise has garnered attention from experts in recent years and is gaining widespread popularity as a form of physical activity (20). Originating as Contrology and later known as Pilates, this exercise method was developed by Joseph Pilates in 1920. Initially employed as part of physical fitness programs for prisoners of war, it eventually evolved into a method for achieving peak fitness levels (21). The results of a meta-analysis have shown that Pilates significantly reduces body weight, BMI, and body fat percentage in overweight or obese adults (22).

Additionally, Batar et al. highlighted that exercise and diet represent significant non-pharmacological interventions in the treatment of diabetes (23). Many individuals with T2DM strive to manage their blood glucose levels through proper dietary planning, medication, and weight loss. Calorie restriction for weight loss, while reducing health risks associated with obesity, can potentially lead to muscle mass loss. Consequently, supplementing dietary measures with physical activity can offset the adverse effects of calorie restriction, with Pilates exercises proving highly effective in muscle strengthening and enhancing individuals' overall physique (22). Related studies have indicated that well-designed Pilates exercises can improve cardio-metabolic risk factors and quality of life scores and reduce depression and anxiety in individuals with T2DM (24-26).

A review of the studies has revealed that physical and mental problems, such as obesity, depression, and anxiety, are more prevalent in individuals with T2DM. Pilates exercises have been shown to have a positive impact on anxiety, oxidative stress, cardio-metabolic risk factors, and the quality of life, particularly among female diabetic patients. Furthermore, both lack of physical activity and obesity are recognized as risk factors for diabetes, emphasizing the importance of adopting a more active lifestyle.

2. Objectives

In the researchers' review of the literature, no interventional study was identified that establishes a correlation between Pilates and anthropometric indices, anxiety, and depression in women with T2DM.

Consequently, this study aimed to investigate the effects of Pilates exercises on anthropometric indices, anxiety, and depression in women with T2DM who are receiving care at the diabetes clinics of Zahedan University of Medical Sciences, Zahedan, Iran.

3. Methods

3.1. Setting and Participants

The present study employed a two-group quasi-experimental design of the pre-test-post-test type. The study population comprised all female patients with a confirmed diagnosis of T2DM who were receiving oral anti-diabetic medication and were seeking care at diabetes clinics in Zahedan between March 2021 and July 2022.

The sample size was determined to be 8 individuals in each group, calculated based on the mean and standard deviation of the percentage of body fat mass from Sharafi and Hassanpour's study. This calculation was made with a 95% confidence interval and a statistical test power of 95% using the following formula (27). To account for potential dropouts and ensure an adequate sample size for data analysis, a total of 60 individuals, with 30 in each group, were included.

$$n = \frac{\left(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta}\right)^2 \left(S_1^2 + S_2^2\right)}{\left(\bar{X_1} - \bar{X_2}\right)^2} = 7.19 \quad (1)$$

Where $Z_{1\text{-}a/2} = 1.96$; $S_1 = 3.46$; $\bar{X_1} = 34.00$; $Z_{1\text{-}\beta} = 1.46$; $S_2 = 1.83$; and $\bar{X_2} = 28.75$.

The participants were selected from among diabetic women attending the diabetes clinic in Zahedan using the convenience sampling method, a research subject selection checklist, and adherence to the study's inclusion criteria. Subsequently, they were randomly assigned to either the intervention or control groups using the random allocation method with permutation blocks.

The inclusion criteria comprised individuals aged 20 - 55 years who voluntarily agreed to participate in the study, provided informed consent, did not have sensory-perceptual disorders, had been diagnosed with diabetes for at least one year, were not taking psychiatric medications, had no history of acute heart attacks or uncontrolled blood pressure, had not engaged in any exercise program for a minimum of 2 months before starting the Pilates exercise program, did not have mobility or vision impairments, had no hearing or cognitive deficits, had no structural spine disorders, had obtained specialist permission to partake in Pilates exercises, experienced no alterations in their oral blood sugar, fat, or antihypertensive medication in the two months prior to and during the study, did not smoke or use drugs, did not use weight loss or anti-anxiety medications during the study, had a BMI equal to or greater than 25 kg/m^2, and scored 11 or higher on the Hospital Anxiety and Depression Scale (HADS).

The exclusion criteria encompassed any refusal to continue participation for any reason, including the inability to perform Pilates exercises or the occurrence of physical risks, such as pain, frequent hypoglycemia during exercises, and being absent for more than two Pilates exercise sessions.

3.2. Data Collection and Instruments

The data collection instrument comprised a questionnaire with three sections. The first section encompassed the patient's demographic information and the disease information form. The second section consisted of a checklist for anthropometric indices; however, the third section contained the HADS.

The patient's demographic information and the disease information form included details such as age, marital status, education, occupation, smoking habits, physical activity level, dietary habits, duration of diabetes, duration of blood sugar-lowering drug usage, and type of oral medication. The checklist for anthropometric indices encompassed measurements of height, weight, WC, hip circumference, BMI, waist-to-hip ratio (WHR), and waist-to-height ratio (WHtR). These measurements were performed and recorded by the researcher.

The Hospital Anxiety and Depression Scale, designed by Snaith in 1983 for screening anxiety and depression in hospital outpatient clinics (28), was utilized in this study. The reliability of the questionnaire was assessed by calculating Cronbach's alpha for the two subscales of anxiety and depression, resulting in reported values of 0.88 and 0.81, respectively.

A pre-test was administered one week before implementing the study plan. After 8 weeks, the anxiety and depression questionnaire was re-administered, and anthropometric measurements, including weight, WC, and hip circumference, were recorded in the relevant checklist.

Upon identifying eligible patients for the study, the researcher introduced herself and provided comprehensive information about the study's objective, methodology, and the confidentiality of patient data. The patients were assured that their participation would not disrupt the services they were receiving and would entail no costs. They were also informed of their right to withdraw from the study at any time. After explaining the

research process, informed consent was obtained from all participants.

To assign patients to the two intervention and control groups, a random allocation method was used, with patients divided into 6 blocks of four (e.g., AABB, ABAB, and BBAA). Each block contained two individuals in each group. The order of these blocks was determined randomly using a table of random numbers. Subsequently, the patients were assigned to the Pilates group based on these blocks (30 individuals, with 15 attending on even days and 15 on odd days); however, the control group consisted of 30 individuals.

The exercise protocol spanned 8 weeks, involving three sessions per week, with each session lasting 60 minutes. Pilates exercises were conducted in a suitable indoor space designated for the exercise program. Initially, the researcher, under the guidance of an experienced physical education specialist proficient in Pilates exercises, provided training to the patients. The patients then independently practiced and executed the exercises.

Data analysis was performed using SPSS 22 software, employing descriptive statistics, such as statistical tables, graphs, frequencies, percentages, and measures of central tendency and dispersion. The normality of the variables was assessed using the Shapiro-Wilk test. Data analysis was carried out using independent *t*-tests and Fisher's exact test. To evaluate the impact of the intervention while controlling for potential confounding variables, the analysis of covariance was utilized while considering the relevant assumptions. The significance level for this study was set at less than 0.05.

Table 1 shows details of the main movements performed in Pilates exercises, along with their repetitions.

4. Results

The results of the study showed no statistically significant difference between the 2 groups in terms of demographic and clinical variables ($P > 0.05$) (Table 2).

As shown in Table 3, the mean value of patients' anxiety levels in the Pilates group before commencing Pilates exercises was 13.33 ± 2.6; nevertheless, after completing the Pilates exercises, the mean value was 3.5 ± 2.41, indicating a statistically significant decrease ($P = 0.001$). However, in the control group, the mean value of anxiety levels before the intervention was 12.8 ± 3.77, and following the intervention, it increased significantly to 14.26 ± 3.3 ($P = 0.001$).

In terms of depression, the findings demonstrated that the mean value of depression levels in the Pilates group before participating in the Pilates exercises was 11.9 ± 2.61. After completing the Pilates exercises, the mean value decreased significantly to 2.56 ± 1.85 ($P = 0.001$). Nonetheless, in the control group, the mean value of depression levels before the intervention was 13.06 ± 3.21, and following the intervention, the mean value increased significantly to 14.13 ± 2.82 ($P = 0.001$) (Table 3).

Furthermore, the results of covariance analysis, accounting for the significant influence of pre-test scores, revealed a statistically significant difference in the average anxiety and depression scores of women diagnosed with T2DM between the two groups after engaging in Pilates exercises ($P = 0.001$).

The study results concerning anthropometric indices demonstrated a positive impact of Pilates exercises on patients in the intervention group. As shown in Table 4, the mean value of WC in the Pilates group before initiating Pilates exercises was 96.20 ± 9.86. After completing the Pilates exercises, this mean value decreased significantly to 92.25 ± 8.56 ($P = 0.001$). Nonetheless, the control group exhibited a different trend, with the mean value of WC before the intervention being 94.87 ± 9.91. After the intervention, this mean value increased significantly to 96.34 ± 9.92 ($P = 0.001$).

Regarding BMI, the findings revealed that the mean value of BMI in the Pilates group before engaging in Pilates exercises was 27.75 ± 1.99. Following the completion of Pilates exercises, this mean value decreased significantly to 26.67 ± 2.03 ($P = 0.001$). Nevertheless, in the control group, the mean value of BMI before the intervention was 28.25 ± 1.77, and after the intervention, it increased significantly to 28.63 ± 1.75 ($P = 0.001$).

In terms of WHR, the results indicated that the mean value of WHR in the Pilates group before commencing Pilates exercises was 0.97 ± 0.06. After completing the Pilates exercises, this mean value decreased significantly to 0.93 ± 0.17 ($P = 0.001$). However, in the control group, the mean value of WHR before the intervention was 0.96 ± 0.17, and after the intervention, it increased, although the increase was not statistically significant ($P = 0.11$) (Table 4).

5. Discussion

It appears that, as an outcome, Pilates has been successful in reducing the severity of depression in the present study by influencing blood sugar control and fostering a sense of accomplishment in disease management. Pilates seems to have contributed positively to mood maintenance and improvement. Moreover, the potential long-term positive effects of exercise on depression are also considered. The results highlight the significant and positive impact of Pilates exercises on various variables, including anxiety, depression, and

Table 1. Pilates Primary Exercises

Movements	Repetition	Movements	Repetition
Breathing exercises	5 - 10	Single - leg kick from behind	5 - 10
Basic stretching exercises to warm up and cool down the body	5 - 10	Single - leg glute bridges	5 - 10
Simple single - leg raise standing and lying on the back	5 - 10	Swimming (table mode)	5 - 10
Simple circle with one leg standing and lying on the back	5 - 10	Cat stretching exercises	5 - 10
Single - leg stretching and double - leg stretching	5 - 10	Ruler from the front and side (adjusted)	5 - 10
Chest lifting	5 - 10	Stretching the spine (forward)	5 - 10

Table 2. Background Variables

Background Variables	Statistical Test	P-Value
Age	Independent *t*-test	0.67
Marital status	Chi-square test	0.76
Ethnicity	Chi-square test	0.94
Occupation	Chi-square test	0.6
Type of blood sugar lowering type	Fisher's exact test	0.27
Duration of diabetes (y)	Independent *t*-test	0.08
Duration of drug treatment (y)	Independent *t*-test	0.12
Tobacco use	Chi-square test	0.57
Educational level	Chi-square test	0.79
Regular walk	Fisher's exact test	0.23
Type of diet	Chi-square test	0.1

anthropometric indices, such as BMI, WC, and WHR, among women with diabetes. Consequently, Pilates significantly reduced anxiety, depression, BMI, and WHR in women with diabetes.

The current study's findings concerning anxiety and depression among women with diabetes align with the findings of previous studies that demonstrated the beneficial effects of Pilates exercises in reducing anxiety and depression among T2DM patients (29, 30). For instance, Cruz-Ferreira (2011) investigated the impact of Pilates exercise on stress and anxiety in adult women aged over 40 years. The study concluded that women experienced a significant reduction in anxiety after three months of Pilates exercise (31).

Pilates exercises, which involve a range of motion in three positions (standing, sitting, and lying down) combined with deep breathing and muscle contractions, have the potential to effectively alleviate anxiety in patients. The positive effects of Pilates on anxiety might be attributed to the specialized nature of Pilates exercises, which engage both the body and the mind, influencing strength, endurance, and flexibility. Unlike many other forms of exercise that predominantly focus on physical aspects, Pilates places importance on the mental dimension. It emphasizes the harmony between the body and the mind, ultimately promoting both physical and mental well-being (32). Regular exercise offers numerous physical, psychological, and social benefits for diabetic patients beyond its impact on glucose metabolism.

Moreover, depression, which is more prevalent among individuals with chronic conditions such as diabetes, can sometimes hinder the initiation of exercise activities. Pilates exercises, with their capacity to enhance breathing, strengthen cerebral blood flow, improve oxygen and glucose utilization in the brain, expedite the transfer of biochemical substances, and boost the activity of blood antioxidant enzymes for the efficient removal of free radicals, also contribute to mood enhancement and reduction of depression severity (33). In line with the findings of the present study, Yucel and Uysal's study demonstrated that Pilates-based mind-body exercise (PBME) positively influenced the quality-of-life parameters in women with T2DM. Consequently, it can be recommended as an integral part of treatment plans to enhance the psychological well-being of patients (26). A meta-analysis conducted by Fleming and Herring investigated the effects of Pilates on the mental health outcomes of various populations, and it concluded that

Table 3. Mean and Standard Deviation of Anxiety and Depression Scores of Women with Diabetes in Pilates and Control Groups [a]

Score	Pre-test	Post-test	Paired *t*-test (P-Value)
Pilates			
Anxiety	13.33 ± 2.6	3.5 ± 2.41	0.001
Depression	11.9 ± 2.61	2.56 ± 1.85	0.001
Control			
Anxiety	12.8 ± 3.77	14.26 ± 3.3	0.001
Depression	13.06 ± 3.21	14.13 ± 2.82	0.001
Anxiety			
Pilates	13.33 ± 2.6	3.5 ± 2.41	
Control	12.8 ± 3.77	14.26 ± 3.3	
Independent *t*-test			
P-value	0.52	0.001	
Depression			
Pilates	11.9 ± 2.61	2.56 ± 1.85	
Control	13.06 ± 3.21	14.13 ± 2.82	
Independent *t*-test			
P-value	0.12	0.001	

[a] Values are expressed as mean ± standard deviation (SD).

all studies reported positive impacts of Pilates on mental health (34).

Regarding the increase in anxiety scores observed in the control group, it can be argued that there is substantial evidence indicating that individuals diagnosed with diabetes frequently experience symptoms of anxiety. This finding might stem from their awareness that the disease necessitates lifestyle changes, a perceived loss of control over their health, and the potential development of diabetes-related complications, including diabetic retinopathy, neuropathy, sexual dysfunction, and macrovascular complications. Additionally, the daily management of diabetes, which involves self-care activities, such as dietary adjustments, complex medication regimens, exercise programs, smoking cessation efforts, and blood sugar monitoring, can contribute to anxiety. Nearly 60% of individuals with T2DM report experiencing anxiety related to the management of their condition. Although there is a high prevalence of anxiety among individuals with T2DM, there is currently no evidence-based treatment protocol specifically tailored for this population (35).

As for the increase in depression scores observed in the control group, it can be attributed to the fact that the coexistence of depression and diabetes is not uncommon and has detrimental implications from both a psychosocial and sociobiological perspective. Individuals who experience depression or anxiety might resort to diabetes-related risky behaviors, such as overeating, as a means of alleviating the symptoms of anxiety and depression (36).

Regarding the anthropometric indices, the results indicated a significant reduction in BMI in the intervention group following the Pilates exercise program. This reduction suggests the effectiveness of Pilates exercises in lowering the BMI of women with diabetes. Exercise contributes to increased insulin sensitivity in tissues, reduced insulin resistance, lowered insulin requirements, regulation of blood glucose levels, improved metabolic control, and ultimately, weight loss (37). A meta-analysis conducted by Wang et al. supported the aforementioned findings, revealing that Pilates had a significant impact on reducing body weight, BMI, and body fat percentage in overweight or obese adults. However, the researchers recommended further large-scale and well-designed randomized controlled trials (RCTs) with immediate reporting to provide further definitive evidence (22).

Furthermore, a study conducted by Batar et al. reported the positive impact of exercise on anthropometric indices and biochemical parameters in diabetic patients, highlighting Pilates as a reliable and effective exercise modality for individuals with diabetes (23). All the aforementioned studies corroborate the

Table 4. Mean and Standard Deviation of Anthropometric Indices of Women with Diabetes in Pilates and Control Groups

Score	Pre-test	Post-test	Paired *t*-test	
	Mean ± SD	Mean ± SD	*t*	P
Pilates				
Waist circumference (cm)	96.20 ± 9.86	92.25 ± 8.56	8.89	0.001
BMI (kg/m^2)	27.75 ± 1.99	26.67 ± 2.03	18.49	0.001
Waist-to-hip ratio	0.97 ± 0.06	0.93 ± 0.17	1.36	0.001
Control				
Waist circumference (cm)	94.87 ± 9.91	93.34 ± 9.92	8.07	0.001
BMI (kg/m^2)	28.25 ± 1.77	28.63 ± 1.75	-8.55	0.001
Waist-to-hip ratio	0.96 ± 0.17	1.01 ± 0.07	-1.6	0.11
Waist circumference (cm)				
Pilates	96.20 ± 9.86	92.25 ± 8.56		
Control	94.87 ± 9.91	93.34 ± 9.92		
Independent t-test				
P	0.6	0.09		
Body mass index (BMI) (kg/m^2)				
Pilates	27.75 ± 1.99	26.67 ± 2.03		
Control	28.25 ± 1.77	28.63 ± 1.75		
Independent *t*-test				
P	0.3	0.001		
Waist-to-hip ratio				
Pilates	0.97 ± 0.06	0.93 ± 0.17		
Control	0.96 ± 0.17	1.01 ± 0.07		
Independent *t*-test				
P	0.86	0.02		

Abbreviations: SD, standard deviation; BMI, body mass index.

favorable effects of Pilates exercises on body composition, weight, and BMI in overweight women, aligning with the findings of the current study. The results indicated a significant reduction in the WC of women in the intervention group following the completion of Pilates exercises, signifying that Pilates contributed to a decrease in WC among these individuals, reflecting its positive influence on fat reduction.

Additionally, the results about the WHR indicated a statistically significant reduction in the WHR among the women who participated in the Pilates group. Similarly, the findings related to the WHtR suggested a reduction in the WHtR among women in the Pilates group, although this reduction did not reach statistical significance. Notably, a study by Nesreen et al. demonstrated that engaging in Pilates exercises for 12 weeks led to a significant improvement in the WHR among women with T2DM, emphasizing the potential of Pilates exercises in enhancing cardio-metabolic risk factors in T2DM patients (24). Moreover, a study by Shadmehri et al. showed that 12 weeks of Pilates exercises resulted in a significant decrease in BMI and WHR among obese diabetic women (38).

Furthermore, a study conducted by Batar et al. revealed that the combination of diet and Pilates exercises could significantly reduce BMI in women with T2DM (23). Additionally, the findings from Salehzadeh et al.'s study indicated that Pilates exercises had a positive and significant impact on parameters such as body fat percentage, BMI, WHR, and balance in individuals (39). The consistency between these results and those of the present study might be attributed to the uniform nature and duration of the intervention and the homogeneity of the target population.

5.1. Conclusions

The findings of this study underscore the beneficial effects of Pilates exercises in reducing anxiety, depression, BMI, WC, and WHR among women with T2DM, ultimately contributing to an improvement in both physical and mental health. Therefore, it is recommended that diabetic patients engage in Pilates exercises under the guidance of a qualified expert to enhance their physical fitness and mitigate or alleviate symptoms of depression and anxiety.

5.2. Limitations

One limitation of this study was the lack of precise assessment and control of patients' dietary habits. Nevertheless, efforts were made to account for the potential confounding effect of diet by inquiring about macronutrient intake.

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Footnotes

Authors' Contribution: All authors discussed the results and contributed to the final manuscript.

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