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Effects Of A Regular Exercise Program On Life Quality Of Patients With Type 2 Diabetes Mellitus

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ABSTRACT

Objective: We aimed to evaluate the effects of a supervised aerobic exercise therapy on quality of life in patients with type 2 diabetes mellitus (DM).

Material and Methods: Thirty-one patients with type 2 DM (8 male/23 female; aged between 42 and 65 years) who had hemoglobin A1c (HbA1c) levels between 7.5% and 9.5% were included in the study. Anthropometric measurements (height, body weight, body fat percentage, body fat mass and body mass index, waist circumference, hip circumference) and cardiopulmonary exercise tests were performed before and after the study. The patients undertook a 12-week aerobic training program that included aerobic-type walking and/or cycling 3 days a week. All patients were asked to complete the Turkish version of the 36-Item Short Form (SF-36) Health Survey before and after the training program. SF-36 is a commonly used questionnaire that was designed to measure life quality of patients who have physical illnesses

Results: We detected significant improvements in all subscales of the SF-36 questionnaire. The emotional role limitation score showed a less significant reduction ($p=0.049$) compared with the other subscales. The anthropometric values were also improved significantly after the 12-week aerobic training program ($p<0.05$).

Conclusion: We observed that a supervised regular aerobic exercise program used in this study had a positive effect on the quality of life in individuals with type 2 DM in our study. Therefore, it might be a beneficial strategy to encourage patients with type 2 DM to do regular exercise during the management of their disease in order to overcome the mental, social, and physical difficulties.

Key words: SF-36, quality of life, supervised aerobic exercise, type 2 diabetes mellitus

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Düzenli Aerobik Egzersizin Tip 2 Diyabetik Hastaların Yaşam Kalitesi Üzerine Etkisi

ÖZ

Amaç: Bu çalışmada gözetim altında yapılan aerobik egzersiz tedavisinin tip 2 Diabetes Mellitus (DM)'lu hastaların hayat kalitesi üzerine etkisi incelendi.
Gereç ve Yöntemler: Tip 2 DM tanısı almış ve hemoglobin A1c (HbA1c) seviyeleri % 7.5 ve %9.5 arasında olan 31 hasta (8 kadın/23 erkek; 42-65 yaş arası) çalışmamıza dahil edildi. Egzersiz programına başlamadan önce ve egzersiz programını tamamladıktan sonra kardiyopulmoner egzersiz testleri ve antropometrik ölçümleri (boy, vücut ağırlığı, vücut yağ oranı, vücut yağ kitlesi, vücut kitle indeksi, bel çevresi, kalça çevresi) yapılarak kaydedildi. Hastalar 12 hafta süreyle haftada 3 gün olacak şekilde egzersiz programına alındı. Egzersiz programı aerobik karakterde, egzersiz modeli olarak yürüme bandı ve/veya bisiklet kullanımına uygun olacak şekilde planlandı. Bütün katılımcılara hem çalışmaya başlamadan önce ve hem de çalışmanın bitiminde olmak üzere iki kez Kısa Form-36 anketi uygulandı. KF-36; fiziksel hastalığı olan bireylerde hayat kalitesini değerlendirmek için yaygın olarak kullanılan bir ankettir.
Bulgular: KF-36'nın bütün skorlarında anlamlı iyileşme tespit edildi. Ancak çalışmamızda emosyonel rol kısıtlaması skorundaki anlamlılık diğerlerine göre daha azdı ($p<0,05$) Ayrıca 12 haftalık egzersiz programı sonrası antropometrik değerlerde de anlamlı iyileşme olduğu saptandı ($p<0,05$).

Sonuç: Çalışmamızın sonucunda gözetim altında uygulanan düzenli egzersiz programının tip 2 DM'li hastalar üzerinde olumlu etkisi olduğu görüldü. Bu nedenle tip 2 DM'li hastaları düzenli egzersiz yapmaları konusunda teşvik etmenin, hastaların sosyal, mental ve fiziksel zorlukların üzerinden gelmelerine yardımcı olabilecek yararlı bir strateji olabileceği sonucuna varıldı.

Anahtar sözcükler: KF-36, yaşam kalitesi, gözetim altında aerobik egzersiz, tip 2 diyabetes mellitus

INTRODUCTION

The importance of the concept of health quality has become of greater interesting all over the world after health was defined as a state of complete physical, mental and social well-being by the World Health Organization. Besides treating major symptoms of chronic disease and increasing life expectancy, in recent years, physicians have also worked and focused on improving mental and social health during the management of chronic diseases. In this regard, the concept of life quality for patients with diabetes has come to be much more significant in terms of determining the therapeutic effect (2).

It was shown by various researchers that quality of life scores of patients with type 2 diabetes mellitus (DM) were lower than people without diabetes (3). On the other hand, it was also pointed out that patients with diabetes had higher Quality Of Life (QOL) scores compared to patients who had to other chronic diseases.

It was also suggested that various exercise therapies such as aquatic-

based, resistance or aerobic exercise, generally improved quality of life in patients with type 2 DM disease (4,5,6).

In our study we aimed to evaluate the effects of supervised aerobic exercise therapy in the quality of life of patients with type 2 DM.

PATIENTS AND METHODS

Patients

Patients with type 2 diabetes mellitus (n=2418) who presented to the endocrinology department of a university hospital over a 3-month period were recruited in the study.

The study had the following inclusion criteria: age between 42 and 65 years and hemoglobin A1c (HbA1c) levels between 7.5% and 9.5%. The exclusion criteria were as follows: coronary artery disease, arrhythmia, autonomic neuropathy, proliferative retinopathy (grade 3-4), arthiritis, neurologic and orthopedic limitations, uncontrolled hypertension, morbid obesity, and insulin pump use. Sixty-seven patients who met these criteria were screened in the laboratory of the Department of Sports Medicine. Thirty patients did not accept participation in the study. Thirty-seven patients were included in the exercise program. Two female patients could not complete the study due to an ankle sprain and angina. Four male (M) patients left the study due to personal limitations. Thirty-one patients (8M/23F) tolerated and completed the whole study protocol (Figure 1). The study was approved by the University's Ethics Review Board for Human studies and the participants gave informed consent prior to commencement of the study.

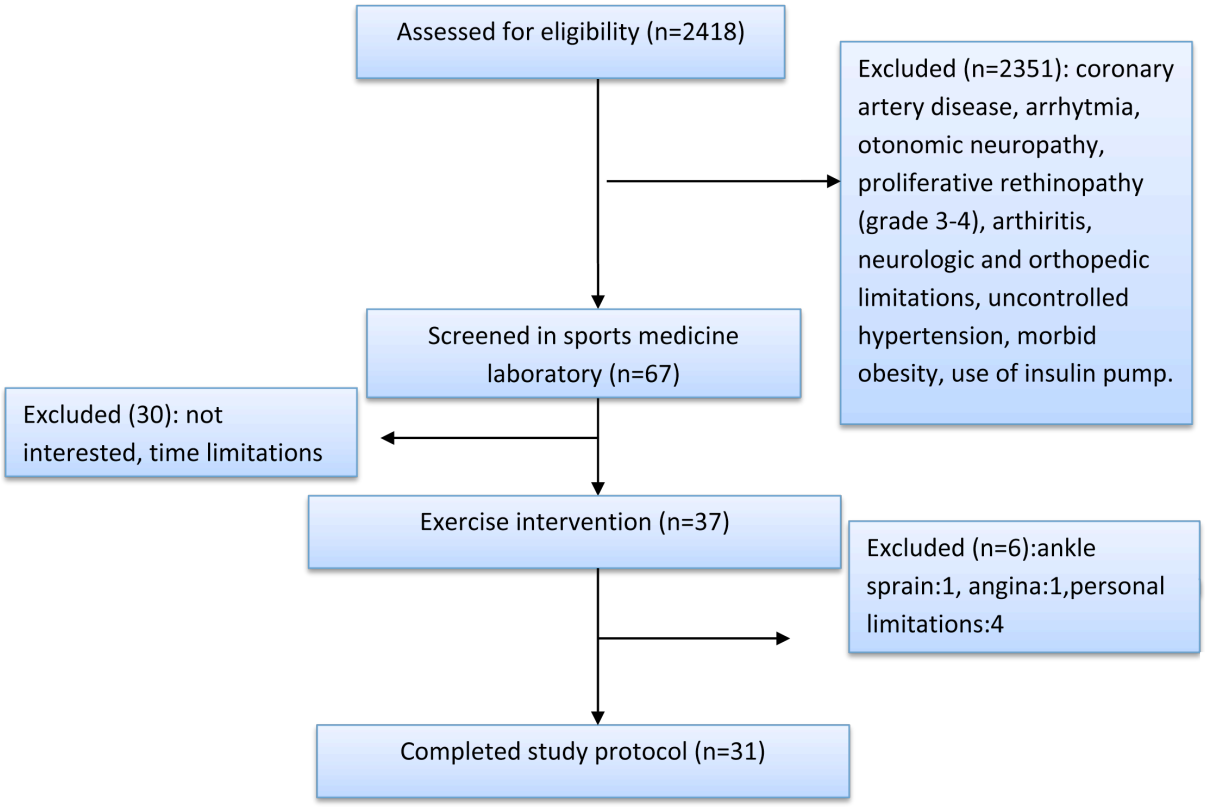


Figure-1. Flow-chart diagram of study design and interventions.

Experimental Protocol

The exercise training protocol was conducted in the sports medicine laboratory of a university hospital. Each patient first underwent a comprehensive physical examination, which included a 12-lead electrocardiogram (ECG) recording, anthropometric measurements and a blood pressure measurement at rest. Thereafter, the Turkish version of the SF-36 questionnaire was given to all patients and they were subjected to a cardiopulmonary exercise test (CPET) using the Bruce protocol (7,8). On the next day, all patients began a 12-week aerobic training program. After completing the supervised exercise program, all of the tests performed at the beginning of the program were repeated at the end. We could not measure metabolic parameters (anaerobic threshold, maximum oxygen uptake (VO_2 max)) after the exercise program because some technical problems occurred in our cardiopulmonary exercise testing (CPET) system. Blood glucose and blood pressure were measured and recorded before and after each exercise session in order to avoid medical problems such as hypoglycemia. Medications of patients were regulated for training days by physicians of the endocrinology department.

Anthropometric Measurements

Height was measured to the nearest millimeter with a wall-mounted Harpenden stadiometer (Holtain, UK). Body weight (BW), body fat percentage (BFP), body fat mass (BFM) and body mass index (BMI) were analyzed using a Tanita Body Composition Analyzer TBF-300 (Tanita Corp., Tokyo, Japan). Waist and hip circumferences (cm) were measured in duplicate with a measuring tape. Waist circumference was measured at the minimum circumference between the iliac crest and the rib cage. Hip circumference was measured at the maximum protuberance of the buttocks.

Assessment of Quality of Life (QOL)

Health-related QOL of patients were measured using the 36-Item Short Form (SF-36) Health Survey. Validity and reliability analyses of the Turkish version of SF-36 were performed by Kocyigit et al (9). It is a well-known and commonly used questionnaire that was designed to measure life quality of patients who have physical illnesses. It has also been used in patients with psychiatric issues as well as healthy people. Using this method, both positive and negative aspects of an individual's state of health can be measured. SF-36 is convenient to apply to patients owing to its short, self-administrative, and pellucid nature. The SF-36 is a survey form that evaluates 8 dimensions of health status with 36 items. Four (physical functioning, role-physical, bodily pain, general health) of these 8 subscales are categorized as physical, and 4 (mental health, role-emotional, social functioning, vitality) of them are mental components (1). There is no total score to the scale. Only total scores in 8 sub-dimensions are calculated. Scores in subscales range between 0 and 100, and higher scores indicate a better state of health (10).

Supervised Exercise Program

The exercise program began under the supervision of specialists with 60 minutes of walking and cycling. The duration was then increased by 6 minutes in each exercise session of the first two weeks culminating with 90 minutes of exercise duration. Exercise intensity adjustment was based on heart

rate level at anaerobic threshold as determined using CPET for each patient. Stretching exercises were performed for warm up and cool down before and after each exercise session because this study is part of longitudinal study that also comprised resistance and combined exercise programs. For the time being we only have results of the aerobic training group. We are planning to publish other results in the future.

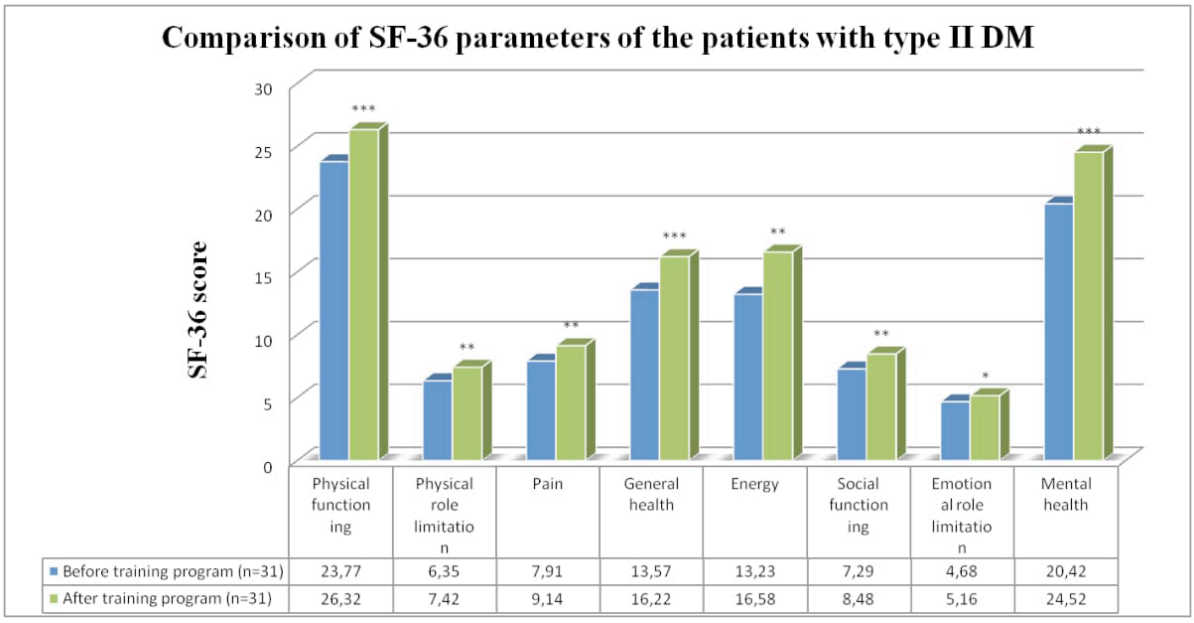
Statistical analyses

The Statistical Package for Social Science (SPSS) software version 13.0 version was used for data analyses (SPSS Inc, Chicago, IL, USA). The Wilcoxon signed-rank test was used to compare the results. A correlation analysis was performed using Pearson's correlation coefficient. In all comparisons, statistical significance was considered at the 95% confidence level ($p<0.05$).

RESULTS

The anthropometric values of patients before and after the exercise program are presented in Table 1. There were significant improvements in all of the anthropometric values ($p<0.001$).

When we compared the SF-36 scores before and after exercise program, we detected significant improvements in all subscales ($p<0.05$). There was a less significant reduction in the emotional role limitation score in our study (Figure 2).



SF-36: (Short Form-36)

*:$p<0.05$; **:$p<0.01$; ***$p<0.01$

Figure-2. Comparison of SF-36 scores of the patients before and after the traning program

However, the changes in HbA1c correlated negatively with changes in pain (r=-0.383, p=0.033) and the general health scores of SF-36 (r=-0.533, p=0.002) in the post exercise measurements. There were also negative correlations between the pain score of SF-36 and fat mass (r=-0.398, p<0.01), waist (r= -0.442, p<0.05) and hip circumference (r= -0.391, p<0.05) of the anthropometric values.

Table 1: Changes in the anthropometric measurements of the patients (Mean ± SEM)

Variables	Pre-excercise program	Post-exercise Program	P value
Stature (cm)	159.58±1.45	159.58±1.45	NS
BW (kg)	79.69±2.22	77.58±2.19	<0.001
BMI (kg/m^3)	31.28±0.76	30.47±0.75	<0.001
BFP (%)	35.86±1.26	33.94±1.30	<0.001
BFM (kg)	28.91±1.46	26.47±1.36	<0.001
WC (cm)	104.29±1.53	102.49±1.55	<0.001
HC (cm)	105.53±1.32	103.53±1.34	<0.001
HbA1c % (gr)	8.56±0.17	7.34±0.13	<0.001

BW: *Body weight;* ***BMI:*** *Body mass index;* ***BFP:*** *Body fat percentage;* ***BFM:*** *Body fat mass;* ***WC:*** *Waist circumference;* ***HC:*** *Hip circumference;* ***NS:*** *not significant.*

DISCUSSION

After analyzing the effects of supervised aerobic exercise on quality of life for our patient group, we found statistically significant score increases in all subscales of SF-36. Amongst these, the highest statistically significant increases were detected in physical functioning, physical role limitation, general health, energy, and mental health subscales (p<0.001). Based on these results, the findings of Ligtenberg's study were similar to ours (11).

Additionally, there were smaller amounts of increases in the scores of pain (p<0.01), social functioning (p<0.05) and emotional role functioning (p<0.05) in our patient group. Our study supports the study by Kirk et al. in this aspect (12). In a similar study, Reid et al. reported an increase in physical functioning after a resistance training program and no significant response to an aerobic exercise program, contrary to the results from our study (13).

Improving the quality of life has become more significant in planning treatments for chronic diseases because medical opportunities advance on a daily basis, In a study that supported this observation, Ozdemir et al. investigated the relationship between mental symptoms and quality of life with type 2 DM and disease variables (14). The authors analyzed SF-36 questionnaires used to evaluate quality of life and found that scores of physical functioning, physical role difficulties, pain, general health, energy, social functioning, emotional role difficulties and mental health scales were statistically significantly lower in their patient group.

Myers et al. examined the relationship between various types of exercise and quality of life in 262 patients with type 2 DM in their study in 2012 (15). In their

study, the patients were divided into three groups as aerobic exercise resistance training and an aerobic-resistance combined group. At the end of this study, the pain score improved significantly in the resistance training group only and the physical functioning scores improved significantly in both the aerobic exercise and combined exercise groups. When the combined exercise group and the aerobic exercise group were compared in terms of mental components, the vitality and mental health scores were reported to improve significantly in the combined exercise group. Furthermore, the vitality score was significantly higher compared with the control group. Physical functioning and general health subscales were significantly higher in all three groups compared with the control group. In our study, we obtained improvement in the pain score with aerobic exercise alone, contrary to their study. However, there were increments in general health and physical functioning scores. In this aspect, our results are consistent with their study.

In another study where the effects of aerobic exercise and resistance training on the quality of life of patients with diabetes were evaluated, it was shown that exercise improved quality of life in many ways, regardless of the type of exercise. In that study, resistance exercise created a significant improvement in physical functioning, role-physical, general health, vitality and Physical Components Summary (PCS), and aerobic exercise caused a significant improvement in physical functioning, bodily pain, general health, vitality, and PCS. Additionally, attention was drawn to the effects of social interaction as a result of exercise and its potential to improve quality of life (1). The contribution of moderate- and high-intensity aerobic exercise to glucose homeostasis, cardiovascular diseases and especially quality of life has been shown in numerous studies (13,16,17).

Differing from the aforementioned studies, Liu et al. investigated the effects of Tai Chi on the quality of life of patients with diabetes or high blood glucose level (pre-prandial blood glucose ≥ 5.6 and ≤7 mmol/L) (18). In their study, the participants joined in a supervised program (1.5 hour/day; 3 days/week; 12 weeks) and their physical functioning, physical role difficulties, pain and vitality scores improved significantly at the end of the study ($p<0.05$). The increased vitality score could be more significant especially for the patient group when one considers their exhaustion and low level of energy as deterrent factors for exercising. The physical activity levels in their study increased compared with basal measurements. The authors concluded that Tai Chi might have caused the patients to be more active and have more energy and could be used as a light alternative to other high-intensity exercises.

However, ensuring individuals have enough motivation and adaptation is one of the difficulties experienced in exercise programs (12). In this aspect, Kirk et al. demonstrated that providing exercise counseling instead of standard exercise brochures was more effective for patients with type 2 DM and their physical activity levels in the 5-week follow-up process. In the same study, a SF-36 questionnaire was used to evaluate the volunteers' quality of life. Accordingly, the scores of vitality and mental health subscales were significantly higher in the group that received exercise counseling compared with basal measurements. We deemed it possible that these results were based on the longer exercise time because all scores of SF-36 in our study were significantly improved. Furthermore, it

can be concluded that supervision of the exercise program implemented in the exercise laboratory was an important motivation-improving factor compared with exercise consultancy. Moreover, this helped patients to socialize with each other and this may have played role in making supervised exercise laboratory advantageous over other settings.

In the study by Ligtenberg, the effects of regular physical activity on the mental well-being of patients with type 2 DM (n=51) were studied (11). After a 6-week exercise program, improvement could be detected in all subscales of the Well-Being Questionnaire (W-BQ). Analyzing the relationship between diabetes, depression and quality of life, Goldney et al. reported that patients with diabetes a significantly higher level of depression compared with the non-diabetic control group (19). Depression has a negative influence on quality of life. SF-36 questionnaire was used and the issues evaluated through the questionnaire were divided in two main categories as physical health and mental health components. The result gathered was that depression had a negative effect on physical health components of patients with diabetes. The researchers explained that depression might cause infection by affecting the immune system, or slow down the process of adherence to medication and diet, or limit physical activity. However, there was no statistically significant relationship found between mental health components of individuals with diabetes and depression.

A different randomized, controlled clinical trial was conducted by Toobert et al. on postmenopausal women with type 2 DM (20). The volunteers performed moderate-intensity aerobic exercises for 30 minutes for 4 days every week and strength exercise twice a week. The levels of HbA_1C, BMI, and plasma fatty acids of this group decreased significantly compared with patients with type 2 DM who did no exercise. However, there was no significant increase in mental and physical health parameters evaluated using the Medical Outcomes Study Short-Form General Health Survey questionnaire, a shorter version of SF-36.

In the Look AHEAD study, one of the multi-center, randomized, controlled and long-term studies in the literature, obese/overweight patients with type 2 DM were divided into two groups as the diabetes support and education control intervention (DSE) group and intensive lifestyle intervention (ILI) (exercise and diet) (21). The effects of ILI were analyzed on depression symptoms, use of antidepressants and health-related quality of life (HRQOL) during the 9.6-year follow-up using the MOS SF-36 and Beck Depression Inventory (BDI) scales. At the end of the study, the incidence of mild and greater depression symptoms were significantly lower in the ILI group compared with the DSE group, whereas the SF-36 PCS scores including physical parameters of quality of life decreased in both groups. However, the decreases in the ILI group were less than in the DSE group. From this point of view, we could gather that ILI can slow down the effects of the aging process on quality of life. The results of their study regarding quality of life are different from many related studies (22, 23) including our study. The main factor for this is allegedly that the study lasted for much longer than the other studies and included the possible effects of aging.

Similarly, a study by Whycherley et al. involved two groups of participants for 16 weeks (24). One of the groups received a calorie-restricted diet and the other group received a calorie

restricted-diet and resistance training (three times a week; 8-12 repetitions; 2 sets a day). After comparing the results using Diabetes-39 questionnaire (D-39) and Problem Areas in Diabetes (PAID) scales, it was observed that quality of life improved significantly in both groups but there was no difference between the groups. This study did not involve a group with exercise only, which differentiates it from our study. Another significant difference is that unlike our study, they found no correlation (except energy and mobility and severity of diabetes) between glycemic control and weight loss, and PAID and D-39 QOL scores in the study. On the other hand, we found a negative correlation between HbA1c and pain and general health score in the post-exercise evaluation, and a negative correlation between the pain score and fat mass, and waist and hip circumference of the anthropometric values.

In the Italian Diabetes and Exercise Study (IDES), a randomized, controlled and multi-center study on large groups, there was a significant relationship between the amount of physical activity performed under supervision and quality of life (25). It was explained how exercise programs without supervision could make patients feel insecure and being in contact with professionals and other participants could have positive effects on certain mental components of quality of life. This would explain the results we achieved after supervising the exercise programs for our volunteers.

In a recent study, there was a significant relationship between glycemic control and diabetes-specific QOL, but there was no relationship between SF-36 and glycemic control (26). This was explained by the small number of insulin-treated patients and therefore patients' good general glycemic control. Considering the patients in our study had poor glycemic control, it would not be surprising to see all SF-36 subscales improve significantly. Nonetheless, in another study, a decrease of 1% or more in the HbA1c value indicated a significant improvement and the same amount of increase in the HbA1c value caused impairment in quality of life; this result is also in line with the results of our study (27).

When we examined the previous studies, we saw that exercise modalities did not provide the same or similar results on SF-36 subscales. As stated in Sukala's study, we also think that the differences between the questionnaires used to determine volunteers' society and lifestyles, the differences between exercise programs and factors such as social interaction could cause different results in studies that evaluate the relationship between exercise and quality of life (1).

One of the limitations in our study was that SF-36 did not question sexual dysfunction; therefore, we could not evaluate quality of life in that aspect. Other limitations were that we did not have a control group and did not use a diabetes-specific questionnaire alongside SF-36.

In light of all these findings, we observed that a supervised regular aerobic exercise program used in this study had a positive effect on the quality of life in patients with type 2 DM.

Therefore, we can conclude that it is beneficial to encourage such patients to exercise during treatment in order for them to overcome the mental, social, and physical difficulties caused by the fact that they have to live with a chronic disease that needs to be kept strictly under control.

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