ANKARA MEDICAL JOURNAL

Research Article

Ankara Med J, 2022;(1):24-36 // 10.5505/amj.2022.41713

DETERMINATION OF PHYSICAL ACTIVITY LEVELS OF PATIENTS WITH DIABETES MELLITUS AND EVALUATION OF ITS RELATIONSHIP WITH TREATMENT COMPLIANCE

Halil Okur[1], Sibel Tunç Karaman[1], Okcan Basat[1]

[1]University of Health Sciences, Gaziosmanpaşa Training and Research Hospital, Department of Family Medicine, Istanbul, Turkey

Correspondence:
Sibel Tunç Karaman (e-mail: drsibeltunc@hotmail.com)

Submitted: 24.10.2021 // Accepted: 16.03.2022

Ankara Yıldırım Beyazıt University Faculty of Medicine
Department of Family Medicine

Abstract

Objectives: Physical activity is a crucial component of the treatment of Diabetes Mellitus (DM). This study aimed to determine the physical activity levels of patients with DM and evaluate the relationship between their adherence to treatment.

Materials and Methods: The study was designed as a single-center, prospective, analytical study. It was conducted with patients who applied to the Family Medicine Outpatient Clinic for any reason, those who had a diagnosis of DM for at least one year. Sociodemographic data, anthropometric measurements, fasting blood glucose, and HbA1C levels were recorded. Physical activity levels were assessed using the General Practice Physical Activity Questionnaire (GPPAQ) and the International Physical Activity Questionnaire (IPAQ). The levels of compliance with drug treatment were assessed using the Modified Morisky Medication Adherence Scale-8 (MMMAS-8).

Results: The mean age of 237 people included in the study was 51.32 ± 8.62 years (25-65), and most were women (n=141; 59.49%). The majority of the participants were physically inactive. (according to IPAQ n=143, 60.34%; GPPAQ n=161, 67.93%). 55.70% (n=132) had a moderate-high level of treatment compliance. No statistically significant correlation was determined between both scales measuring physical activity level and compliance of individuals to drug treatment (p=0.110 for GPPAQ; p=0.714 for IPAQ).

Conclusion: No significant correlation was found between the physical activity levels of patients with DM and their compliance with drug therapy. However, it has been observed that the results obtained with GPPAQ, a new measurement tool that can be easily applied in primary care, are also instructive.

Keywords: General Practice Physical Activity Questionnaire, Diabetes Mellitus, Physical Activity, Modified Morisky Medication Adherence Scale-8, Medication Adherence, International Physical Activity Questionnaire.

ANKARA MEDICAL JOURNAL

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder that requires continuous medical care, in which the organism can not adequately benefit from carbohydrates, fats, and proteins due to insulin deficiency or defects in the effect of insulin.[1] In many diseases, including DM, lack of physical activity is an important and modifiable risk factor.[2] Physical activity, structured by determining personal goals and performed regularly, is known to help regulate DM and delay the development of complications.[3] Therefore, physical activity, together with drug therapy, medical nutrition therapy, and patient education, are counted among the constant elements of DM treatment.[4] Studies evaluating physical activity in patients with DM in the literature have shown that a majority of patients lead a sedentary life.[5-7]

In order for the medical treatments applied to the patients to be beneficial, the concept of "adherence to treatment," known as taking the prescribed treatment in the recommended form, at the appropriate time and dose, and ensuring continuity in the process determined for the treatment, is important.[8] A few studies concluded that adherence to drug therapy is insufficient in type 2 DM patients.[9-11] When the level of adherence to treatment is low in patients with DM, the effectiveness of the treatment decreases, and the course of the disease is adversely affected. This condition may lead to the development of complications, the occurrence of other diseases, and death.[12-14]

Many methods can be used to evaluate the physical activity levels of individuals and their compliance with treatment.[15] Although there are studies in the literature in which physical activity and adherence to treatment are evaluated separately in patients with DM, to our knowledge, there is no study examining the relationship between these two concepts.

This study aimed to evaluate the relationship between the physical activity levels of patients with DM and the level of compliance with the treatment given.

Materials and Methods

Study population and study design

This analytical study was designed as a single-center and prospective study. It included 237 patients between the ages of 18-65, admitted to the Family Medicine Outpatient Clinic of a tertiary hospital for any reason, between February 15th and June 15th, 2020, who had a diagnosis of DM for at least one year and agreed to participate in the study.

Those aged <18 and those aged>65 years, those who had a history of severe cardiovascular disease, advanced stage pulmonary diseases, a musculoskeletal disease that prevents physical activity, gestational diabetes mellitus, those diagnosed with DM less than one year ago, those who were pregnants, those who breastfeed, and those with communication barriers were excluded.

According to the calculation result made by using the G-Power program, when considering the 1st type error as 5% (bidirectional) and the 2nd type error as 5% (95% power), with the percentage of being physically active as determined by the scale in the sample literature, a total of at least 172 cases was found to be suitable to include.

Data collection tools

Patient information form:

A patient information form was formulated by us using the literature, which included the participants' sociodemographic characteristics (age, gender, marital status, educational level, working status), information on DM disease (type of DM, duration of DM, treatment used, presence of complications related to DM, type of complication, hospitalization in the last year, adherence to diet) and general health status (presence of additional diseases, medication, alcohol and cigarette use) were questioned. The participant's blood pressure (mmHg), waist circumference (cm), height (m), weight (kg), and BMI (Body Mass Index, kg/m^2) values were measured and recorded. Previously measured fasting blood glucose (FBG, mg/dl) and HbA1C (%) levels were noted as well.

General Practice Physical Activity Questionnaire

General Practice Physical Activity Questionnaire (GPPAQ), the first of the scales used to determine the physical activity levels of the participants, was developed in 2002 by The London School of Hygiene and Tropical Medicine in England to evaluate the physical activity level of adults in primary care.[16] Turkish validity and reliability study was performed by Noğay et al. in 2019 (Cronbach α=0.74).[17] The scale consists of 3 parts and seven questions. In the first part, the activities of the participants at work are questioned. In the second part, physical exercises, walking, cycling, hobbies, and housework in the last week, how many hours a week are done, and in the last part, walking speeds are asked. Walking, housework, gardening, and hobby activities are not considered as they are not significant and reliable when calculating total physical activity. People are divided into four groups according to their physical activity levels as active, moderately active, less active, and sedentary.[16,17]

International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ), the second scale used to determine the physical activity levels of the participants, was developed by Craig et al. in 2003.[18] The Turkish validity and reliability study of the short and long forms of the questionnaire was performed by Sağlam et al. in 2010.[19] The scale consists of 4 parts and seven questions. In the first part, whether the participant did a vigorous physical activity and if it was done, the duration of it is questioned. In the second part, whether moderate physical activity is done, and if it was done, its duration is evaluated. In the third part, it is questioned whether the participant walked for more than 10 minutes in the last week and if it was done, its duration is questioned. The fourth part consists of a single question evaluating the time spent sitting. In evaluating the results, MET-min (Metabolic Equivalent) score is used. While calculating the total MET value of the participant, the minutes of sitting (1.5 MET-min), walking (3.3 MET-min), moderate-intensity physical activity (4 MET-min), and vigorous physical activity (8 MET-min) within one week were used. It is categorized as inactive if the total MET-min/week value is below 600, minimally active if 600-3000 MET-min/week is detected, and active if it is above 3000.[18,19]

Modified Morisky Medication Adherence Scale-8

The treatment adherence levels of the participants were evaluated with the Modified Morisky Medication Adherence Scale-8 (MMMAS-8) prepared for DM patients in 2006 by Morisky et al.[20] The validity and reliability study of the scale was performed by Sayıner et al. in 2019.[21] The scale consists of 8 questions. Answering "no" to the first four questions, sixth and seventh questions, and "yes" to the 5th question, never/rarely to the 8th question score 1 point. Other answers do not receive points. While 8 points are considered as high adherence to treatment, 6-7 points indicate moderate adherence, and below 6 points indicate low adherence.[20,21]

Statistical analysis

The IBM SPSS Statistics 22 program was used for statistical analysis. The compliance of the parameters to normal distribution was evaluated with the Shapiro-Wilk test. In addition to descriptive statistical methods (mean, standard deviation, frequency) in more than two-group comparisons, one-way ANOVA was used when numerical variables showed normal distribution, and the Tukey HDS test and Tamhane's T2 test determined the group that caused the difference. The Kruskal-Wallis test was used when there was no normal distribution, and Dunn's test was used to determine the group that caused the difference. Mann-Whitney U test evaluated the comparisons of non-normally distributed parameters between two groups. The Chi-square test and Fisher Freeman Halton test compared qualitative data. Pearson's correlation analysis was performed to examine the relationships between parameters that conform to a normal distribution, and Spearman's rho correlation analysis examined relationships between parameters that did not conform to a normal distribution. The statistical significance was considered at the level of $p<0.05$.

ANKARA MEDICAL JOURNAL

Results

The mean age of the 237 participants included in the study was 51.32±8.62 years (min:25, max:65), and 59.49% were female (n=141). Table 1 presents the sociodemographic characteristics of the participants.

The mean height of the participants was 1.63±0.09 m, the mean weight was 83.88±15.49 kg, and the mean BMI was 31.75±5.7 kg/m^2. The mean value of participants' waist circumference measurement was 106.24±12.58 cm. The participants had the diagnosis of DM for an average of 6.63±5.47 (min:1, max:30) years. The mean FBG values were 173.87±92.6 mg/dl, and the mean HbA1C values were 8.37±2.38 %. While 57.81% (n=137) had used only OAD in the treatment of DM, 38.40% (n=91) had combined therapy. 61.60% (n=146) had additional drug use due to another disease. It was found that 74.30% (n=176) had no previous complications. As complications, retinopathy (34.43%; n=21) and neuropathy (32.79%; n=20) were reported the most. While 28.69% (n=68) were active smokers, 6.75% (n=16) reported that they used any amount of alcohol. The anthropometric measurements of the participants, their general health status, and information about diabetes are presented in Table 2.

The total MET values of the participants ranged from 180 to 8490 minutes (mean 1304.11±960 min). While 60.34% (n=143) of the participants were inactive according to IPAQ, 35.44% (n= 84) were minimally active and 4.22% (n=10) were very active. According to GPPAQ, 8.02% (n=19) was active, 14.35% (n=34) was moderately active, 9.70% (n=23) was less active and 67.93% (n=161) were considered sedentary. The mean score of the MMTUS-8 was 5.74±2.05, and 55.70 % of the participants (n=132) had a moderate-high level of treatment compliance.

Table 1. Sociodemographic characteristics of the study population

		Min-Max	Mean±SD
Age (years)		25-65	51.32±8.62
		n	**%**
Gender	Female	141	59.49
	Male	96	40.51
Education status	Illiterate	40	16.88
	Primary school	131	55.27
	Middle school	25	10.55
	High school	34	14.35
	University	7	2.95
Marital status	Married	205	86.50
	Single	32	13.50
Working status	No	154	64.98
	Yes	83	35.02

According to the results obtained from the scales used, the distribution of the physical activity levels and treatment compliance levels of the participants is summarized in Table 3.

No statistically significant correlation was determined between both scales measuring physical activity level and adherence to drug therapy (p:0.110 for GPPAQ; p:0.714 for IPAQ). Table 4 shows the relationship between the physical activity levels of the patients and their compliance with drug treatment according to the results obtained from the scales.

Table 2. Health status, characteristics of diabetes, and anthropometric measurements of the participants

		Min-Max	Mean±SD (median)
BMI (kg/m^2)		18.99-59.58	31.75±5.7
Waist circumference (cm)		70-160	106.24±12.58
Diastolic BP (mmHg)		50-100	76.84±8.19 (80)
Systolic BP (mmHg)		90-180	123.42±12.71 (120)
FBG (mg/dl)		77-743	173.87±92.6 (140)
HbA1c (%)		5.2-17	8.37±2.38 (7.6)
Duration of disease (years)		1-30	6.63±5.47
		n	**%**
DM Medication	OAD	137	57.81
	Insulin	9	3.80
	Combined	91	38.40
DM Complication (n=61)	Retinopathy	21	34.43
	Nephropathy	18	29.51
	Neuropathy	20	32.79
	Diabetic foot	2	3.28
History of hospitalization	No	232	97.89
	Yes	5	2.11
Diet compliance	Yes	111	46.84
	Partially	73	30.80
	No	53	22.36
Smoking status	Active smoker	68	28.69
	Ex-smoker	60	25.32
	Non-smoker	109	45.99
Alcohol Use	Yes	16	6.75
	No	221	93.25
Additional chronic diseases	No	76	32.07
	Yes	161	67.93
Additional drug use	Yes	146	61.60
	No	91	38.40

BMI: body mass index (kg/m^2). BP: Blood Pressure, DM: Diabetes Mellitus, FBG: Fasting Blood Glucose.

Table 3. Distribution of participants' physical activity levels and medication adherence levels according to the results obtained from the scales used

		Min-Max	Mean±SD (median)
IPAQ Sub-dimensions (min/week)	Vigorous MET	0-2880	48.95±323.55 (0)
	Moderate-int. MET	0-4800	206.5±567.6 (0)
	Walking MET	0-6930	505.44±650.92 (346,5)
	Sitting MET	0-1260	543.23±261.34 (540)
	Total MET	180-8490	1304.11±960.14 (1035)
MMMAS-8 score		0-8	5.74±2.05 (6)
		N	%
Activity levels According to IPAQ	Inactive	143	60.34
	Minimally active	84	35.44
	Active	10	4.22
Activity levels According to GPPAQ	Active	19	8.02
	Moderately active	34	14.35
	Less active	23	9.70
	Sedentary	161	67.93
Treatment compliance	Low	105	44.30
	Moderate	66	27.85
	High	66	27.85

Data presented as Mean±SD and min-max. GPPAQ: General Practice Physical Activity Questionnaire, IPAQ: International Physical Activity Questionnaire, MET: Metabolic Equivalent, MMMAS-8: Modified Morisky Medication Adherence Scale-8.

Table 4. The relationship between the physical activity levels of the participants and their compliance with treatment

MMMAS-8					
		Score Mean±SD (median)	Level of adherence to treatment n (%)		
Activity levels			Low	Moderate	High
GPPAQ	Active	5.95±2.01 (7)	8 (42.11%)	5 (26.32%)	6 (31.58%)
	Moderately active	5.44±2.41 (6)	15 (44.12%)	10 (29.41%)	9 (26.47%)
	Less active	4.78±2.17 (5)	14 (60.87%)	6 (26.09%)	3 (13.04%)
	Sedentary	5.91±1.92 (6)	68 (42.24%)	45 (27.95%)	48 (29.81%)
		p: 0.110	*p: 0.700		
IPAQ	Inactive	5.82±1.97 (6)	62 (43.36%)	41 (28.67%)	40 (27.97%)
	Minimally active	5.6±2.12 (6)	40 (47.62%)	22 (26.19%)	22 (26.19%)
	Active	5.8±2.62 (6.5)	3 (30.00%)	3 (30.00%)	4 (40.00%)
		p: 0.714	*p: 0.825		

Data presented as Mean±S and n (%). * Chi-Square Test
GPPAQ: General Practice Physical Activity Questionnaire, IPAQ: International Physical Activity Questionnaire, MMMAS-8: Modified Morisky Medication Adherence Scale-8.

Discussion

The present study investigated the relationship between physical activity and adherence to treatment of patients with DM. Although the physical activity levels of the majority of patients with DM were low, it was observed that their treatment compliance was moderate to high. No significant relationship was found between physical activity levels and compliance with treatment.

DM is a disease with an increasing frequency in society, with a high rate of morbidity and complications. In order to achieve success in the treatments given, the patient's compliance with the treatment is critical. In addition, adequate physical activity is an essential component of DM treatment.[3,4]

There are many studies in the literature evaluating physical activity in patients with DM. In these studies, different results, which were thought to be due to the sociodemographic characteristics of the patients and physical activity measurement methods, were obtained. Physical activity was mostly evaluated by using UFAA, and there are also studies using different measurement tools.[6,7]

In the study of Duarte et al. using IPAQ, 8.7% of diabetes patients were very active, 60.6% minimally active, and 30.7% inactive[6]. Similarly, Çolak et al. evaluated the patients as 39.5% inactive, 51.9% moderately active, and 8.5% active.[7]

Consistent with the literature, the results obtained from both physical activity assessment scales (IPAQ and GPPAQ) used in our study were compatible with each other, and it was determined that the majority of the patients were inactive according to IPAQ and sedentary according to GPPAQ.

Previous studies have demonstrated that the sociodemographic characteristics of the patients can affect the level of physical activity.[22,23] It has been observed that the level of physical activity decreases with increasing age. In a study performed in Sri Lanka, the level of physical activity decreased according to UFAA with increasing age, but no significant difference was determined.[22] In our study, while there was no significant difference in terms of activity levels and mean age according to IPAQ, the difference between GPPAQ and mean age was statistically significant. The results were thought to be determined in this way due to the increase in chronic diseases and decrease in the effort capacity of the patients as the age progresses.

Different results were obtained about gender. In a study in which the physical activity levels of diabetic patients were measured and the calories they spent weekly were calculated, no significant relationship was found between the level of physical activity and gender.[23] However, men were significantly more active than women in our study. It is thought that women can spend most of their time at home as they undertake more household chores and childcare, thus causing physical activity to appear low.

The positive effects of physical activity on BMI and waist circumference are known.[24,25] In an experimental study performed with type 2 diabetes patients, a significant decrease was found in the BMI of the physical activity program compared to the control group.[24] In another study, a significant inverse relationship was found between physical activity and waist circumference, but no relationship was found with BMI.[25] The results obtained from our study were similar to most studies in the literature.

Many studies have revealed that physical activity positively affects the decrease in HbA1C and BG.[26-28] A literature review determined that a 100-minute weekly increase in physical activity resulted in an average of 0.16 % decrease in HbA1C and a 4.71mg/dl decrease in FBG.[26] In another study, a significant decrease was determined in HbA1c at 3 and 6 months in the group that underwent physical activity and nutrition interventions compared to the control group.[27] A meta-analysis revealed that in addition to a structured physical activity program, only suggesting physical activity resulted in a decrease in HbA1C.[28] Although a significant relationship was found between physical activity and HbA1C and FBG levels in the literature, no significant relationship was found between physical activity levels and HbA1C and FBG levels in our study. It is thought that this may be due to the inability to standardize many factors that may cause deterioration in DM regulation, such as adherence to diet, additional chronic disease, and the presence of additional drugs used.

When previous studies were examined, it was indicated that good adherence to treatment, as well as exercise, positively affected the course of diabetes, reduced the need for medication, and decreased HbA1C and BG.[13,14,29] In a study performed in 2017, HbA1C and treatment compliance levels were followed up for one year, and the HbA1C levels of the intervention group decreased significantly compared to the control group[14]. Similar to HbA1c, Özkaptan et al. found a negative correlation between treatment adherence and FBG levels.[29] The study of Fadare et al. revealed that adherence to treatment did not have a significant effect on the instantaneous BG level.[30]

Our study determined that HbA1C levels were higher in patients with low treatment compliance, which was consistent with the literature. There was no significant difference between treatment compliance level and FBG. In medical treatments, it is known that drugs must reach a certain dose in the blood in order to be effective. Compliance with treatment is vital to provide and maintain an effective dose. In this context, it was concluded that HbA1C values were found to be lower in patients with better adherence to treatment. On the other hand, FBG can be affected by variables that can affect blood sugar in a short time, apart from the general course of diabetes. Since these variables could not be controlled, it is thought that no difference was detected.

In addition, in our study, the relationship between the physical activity level of the patients and their compliance with drug treatment was investigated. While 55.70% of the patients were found to have a high or moderate level of treatment compliance, it was observed that the majority were included in the inactive and sedentary group. However, there was no statistically significant relationship between the participants' physical activity levels and their adherence to the treatment. To our knowledge, there is not yet a study in the literature investigating the relationship between physical activity levels of patients with DM and adherence to drug treatment. We think that in the primary care follow-up of patients with diabetes, physical activity recommendations should be repeated at each meeting with the patient, personal goals should be determined, and patients should be encouraged.

Limitations of the study

Our study has some limitations. Firstly, since the number of Type 1 DM patients that can be reached is limited, only Type 2 DM patients were studied. Latter, it is thought that the results of the low activity levels obtained from the physical activity scales are not only related to the diagnosis of DM but also related to the sociocultural level and lifestyles of the participants who could be reached in the study.

In this study, in which we aimed to evaluate the relationship between physical activity levels and adherence to treatment in patients with Type 2 DM, it was observed that the majority of the patients had low physical activity levels, and their compliance with drug treatment was at a moderate-high level. However, no significant relationship was found between physical activity levels and adherence to drug therapy. Moreover, although not statistically significant, it was concluded that since the results obtained with GPPAQ, which is a short and easy-to-understand new measurement tool that can be easily applied in primary care, are also instructive, it can be used more frequently in determining the level of physical activity in primary care.

Acknowledgments: None

Ethical Considerations: Ethical permission to perform this study was obtained from the Local Ethics Committee (Approval No:29; Date: 05.02.2020). The study was conducted under the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants.

Conflicts of Interest: The authors declare that they have no competing interests, financial or otherwise, related to the current work.

Funding: There was no source of funding for this research.

References

1. TEMD Diabetes Mellitus ve Komplikasyonlarının Tanı, Tedavi Ve İzlem Kılavuzu-2020 [Internet]. https://temd.org.tr/admin/uploads/tbl_kilavuz/20200625154506-2020tbl_kilavuz86bf012d90.pdf (Accessed: 20.10.2021)
2. Global recommendations on physical activity for health. Geneva: WHO, 2010 [Internet]. https://www.who.int/publications/i/item/9789241599979 (Accessed:20.10.2021)
3. Kirwan JP, Sacks J, Nieuwoudt S. The essential role of exercise in the management of type 2 diabetes. Cleve Clin J Med. 2017;84(7):15-21.
4. TSBHS. Türkiye Diyabet Programı 2015-2020, Ankara. Sağlık Bakanlığı Yayınları. 2014(816):13.
5. Oliveira C, Simões M, Carvalho J, Ribeiro J. Combined exercise for people with type 2 diabetes mellitus: a systematic review. Diabetes Res Clin Pract. 2012;98(2):187-98.
6. Duarte CK, Almeida JC, Merker AJ, Brauer Fde, Rodrigues TC. Physical activity level and exercise in patients with diabetes mellitus. Rev Assoc Med Bras(English Edition). 2012;58(2): 215-21.
7. Çolak TK, Acar G, Dereli E, et al. Association between the physical activity level and the quality of life of patients with type 2 diabetes mellitus. J Phys Ther Sci. 2016;28:142–47.
8. Ho PM, Bryson CL, Rumsfeld JS. Medication adherence:Its importance in cardiovascular outcomes. Circulation. 2009;119:3028-35 .
9. Krapek K, King K, Warren SS et al. Medication adherence and associated hemoglobin A1C in type 2 diabetes. Ann Pharmacother. 2004; 38(9):1357–62
10. Rubin Richard R. Adherence to pharmacologic therapy in patients with Type 2 diabetes mellitus. Am J Med. 2005; 118 Suppl 5A:27–34.
11. Asche C, Lafleur J, Conner C. Review of diabetes treatment adherence and the association with clinical and economic outcomes. Clinical Therapeutics. 2011; 33:74-109.
12. Wood B. Medication adherence, the real problem when treating chronic conditions. US Pharm. 2012;37(4):3-6.
13. Tominaga Y, Aomori T, Hayakawa T, Morisky DE, Takahashi K, Mochizuki M. Relationship between medication adherence and glycemic control in Japanese patients with type 2 diabetes. Pharmazie. 2018;73(10):609-12.
14. Hammad MA, Mohamed Noor DA, Syed Sulaiman SA. The effect of patient's adherence on HBa1c control. Archives of Medical and Pharmaceutical Sciences Research (AMPSR):2017;01(01):30-5.
15. Strath SJ, Kaminsky LA, Ainsworth BE, et al. Guide to the assessment of physical activity: Clinical and research applications: a scientific statement from the American Heart Association. Circulation. 2013;128(20):2259-79.

16. Department of Health. The general practice physical activity questionnaire (GPPAQ): a screening tool to assess adult physical activity levels within primary care. London: Department of Health, 2009.
17. Kaya Noğay A, Özen M. Birinci basamak için fiziksel aktivite anketinin Türkçe uyarlamasının geçerlilik ve güvenilirliği. Konuralp Medical Journal. 2019;11(1);1-8.
18. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35(8):1381-95.
19. Saglam M, Arikan H, Savci S, et al. International physical activity questionnaire: reliability and validity of the Turkish version. Perceptual and motor skills. 2010; 111(1): 278-84.
20. Morisky DE, Ang A, Krousel-Wood M, Ward HJ. Predictive validity of a medication adherence measure in an outpatient setting. J ClinHypertens. 2008;10:348-54.
21. Sayiner ZA, Savaş E, Kul S, Morisky DE. Validity and reliability of the Turkish version of the 8-Item Morisky Medication Adherence Scale in patients with type 2 diabetes. Eur J Ther 2020; 26(1): 47-52.
22. Ranasinghe DC, Ranasinghe P, Jayawardena R, Matthews DR, Katulanda P. Evaluation of physical activity among adults with diabetes mellitus from Sri Lanka. Int Arch Med. 2014;7:15.
23. Mynarski W, Psurek A, Borek Z, Rozpara M, Grabara M, Strojek K. Declared and real physical activity in patients with type 2 diabetes mellitus as assessed by the International Physical Activity Questionnaire and Caltrac accelerometer monitor: a potential tool for physical activity assessment in patients with type 2 diabetes mellitus. Diabetes Res Clin Pract. 2012;98(1):46-50.
24. Wisse W, Boer Rookhuizen M, de Kruif MD, et al. Prescription of physical activity is not sufficient to change sedentary behavior and improve glycemic control in type 2 diabetes patients. Diabetes Res Clin Pract. 2010;88(2):e10-e13.
25. Daniele TM, Bruin VM, Oliveira DS, Pompeu CM, Forti AC. Associations among physical activity, comorbidities, depressive symptoms and health-related quality of life in type 2 diabetes. Arq Bras Endocrinol Metabol. 2013;57(1):44-50.
26. Boniol M, Dragomir M, Autier P, Boyle P. Physical activity and change in fasting glucose and HbA1c: a quantitative meta-analysis of randomized trials. Acta Diabetol. 2017;54(11):983-991.
27. Cradock KA, ÓLaighin G, Finucane FM, Gainforth HL, Quinlan LR, Ginis KA. Behaviour change techniques targeting both diet and physical activity in type 2 diabetes: A systematic review and meta-analysis. Int J Behav Nutr Phys Act. 2017;14(1):18.
28. Umpierre D, Ribeiro PA, Kramer CK, et al. Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: a systematic review and meta-analysis. JAMA. 2011;305(17):1790-99.
29. Özkaptan BB, Kapucu S, Demirci İ. Relationship between adherence to treatment and acceptance of illness in patients with type 2 diabetes. CukurovaMedicalJournal. 2019; 44(1), 447-54.

30. Fadare J, Olamoyegun M, Gbadegesin BA. Medication adherence and direct treatment cost among diabetes patients attending a tertiary health care facility in Ogbomosho, Nigeria. Malawi Medical Journal. 2015;27(2): 65-70.