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Pilates-Based Mat Exercises and Parameters of Quality of Life in Women With Type 2 Diabetes

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Abstract

Background: Physical exercises increase quality of life (QoL) in diabetics. However, the optimal exercise type for patients with diabetes has not yet been established. It is unknown whether pilates is a suitable form of exercise for the QoL of patients with diabetes.
Objectives: The aim of this study was to investigate effects of Pilates-based mat exercise (PBME) on glycemic control, anxiety, depression, and QoL in women with type 2 diabetes.
Materials and Methods: This prospective and randomized study was conducted with 24 women in the Pilates group and 21 women in the control group. Socio demographic data were collected from both groups, including the duration of diabetes since diagnosis, medications being taken, insulin injections, sleep problems, and so on, as well as hospital records of blood laboratory test outcomes (fasting blood glucose, postprandial blood glucose, and glycosylated hemoglobin). Pain and fatigue symptoms were assessed using the visual analogue scale. Participants completed the 36-item short form health survey and the hospital anxiety depression scale. Participants in the exercise group performed PBME three times per week for 12 weeks. Both groups continued their routine diet and medical follow-ups during the intervention. Data from the groups were compared before and after the program.
Results: Pain (3.00 ± 4.00, 2.00 ± 2.00, P = 0.001), fatigue (5.00 ± 2.00, 4.00 ± 1.00, P = 0.0001), mental health-related QoL (29.00 ± 5.00, 35.00 ± 3.00, P = 0.0001), anxiety (8.00 ± 3.00, 7.00 ± 3.00, P = 0.023), depression (9.00 ± 2.00, 8.00 ± 2.00, P = 0.019), fasting blood glucose (140.00 ± 31.00, 139.5 ± 32.00, P = 0.026), and glycosylated hemoglobin values (6.70 ± 1.16, 6.30±1.00, P = 0.001) in the Pilates group differed before and after the intervention. In the control group, only glycosylated hemoglobin values (6.53 ± 1.42, 6.40 ± 1.27, P = 0.008) differed before and after the intervention.
Conclusions: PBMEs affect the parameters of QoL in women with type 2 diabetes, and they might be recommended as a part of their treatment program.

Keywords: Diabetes Mellitus Type 2, Pilates-Based Exercises, Quality of Life, Depression, Women

1. Background

The incidence of type 2 diabetes mellitus (T2D), a chronic metabolic disease, is rapidly increasing worldwide, especially in women (1). One of the goals of treatment is to improve quality of life (QoL), because patients with diabetes particularly women report poorer perception of QoL (2, 3). Diabetes can affect QoL via hypoglycemic symptoms, the chronicity of the disease, medications, routine blood glucose monitoring, insulin therapy, and exercise demands (4-6). Impaired QoL in patients has also been directly associated with depression and anxiety, a comorbid health problem in diabetics (7-9). Depression is associated with higher levels of glycosylated hemoglobin (HbA1c), poorer glycemic control, and increased risk of developing diabetes-related complications (4).

In T2D patients, alternative methods of physical exercise have clear beneficial effects, such as improving better glycemic values, controlling depression, and increasing QoL (1, 6, 10). The contraction and relaxation of skeletal muscles lower blood glucose levels; therefore, physical exercise plays a role in controlling diabetes, along with dietary therapy and medication (1, 11). Physical exercise is correlated with adequate long-term glycemic control in terms of HbA1c levels and increased insulin sensitivity (1, 11). However, the optimal exercise type for patients with T2D has not yet been established (12). Increased muscular glucose uptake during exercise is closely associated with exercise at any intensity (13).

Pilates exercise is a type of body conditioning incorporating the principles of concentration, control, precision, and breathing. Several studies have shown the positive effects of Pilates on body mass index (BMI), flexibility, endurance, balance, perception of functionality, QoL, physical self-concept, and perception of health status (11, 13, 14). In addition, other studies have demonstrated the effectiveness of Pilates in patients with type 1 diabetes, as well as the benefits of aerobic or resistance exercise for patients with T2D (15, 16). However, it is unknown whether Pilates is a suitable form of exercise for women with T2D.

2. Objectives

This study aimed to investigate the effects of Pilates-based mat exercise (PBME) on glycemic control, anxiety, depression, and QoL in women with T2D to determine whether it can be used as a complementary therapy for such patients.

3. Patients and Methods

A total of 56 women with T2D who maintained regular diet and medical follow-ups at the department of endocrinology and metabolism of Bezmialem Vakif university in Istanbul, Turkey were enrolled in this clinical trial. Participants were randomly allocated to the Pilates exercise group or control group, 28 for each (simple allocation using www.random.org). The ethical review committee of the university approved the study (number: B.30.2.BAV.0.05.05/414). All participants provided written informed consent in the accordance with the declaration of Helsinki. The participants of both groups were aged 18 - 65 years and were not currently participating in any other regular physical exercise program. Those with severe diabetic complications, such as mobility difficulties, visual impairments, major depressive disorders, and medical contra-indications (e.g., risk of heart attack or stroke), were excluded from the study (n = 4 were from control group). During this study, patients in both groups continued their prescribed medical and dietary treatments. Four women in the Pilates group dropped out because they did not like the training venue, had difficulties exercising owing to headache or hypertension, or did not enjoy the exercises. Three women from the control group dropped out because they did not attend the final assessment (see Figure 1 for the flow diagram of the patients).

3.1. Data Collection Assessments

Before starting the exercise program, socio demographic data were collected from all participants, including age, occupation, and duration of diabetes, BMI, educational status, marital status, medications, and insulin injections. As hypoglycemia symptoms such as discomfort and excessive sweating may cause sleep problems, we noted the presence of sleeping difficulties. We assessed pain at rest and fatigue during the day with the visual analogue scale (VAS) ranging from 0 to 10, with 0 indicating that no pain or fatigue, and 10 indicating severe pain or fatigue (17). Blood test data, including fasting blood glucose, postprandial blood glucose, and HbA1c, were collected from hospital records (3).

QoL was assessed using the Turkish version of the 36-item Short-Form Health Survey (SF-36), which is widely used in health research (18). The SF-36 includes eight dimensions, as follows: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health. All domains are summarized in two composite scores of physical health and mental health (SF-36-PH and SF-36-MH, respectively). The item scores for each dimension are summed on a scale from 0 (worst) to 100 (best). Higher scores indicate better functioning. The SF-36 is well documented in terms of reliability and validity. For reliability, the Cronbach's alphas fall between 0.7 and 0.8 for all sub-parameters. The internal validity of SF-36 is $\geq$0. 81 for mental health and $\geq$ 0. 83 for physical health (18, 19).

We used the hospital anxiety depression scale (HADS), a self-report instrument that is designed to detect depression and anxiety symptoms separately. It consists of seven items for anxiety and seven for depression. Its 14 questions each range from 0 (not present) to 3 (considerable). For each final score of depression and anxiety, scores > 11, 8 - 10, and < 7 points indicate the presence of increased symptoms of anxiety or depression, borderline anxiety or depression, and no problems, respectively (20). Cronbach's alpha for HADS-anxiety varies from 0.68 to 0.93 (mean 0.83), and that for HADS-depression varies from 0.67 to 0.90 (mean 0.82). In the literature, an optimal balance between sensitivity and specificity was achieved when caseness was defined by a score of $\geq$ 8 for both anxiety and depression (21). All measurements were repeated at the end of the period.

3.2. Training Program

After assessments and before the intervention, we held a half-day patient education session about diabetes and exercise. As diaphragmatic breathing is an effective method for improving glycemic parameters in T2D patients (22), a trained physiotherapist taught patients diaphragmatic breathing before leading the PBME program. For 12 weeks during the summers of 2012 and 2013, Pilates participants performed PBME at 11 a.m. every Monday, Wednesday, and

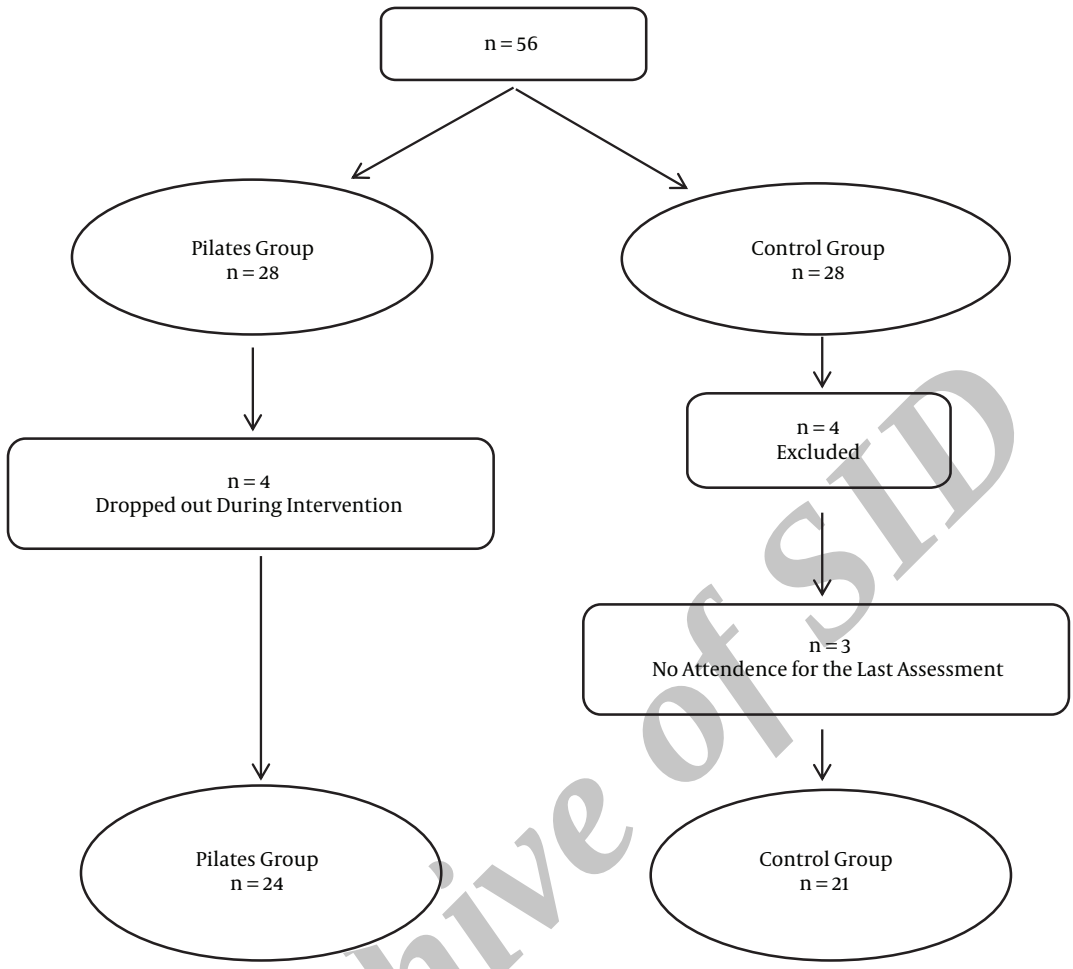

Figure 1. Flow Diagram of the Patients

Friday. All of the sessions took place in the hospital's garden. Sessions were initially 45 minutes long but were increased to 70 minutes by the end of the study. The sessions included a warm-up; stretching; basic aerobic Pilates training for arms, legs, and body; and cool-down. We avoided high-intensity exercises and advanced Pilates because of the concerns of possible hypoglycemic shock and other complications in patients with T2D. Patients self-controlled their blood glucose in the first sessions (before, during, and after the exercise period) and continued exercising if it was 100 - 180 mg/dL, (1, 4). During the exercises, we monitored patients for possible complications like fatigue, dizziness, headache, feeling faint, difficulty breathing, decreased alertness, numbness in hands/feet, pain, and cold sweats.

3.3. Statistical Analysis

We checked whether the distribution of data was normal by using the Kolmogorov-Smirnov test. Since this case had non-normal data distribution, descriptive statistics were presented as median and interquartile range (MD $\pm$ IQR). In the initial calculation of power analysis, SF-36 was used for the row change between groups. In the sample size formula, the "General Health" sub parameter of the SF-36 was chosen, since it was theoretically the widest item in its mean and standard deviation. In the literature, it was found that the lowest level was 5 points of mean $\pm$ 8 points of standard deviation for between-group changes to be significant before and after the intervention; therefore, a minimum sample size of 20 per group was determined to have 80% power and a 95% confidence level. Statistical analysis was performed using IBM SPSS for Windows version 19. Comparisons within groups before and after the program

were carried out using the Wilcoxon test instead of paired sample t test, because variables were generally score type, and the differences in standard deviation were higher than the differences of the mean in the groups. Paired binary categorical variables were evaluated using the McNemar test. The Mann-Whitney U test was performed to verify differences between groups.

4. Results

A total of 45 women with T2D in both groups completed the study. Table 1 presents the participants' clinical features and questionnaire results before and after the 12-week intervention. The Md ± IQRs are shown in the Table 1.

4.1. Primary Outcome Measures

At the end of the intervention, only pain differed significantly between the Pilates group and the control group (2.00 ± 2.00 vs. 3.00 ± 2.00, respectively, $P < 0.05$). In the Pilates group, pain, fatigue, SF-36-MH, anxiety, depression, fasting blood glucose, and HbA1c were significantly lower after the intervention (all $P < 0.05$). Meanwhile, in the control group, only HbA1c differed significantly after the intervention (6.53 ± 1.42 to 6.40 ± 1.27, $P < 0.05$).

4.2. Secondary Outcome Measures

Most of the women in each group (79.2% and 90.5%, in the Pilates group and control group, respectively) had graduated from primary school, and the others had university degrees. In the Pilates group and control group, 22 (91.7%) and 18 (85.7%) women were married, respectively; the others were single. Meanwhile, 12 (50%) and 9 (42.9%) women in the Pilates group and control group administered daily insulin injections, respectively ($P = 0.632$). Furthermore, 15 (62.5%) and 15 (71.4%) women in the Pilates group and control group, respectively, took medications for diabetes ($P = 0.526$). All patients took additional medications for reasons other than diabetes, such as hypertension and hyperlipidemia.

At baseline, 16 (66.7%) and 18 (85.7%) women in the Pilates group and control group, respectively, had sleeping difficulties; however, there were no significant changes in the number of participants who had sleeping difficulties after the intervention (McNemar, $P = 0.138$ and $P = 0.06$, respectively).

5. Discussion

This study investigated the effectiveness of PBME on parameters of quality of life in women with T2D. There were significant differences in HbA1c, pain, fatigue, mental health-related QOL, anxiety, depression, and fasting blood glucose after 12 weeks of PBME.

Other studies on the effects of exercise on diabetes report varying results. Yanagawa et al. found no significant improvement in insulin resistance in elderly diabetes patients after a 12-week exercise program (23). Furthermore, Gram et al. evaluated two intervention groups walking at moderate intensity or exercising; however, 4 and 12 months later, there was no difference in HbA1c in comparison to the control group (24). In contrast, some studies have shown that aerobic and resistance training positively affects HbA1c (17, 23). Nagarathna et al. reported that yoga is similar to exercise with respect to reducing blood glucose and HbA1c (6). The results of our study indicate that PBME designed for women with T2D can be recommended as a part of a treatment program. Nevertheless, additional studies are required to confirm whether Pilates is beneficial for patients with T2D. One of the weak points of our study was that we did not compare PBME to other kinds of exercise.

Further improving the effects of the PBME intervention may produce greater and permanent differences between the Pilates group and control group in the long term (11, 12). Ideally, we would have continued this study by increasing the intervention duration to 12 months, but we were constrained by a lack of proper facilities; this represents another weakness of the study.

When planning an exercise program for patients with diabetes aiming to improve insulin sensitivity, the type, duration, and intensity of exercise are important parameters that must be considered (1); however, these have yet to be established (25). Lincoln et al. prescribed 16 weeks of resistance exercise to 29 patients with T2D; QoL evaluated according to the SF-36 showed significant improvement in the mental health status of their patients, similar to the present study (26). Oliveira et al. recommended structured exercises plus splitting aerobic and resistance training into separate sessions for the best results in T2D patients (11); therefore, other exercises combined with PBME should also be considered.

Imayama et al. found that not using insulin, fewer comorbidities, lower BMI, and a higher physical activity level were significantly associated with better QoL in adults with T2D (27). Even diabetics who could not lose weight but who participated in regular exercise had significantly improved glycemic control and blood markers such as HbA1c (4). Despite the positive results of our study, the BMI of the Pilates group patients did not change significantly after the intervention. Individuals with insulin resistance and limited physical activity should incorporate a program involving exercises such as PBME into their weekly regimes

Table 1. Clinical Characteristics and Questionnaire Outcomes of the Two Groups Before and After the Program[a]

Parameters	PG (n = 24)	CG (n = 21)	Mann Whitney U Test (P)	PG Wilcoxon (P)	CG Wilcoxon (P)
Age	58.50 ± 7.00	53.50 ± 9.00	0.007	NA	NA
Duration of diabetes, mo	24.29 ± 131.00	48.00 ± 24.00	0.962	NA	NA
BMI, kg/m^2-before	32.20 ± 6.93	30.84 ± 8.09	0.785	0.100	0.867
BMI, kg/m^2-after	32.03 ± 7.31	30.46 ± 7.93	0.707	0.100	0.867
Pain-before	3.00 ± 4.00	3.00 ± 3.00	0.477	0.001	0.308
Pain-after	2.00 ± 2.00	3.00 ± 2.00	0.001	0.001	0.308
Fatigue-before	5.00 ± 2.00	4.50 ± 1.00	0.530	0.0001	0.42
Fatigue-after	4.00 ± 1.00	4.00 ± 2.00	0.645	0.0001	0.42
SF-36-PH-before	40.00 ± 3.00	40.00 ± 0.00	0.932	0.120	0.33
SF-36-PH after	41.00 ± 4.00	41.00 ± 4.00	0.764	0.120	0.42
SF-36-MH-before	29.00 ± 5.00	29.00 ± 11.00	0.187	0.0001	0.132
SF-36-MH-after	35.00 ± 3.00	35.00 ± 1.00	0.912	0.0001	0.132
Anxiety-before	8.00 ± 3.00	8.00 ± 1.00	0.781	0.023	0.162
Anxiety-after	7.00 ± 3.00	7.00 ± 1.00	0.422	0.023	0.162
Depression-before	9.00 ± 2.00	9.00 ± 2.00	0.428	0.019	0.08
Depression-after	8.00 ± 2.00	8.00 ± 1.00	0.297	0.019	0.08
Fasting blood glucose-before	140 ± 31.00	131.5 ± 42.00	0.495	0.026	0.13
Fasting blood glucose-after	139.5 ± 32.00	146.5 ± 33.00	0.259	0.026	0.13
Postprandial blood glucose-before	160.00 ± 55.00	162.5 ± 57.00	0.599	0.520	0.219
Postprandial blood glucose-after	164.00 ± 47.00	167.50 ± 46.00	0.973	0.520	0.13
HbA1c-before	6.70 ± 1.16	6.53 ± 1.42	1.000	0.001	0.008
HbA1c-after	6.30 ± 1.00	6.40 ± 1.27	0.367	0.001	0.008

[a] Values are expressed as mean ± SD.

to complement other treatments.

T2D patients often complain of pain and fatigue related to diabetes symptoms, emotional distress, depressive symptoms, and higher BMI (17, 28). In our study, the pain and fatigue decreased significantly after the intervention in the Pilates group. Thus, the relationships of PBME with pain and fatigue in patients with T2D should be clarified in future studies.

Group therapy is another method of improving the QoL of patients with diabetes (1, 4). Accordingly, the patients in our study exercised in a group. Educational meetings also increased patients' awareness of their disease and helped them gain a sense of control. The training meeting before starting the PBME program motivated patients to continue exercising regularly.

Collins et al. implemented the HADS and found high levels of anxiety and depression symptoms in their diabetes patients (29). Our patients had no severe anxiety or depression before or after the intervention. Only Pilates group patients' anxiety and depression levels improved significantly after the intervention. Thus, detailed studies on depression and anxiety in patients with diabetes might be planned with psychiatrists.

As homogenizing groups and prescribing exercise might be hazardous for some patients, we excluded patients with diabetic complications. Therefore, additional studies with a stronger methodology should be performed to clarify the effectiveness of PBME for such patients. Nevertheless, having a homogenized group with a sufficient number of participants was a strong point of this study.

A cornerstone of healthcare professionals' teaching should be promoting exercise, especially for those with diabetes. In summary, PBME is an effective method as a part of treatment program for women with T2D in that it improves HbA1c, fasting blood glucose, pain, fatigue, mental health-related QoL, anxiety, and depression. Future studies should analyze these parameters in further detail to confirm the findings. As the number of people with diabetes is increasing, studies aiming to develop types of exercises particularly beneficial for such patients are urgently

required.

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Footnotes

Authors' Contribution: Hulya Yucel was responsible for designing, executing, and writing up the study from beginning to end. Omer Uysal made the statistical analysis of the study and reviewed the final approval of the manuscript.

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