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Which exercise type is more effective for diabetic patients?

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ABSTRACT

Background: Type 2 Diabetes Mellitus (DM) is a widespread worldwide disease. Exercise therapy is an effective method but which exercise types are more effective is an important question. **Objectives**: This study was designed to compare the effects of three different exercise programs on physical function and quality of life in Type 2 DM.
Method: Forty-two patients with Type 2 DM participated in the study. The patients were randomly assigned to three groups. Client based exercises in accordance with physiotherapy assessment were applied to group 1 (aged 51.42±4.60 years; body mass index 35.28±4.21 kg/m² kg/m²), Clinical Plates exercises were applied to group 2 (aged 53.07 ±5.12 years; body mass index 35.56±4.83 kg/m²) and a standard program including calisthenic exercises were applied to group 3 for 12 weeks, 3 days a week. 6 minutes walk test (6 MWT) and physiological cost index (PCI), timed up and go test (TUG) and SF-36 quality of life questionnaire were performed before and after the 12-week exercise program. Results: Intra-group comparison of pre-post treatment values showed that in the first group, there were significant differences after treatment in TUG, 6 MWT, PCI, body mass index and SF-36. Moreover, inter-group comparison showed that there were significant differences in TUG, 6 MWT, PCI and SF-36 compared to other groups in first group ($p<0.05$). **Conclusion:** These results confirm that, client based exercise protocol is more effective than other exercise protocols in terms of quality of life and physical performance. So this exercise protocol may be a beneficial alternative.
Keywords: Exercise, Physical performance, Physiological cost index, Type 2 Diabetes Mellitus

Introduction

Diabetes Mellitus (DM) is a metabolic disorder, which is characterized by defects of insulin secretion results in carbohydrate, fat and protein metabolism disturbances. If hyperglycaemia can't be controlled, chronical complications of diabetes occur in time. Furthermore coronary heart diseases, cerebrovascular disorders and peripheral vascular illness may occur in early ages and may be more aggressive[1,2].Type 2 Diabetes is the most common form of diabetes that generates 90% of all diabetes cases. It usually depends on obesity and physical inactivity. In developed countries 5-10% of the society has type 2 Diabetes diagnosis. The illness typically appears after the age of 40 and its prevalence increases by aging [3,4].Nowadays, DM and other chronicle diseases with same risk factors are important health conditions. The prevalence of type 2 Diabetes is rapidly ascending in developed and developing countries because of life-style changes. While diabetes population was 285 million in the end of 2009, this number is expected to be 438 million in 2030 [3]. Main reasons behind this condition include population growth, aging and urbanization. Because of these changes prevalence of obesity and physical inactivity is also increasing [4-6].In spite of beneficial effects of exercise, 69% of patients don't do enough physical activity. Which makes it more important to develop strategies about this situation [7].Physical activity when applied regularly with coordinated exercise sessions, improves glycemic control and lipid profile, decreases blood pressure, abdominal fat mass, cardiovascular morbidity and mortality. And also exercise improves metabolic control, anthropometric parameters and blood pressure[8]. Unfortunately, a very low rate of only % 30-40 of these patients

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exercises regularly[9,10].Quality of lifeis an important indicator of health status of these patients. Exercise also affects this condition with other beneficial physiological factors [11].There are evidences about positive effects of exercise on quality of life. But there isn't enough information about the relationship between physical activity, quality of life and Diabetes [12].

Researches in many countries found that with healthy lifestyle changes, risks of Diabetes decrease in % 44-58 rate, which means that DM can be prevented and postponed. Mortality risks of diabetic patients are twice more than their healthy equals. %60-75 of diabetics are lost because of cardiovascular diseases. The cost of treatment is another issue about Diabetes. In the last 25 years, expenditures are increased by two times and it is a serious load for governments. This situation can be controlled with lifestyle modifications, exercise treatment and diet [8-10].Type 2 DM affects a huge population. Half of diabetics over 60 have sensation and motor deficits, which result in functional disorders and affect gait characteristics and balance negatively [13-20].

Aim of the study

In many researches physical performance and quality of life are found to be in low levels in people with Type 2 DM whose physical activity level is also low. The purpose of our study was to investigate the effects of a special exercise program on physical function and quality of life in this population.

Materials and Methods

Four out of forty six patients with Type 2 Diabetes Mellitus who initially joined the study discontinued because of individual reasons. So we had forty-two participants. Demographic features and body mass index (bmi) of the patients were recorded (table 1). The patients were randomly assigned to three groups. Custom designed exercises in accordance with physiotherapy assessment were applied to group 1 (aged 51,42±4.60 years; bmi 35.28±4.21 kg/m² kg/m²), Clinical Plates exercises were applied to group 2 (aged 53.07 ±5.12 years bmi 35.56±4.83 kg/m²) and a standard program with calisthenic exercises was applied to group 3 for 12 weeks, 3 days a week. On the other hand, 6 Minutes Walk Test and Physiological Cost Index, Timed Up and Go Test, SF-36 Quality of Life Questionnaire were performed both before and after the 12-week exercise program. We used SPSS 18 analysis system and applied Wilcoxon signed rank test for intra-group comparison and Mann-Whitney U test for inter-group comparison. If the results were $p \leq 0.05$, it was considered statistically significant

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Table 1: Demographic features of patients with type 2 diabetes mellitus

	Group 1 (X±SD)	Group 2(X±SD)	Group 3(X±SD)	x^2
Age (year)	51.42±4.60	53.07±5.12	52.92±4.58	0.50
Diabetes duration (year)	5.50±1.82	6.28±3.42	5.42±2.06	0.49
Height (cm)	163.07±6.42	163.26±8.56	164.07±7.46	0.64
Weight (kg)	92.84±14.30	94.65±14.09	85.07±15.27	1.59
BMI (kg/m²)	35.28±4.21	35.56±4.83	31.42±4.14	3.84

Inclusion criteria

- Aged between 40-65 years
- Patients who can walk independently.
- Patients who accept doing exercises.

Exclusion criteria

- Patients with orthopaedic or surgical problems that prevent walking.
- Patients with neuropathy that prevent walking.
- Patients who have foot ulcers.
- Patients with neurological problems.
- Patients with systemic problems that cause contraindication for exercise.

Tests below were applied to all participants:

6 Minutes Walk Test (6MWT)

In this test, the patients were asked to walk -but not run- at their highest speed for 6 minutes in a distance of 30 meters. Patients' heart rate and blood pressure were recorded before the test. Patients' heart rate and blood pressure were recorded again after the test to measure physiological cost index (PCI)[21].

Timed Up and Go Test (TUG)

Patients were asked to stand up, walk to a target point which was 3 meters away, revolve around the point, walk back to their seat again and sit down. The duration of whole activity was measured. The test was repeated three times and average of these three walking periods was calculated. This test measures not only walking time, but also motion series [22].

Quality of Life (SF-36)

SF-36 is a scale that reflects quality of life with a physical and mental dimension. Physical function, physical role function, pain, general health, vitality, social function, emotional role function and psychological well-being are the categories of that scale. Every category is scored between 0-100. While zero shows poor function, 100 shows best function. High score indicates better quality of life. SF-36 is a valid and reliable scale that is utilized commonly in chronicle diseases. It has also test-retest reliability and internal consistency. Two summary results are obtained after the test: physical and mental scores [23].

Body Mass Index

BMI is a measurement of body fat based on height and weight. We calculated the BMI by Jawon X-Scan Plus II device. BMI is calculated by dividing patient's body mass to the square of his/her height (kg/m²) [24].

Custom Designed Exercises

This exercise program was prepared specific to each patient in this group according to his/her physiotherapy assessment, functional performance tests and body analysis results. This exercise type focuses on patients' physical demands. Stretching and flexibility exercises were given to shortened structures, and strengthening exercises were given to weak muscles within the exercise program. Each session started with warm-up exercises and ended with cool-down exercises. This exercise type included aerobic exercises with a more rhythmic pattern. In this group exercises were applied with music with harmony between the exercise and the music. Blood pressure was measured before, after and during the exercise. The rhythm of exercise was different for each member of the groups.

Sessions began with 15 minutes warm-up exercises. These exercises included range of motion exercises of:

- Neck(flexion, extension, lateral flexion and rotation),
- Shoulder(flexion, extension, abduction, adduction, internal and external rotation),
- Elbow(flexion and extension),
- Forearm(pronation and supination),
- Wrist(flexion and extension),
- Hip(flexion, extension, abduction and adduction, internal and external rotation),
- Knee(flexion and extension),
- Foot(dorsi and plantar flexion, pronation and supination),
- And trunk (flexion, extension, lateral flexion and rotation).

And then stretching exercises were applied in different positions. The program continued with postural exercises. Then rhythmic aerobic exercises were performed in standing position. Aerobic exercises were rhythmic walking, running, and jumping in different directions. After aerobic exercises strengthening exercises began. These exercises were specific to each patient. Final step was 5-minute cool-down exercises [6, 23, 25, 26].

Plates Exercises

Plates exercises were applied as a group treatment. Each session started with warm-up exercises. Then stretching in different positions, trunk flexibility exercises, upper and lower limb strecting and co-contraction exercises were performed. Later on, abdominal, hip, dorsal and shoulder muscle groups were strengthened with shoulder bridge, corkscrew, roll-up, roll down, clam, side kick, staggered legs, scissors, swimming, swan dive, breast stroke preparation, abdominal preparation and oblique preparation exercises in different sessions. After that strengthening exercises were performed by theraband to different muscle groups. And the session was finished with cool-down exercises[27,28].

Chalistenic Exercises

Each session started with 10 minutes warm-up exercises. These exercises included range of motion exercises of neck (flexion, extension, lateral flexion and rotation), shoulder (flexion, extension, abduction, adduction, internal and external rotation), elbow (flexion and extension), forearm (pronation and supination), wrist (flexion and extension), hip (flexion, extension, abduction and adduction, internal and external rotation), knee (flexion and extension), foot (dorsi and plantar flexion, pronation and supination) and trunk (flexion, extension, lateral flexion and rotation). After warm-up hip-knee and shoulder combining exercises, taking steps to different directions and turning exercises were performed. And then mat exercises including abdominal, dorsal, hip and shoulder muscle groups were applied. The session ended with 10 minutes cool-down exercises [23,29, 30].

Results

42 DM patients that participated in our study were randomly assigned to three groups. Custom designed exercises were applied to group 1 (aged 51.42±4.60 years; bmi 35.28±4.21 kg/m²; duration of diabetes 5.5±1.82 years), Plates exercises were applied to group 2 (aged 53.07±5.12 years; bmi 35.56±4.83 kg/m²; duration of diabetes 6.28±3.42 years) and chalistenic exercises were applied to group 3 (aged 52.92±4.58 years; bmi 31.42±4.14 kg/m²; duration of diabetes 5.42±4.58 years) for 12 weeks, 3 days a week.

Statistical analysis

Intra-group comparison of pre-post treatment values showed that in the first group, there were significant differences after treatment in TUG, 6 MWT, PCI, BMI and SF-36. In the second group, there were significant differences after treatment in 6MWT, PCI, and TUG. In the third group, there were significant differences after treatment in BMI, PCI and TUG ($p<0.05$). Inter-group comparison showed that there were significant differences in SF-36 score (Figure 1), TUG, 6MWT (Figure 2) and PCI (Figure 3) in custom-designed exercise group compared to other groups ($p<0.05$) (table 2). These results confirm that custom-designed exercise protocol is more effective than other exercise protocols in terms of quality of life and functional performance.

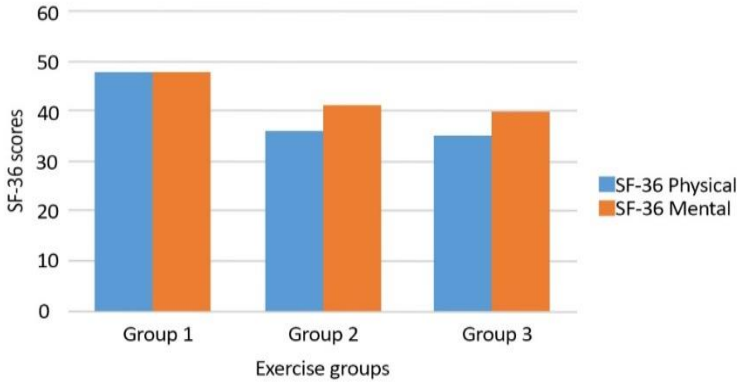

Fig 1: SF-36 Quality of Life Scores of Exercise Groups

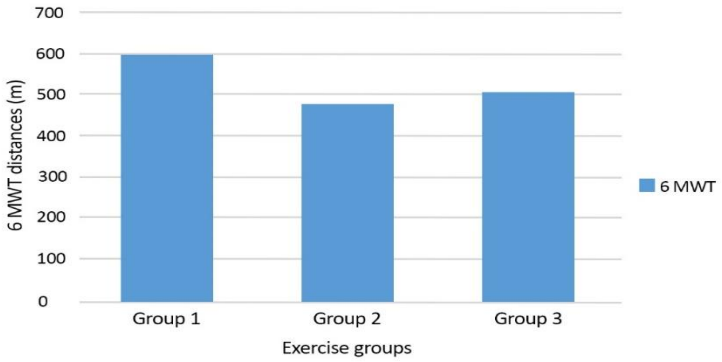

Fig 2: Six Minutes Walk Test Results of Exercise Groups

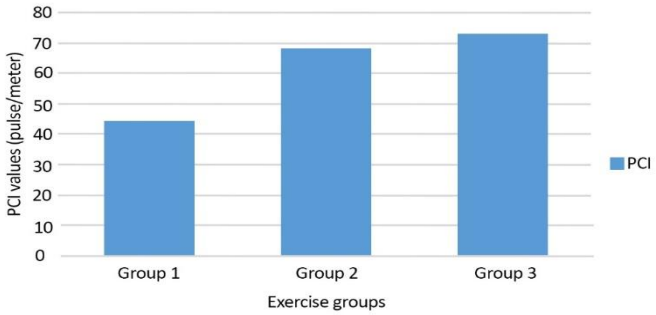

Fig 3: Physiological Cost Index Results of Exercise Groups

Table 2: Comparison of functional performance and quality of life results of three groups after exercise

	Group 1 (X±SD)	Group 2 (X±SD)	Group 3 (X±SD)	x^2	p
6 minutes walk test (meter)	593.21±78.77	475.71± 77.82	502.85± 78.87	12.19	<0.001
Physiological cost index (pulse/meter)	0.44± 0.10	0.68± 0.21	0.73± 0.21	16.55	<0.001
Timed up and go test (second)	6.71± 1.13	8.28± 3.09	7.64±1.59	3.66	*0.01
SF-36 Physical(0-50 points)	48.15± 6.98	36.14± 6.08	35.38± 7.45	16.74	<0.001
SF-36 Mental(0-50 points)	48.19± 6.55	41.73± 8.75	40.17± 9.92	6.03	*0.04

*p<0.05

Discussion

After the study, there were significant improvements in all three groups. Considering our hypothesis, the most significant changes are observed in custom designed exercise group. Especially, the intra-group results for the first group in 6 MWT, PCI, TUG, Body Mass Index and SF-36 scores were significantly different after the treatment. Quality of life and functional performance are the main points of this study. In Plates group there were statistically significant changes in PCI, TUG and 6 Minutes Walk Test results after the treatment. In Chalistenic group there were statistically significant changes in BMI, PCI and TUG after the treatment. These positive changes in all three groups aren't unexpected. Because whatever the type of exercise, it will doubtlessly be effective in DM patients. But the aim of our study was to determine the most effective exercise type out of these three groups.

Herriott et al (2004) demonstrated significant changes in TUG test. 20 patients with Type 2 DM and 20 healthy people joined the study. TUG score was 10.46±1.8 sec in diabetes group and 8.95±1.9 sec in healthy group. This difference is statistically meaningful [31].In our study TUG score is 9.64±2.02 s in the first group, 9.50±2.70 s in the second group and 9.00± 1.24 s in the third, before the exercise period. After the exercise, however, the scores are 6.71±1.13 s, 8.28± 3.09 s, and 7.64±1.59 s respectively. Significant improvements were observed in all groups after the treatment. TUG score, on the other hand, improves in custom designed group compared to other groups after the treatment. In Herriot's study age mean is higher than our study. But in both studies TUG scores are high because of limitations in functional capacity due to diabetes. There are a few studies that compare the effects of different exercise types on functional performance and quality of life. Ozdirenct et al (2003) compared functional capacity of 30 cases with Type 2 DM to that of 30 healthy individuals. BMI values were similar to the results of our study. 6 Minutes Walk distances were higher in the healthy group. Results were close to pre-exercise values of our study [32]. Lambers et al (2008) designed a study in which an exercise program was applied to 46 diabetic patients for 3 months, 3 days a week. Patients were randomly assigned to three groups including a combined exercise group, an endurance exercise group and a control group. While the combined group included cardiovascular and endurance exercises, no exercise program was given to the control group[29].

But in our study we applied exercise programs to all of the patients. After the exercise program in combined exercise group 6 minutes walk distance raised from 539 meters to 594 meters, which is statistically meaningful. In quality of life results there weren't meaningful differences between the groups. In our study 6 minutes walk distances and SF 36 scores were improved in favour of the first exercise group. We also calculated PCI scores after walk test in our study.

Ozdirenc et al (2004) performed a study on hospitalized Type 2 DM patients to assess the acute effects of a short exercise period. 44 participants were divided into two groups and a low intensity exercise programme was applied to the exercise group for 12 days. However, there was no exercise intervention for the control group. 6MWT was applied before and after the exercise period in this study. Walking distance was statistically increased in the exercise group. While it was 455 m before the exercise, the distance increased to 537 m afterwards. In the control group, however, it was 464 m and 511 m before and after the exercise respectively. In this study, the type of the exercise was similar to our chalistenics except therapy and exercises [30].Similarly, in our chalistenic exercise group walking distance was 467 m before the intervention and 502 m after the intervention. According to the results, a short exercise period is also effective for DM patients. Nevertheless, we applied a 12-week exercise program.In 2011 Kwon et al performed four different programmes (resistance, aerobic, combine and control) on 136 patients with type 2 DM for 6 months. After the treatment, body weight statistically decreased in

aeorobic and resistance exercise groups compared to the control group [6].

In our study bmi values diminished in the first and third groups after the exercise program.

There are some studies investigating the effectiveness of different exercise protocols on diabetic patients. The most popular one is Plates. The aim of this exercise is to increase the body perception and awareness.

Although there are many studies about the effectiveness of Plates, not many have focused on type 2 DM. In some of these studies BMI values weren't recorded before and after exercise periods like Carvalhoin 2009and Rogers and Gibson in 2006[27].

Bird et al (2012) performed a study on 27 patients with type 2 DM. Patients were randomly divided into two groups (group 1 Plates, group 2 control). For group 1 Plates exercises were applied for 16 weeks, 2 days a week. TUG speed increased to 90 seconds in that study [33]. In our Plates group this value was 82 seconds.

Segal et al (2004) similarly conducted a study on 47 patients with type 2 DM. Plates programme was 6 months. After this period BMI decreased significantly [34). Although the exercise program is shorter in our study (12 weeks), bmi decreased significantly in the first and third group. On the other hand, while we applied the exercise program 3 days a week, in Segal's study the exercises were applied only once a week.

Type 2 DM, just like any other chronical disorder affects the quality of life. Eckert et al assessed quality of life of 370 DM patients (aged 63.2 years, diabetes duration 10.6 years and bmi>35 kg/m²) with SF-36 health questionnaire. At the end of the study both physical and mental parameters of SF-36 were in low values [23]. In our study these values were similarly low. But after the exercise program, these values increased significantly in the first group. We also assessed bmi, which also decreased after the exercise program. Therefore the relation between bmi and quality of life is a main point that must be focused on.

Finally, when investigating the studies on Type 2 DM that compare different exercise programs; it is clearly obvious that a 12-week custom designed exercise program in accordance with physiotherapy assessment is more effective than many other protocols.

Bullet Points of the study	
1.	Exercise is much more effective when planned for individual needs than Plates and calisthenic exercises applied in groups.
2.	Gaining the exercise habits of patients with type 2 diabetes is extremely positive
3.	The fact that the exercises were practiced by the same physiotherapist for 12 weeks is one of the differentiating aspects of the study.
4.	Several important parameters such as energy consumption, walking performance, walking speed, body fat percentage, visceral fat mass, body mass index, fatigue, balance, quality of life and depression were evaluated in the study.

Conclusion

A 12-week exercise program not only improved quality of life, gait performance and speed, but also decreased energy consumption and body mass index in Type 2 DM patients. Our study showed that when exercise programmes are planned according to physiotherapy asssessment, they could be more effective than Plates or Chalistenic exercise programmes. According to these results the importance of regular exercise for Type 2 DM patients was emphasized since these specific exercise programs lead to significant improvements in many aspects.The keypoint is that the exercises need to be applied by a physiotherapist with professional knowledge and skill about Type 2 DM.The exercises used in this study affected the lifestyle of the patients with type 2 DM. An exercise program was applied for a long period and this is a gain in itself. In the future, in order to rise awareness of this disorder, we are planning to reach more patients and carry on our study.

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Ethical approval: The study protocol was approved by the clinical studies ethical committee of Hacettepe University Medical School with the project number go13/320. After that we contacted to the Turkish Diabetes Association in order to invite the people with DM to the study.

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