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RESEARCH

Relationship of self-efficacy and physical activity with cognitive level in older adults with type 2 diabetes

Tip 2 diyabeti olan yaşlı bireylerde bilişssel düzeyin öz-etkililik ve fiziksel aktivite ile ilişkisi

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Abstract

Purpose: This study was conducted to determine the mental, self-efficacy, and physical activity levels of older adults with type 2 diabetes mellitus and examine the factors affecting the cognitive level.
Materials and Methods: This descriptive correlational study was designed with a sample of 170 older adults. Data were collected using a personal information form, the Standardized Mini-Mental Test (SMMT), the Type 2 Diabetes Self-Efficacy Scale, and the Physical Activity Scale for the Elderly (PASE).
Results: The mean cognitive level score of the participants was 22.99 ± 5.36. It was found that the total physical activity score, total self-efficacy score, and the self-efficacy sub-dimensions of diet and diabetic foot control, medical treatment, and physical exercise explained 84.9% of the variance in cognitive level (Adjusted R^2 = 0.849). A statistically significant difference was found in total physical activity, total self-efficacy, and the self-efficacy sub-dimensions of diet and diabetic foot control, medical treatment, and physical exercise between older adults with and without cognitive impairment. These influential factors were found to explain 89.2% of the variance in cognitive level.
Conclusion: Total physical activity, overall self-efficacy, and self-efficacy sub-dimension scores were found to influence the cognitive levels of older adults. Thus, risk groups can be identified among elderly individuals with Type 2 DM regarding cognitive levels, allowing for targeted monitoring of these individuals. The results of this study may offer valuable insights for planning interventions aimed at enhancing self-efficacy and physical activity, both of which are associated with cognitive levels.
Keywords: Self-efficacy, Type 2 diabetes mellitus, physical activity, older adults, cognitive level, nursing.

Öz

Amaç: Bu çalışma tip 2 diyabetli yaşlı bireylerin bilişsel, öz-yeterlik ve fiziksel aktivite düzeylerini belirlemek ve bilişsel düzeyi etkileyen faktörleri incelemek amacıyla yapılmıştır.
Gereç ve Yöntem: Bu tanımlayıcı korelasyonel çalışma, 170 yaşlı yetişkinden oluşan bir örneklemle tasarlanmıştır. Araştırma verilerinin toplanmasında kişisel bilgi formu, Standardize Mini Mental Test (SMMT), Tip 2 Diyabet Öz-Etkililik Ölçeği, Yaşlılar İçin Fiziksel Aktivite Ölçeği (PASE) kullanılmıştır.
Bulgular: Katılımcıların ortalama bilişsel düzey puanı 22,99 ± 5,36 idi. Fiziksel aktivite toplam puanı, öz yeterlilik toplam puanı, diyet ve diyabetik ayak kontrolü, tıbbi tedavi ve öz yeterliliğin fiziksel egzersiz alt boyutunun varyansın %84,9'unu (Düzeltilmiş R2= 0,849) açıkladığı belirlendi. bilişsel düzey. Bilişsel bozukluğu olan ve olmayan yaşlı yetişkinler arasında öz yeterliliğin toplam fiziksel aktivite, toplam öz-yeterlik, diyet ve diyabetik ayak kontrolü, tıbbi tedavi ve fiziksel egzersiz alt boyutları açısından istatistiksel olarak anlamlı farklılık bulunmuştur. Bilişsel bozukluğu olan ve olmayan yaşlı bireylerin fiziksel aktivite toplam, öz-etkililik toplam,diyet+ayak kontrolü, tıbbi (medikal) tedavi ve fiziksel egzersiz öz-etkililik alt boyutu arasında istatistiksel olarak anlamlı fark olduğu bulunmuştur (
Sonuç: Toplam fiziksel aktivite, genel öz-yeterlik ve öz-yeterlik alt boyut puanlarının yaşlı yetişkinlerin bilişsel düzeylerini etkilediği bulunmuştur. Böylece Tip 2 DM'li yaşlı bireylerde bilişsel düzeyler açısından risk grupları belirlenerek bu bireylerin hedefe yönelik takibi sağlanabilecektir. Bu çalışmanın sonuçları, her ikisi de bilişsel düzeylerle ilişkili olan öz yeterliliği ve fiziksel aktiviteyi artırmayı amaçlayan müdahalelerin planlanması için değerli bilgiler sunabilir.
Anahtar kelimeler: Öz yeterlilik, tip 2 diyabet, fiziksel aktivite, yaşli yetişkinler, bilişsel düzey, hemşirelik

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INTRODUCTION

Type 2 diabetes (DM) is a significant public health issue with a rising prevalence worldwide and in our country. According to the 2019 report by the International Diabetes Federation, there are 463 million people aged 20 to 79 with DM globally. Additionally, one in every five individuals with DM is 65 years of age or older (136 million)[1]. Research indicates that healthy lifestyle management, sufficient knowledge and skills, and avoidance of risky behaviors play a critical role in effectively managing type 2 DM[2]. Acute and chronic complications occur in type 2 DM cases when adequate precautions cannot be taken and disease control cannot be achieved. One of the complications observed in the later stages of the disease is the deterioration of cognitive function[3].

Type 2 diabetes mellitus (DM) and aging are both associated with physiological changes that can slow cognitive function and may increase the risk of Alzheimer's disease or other forms of dementia[4]. Research indicates that type 2 DM raises the risk of cognitive impairment by 1.2 times, Alzheimer's disease by 1.5 times, and other types of dementia by 2.5 times[4]. Functions such as attention, memory, visual/spatial skills, and psychomotor speed gradually decline in patients with type 2 DM and with advancing age[5].

Sufficient levels of self-efficacy in managing the condition, avoiding complications, and participating in healthy behaviors like physical activity are necessary for people with type 2 diabetes. The definition of self-efficacy is a person's belief in their ability to perform at a particular level, such as engaging in physical activity[6]. At the same time, self-efficacy affects individuals' ability to act on any issue, and high self-efficacy in individuals with type 2 DM may aid in managing the disease more effectively, facilitate treatment adherence, and lead to a positive outcome[7]. Having sufficient self-efficacy and the ability to control one's glycemic levels is highly effective in treating type 2 diabetes mellitus (DM) and reducing the risk of complications, such as cognitive dysfunction[8]. Individuals with type 2 DM who possess high self-efficacy are reported to be more successful in adopting positive health behaviors essential for achieving balanced nutrition, proper medication use, and regulated physical activity, which help prevent disease-related complications[9]. The literature states that the ability of individuals with type 2 diabetes mellitus (DM) to control their glycemic levels through sufficient self-efficacy is highly effective in treating DM and reducing the risk of future complications, such as cognitive dysfunction[8]. Furthermore, when cognitive impairment is present in individuals with type 2 DM, effective disease management becomes challenging, and their self-efficacy levels tend to decrease. With decreased self-efficacy, treatment adherence becomes more challenging, healthy nutrition declines, and the physical activity required for treatment is neglected, leading to an increase in cognitive impairment[10]. In elderly individuals with type 2 DM, physical activity levels and self-efficacy are important for maintaining cognitive function. Research suggests that to prevent age-related cognitive decline, regular physical activity is recommended alongside pharmaceutical treatment[11].

In older adults with type 2 DM, regular physical activity is also important for cognitive function and plays an important role in blood glucose level control. Regular exercise improves cognition (learning skills, memory, etc.), reduces the risk of cognitive impairment, and has a positive effect on the nervous system[11]. According to a study, physical activity reduces the risk of cognitive impairment, and engaging in physical activity throughout life is essential for healthy brain aging. Physical activity of any kind, even at a low level, improves cognitive performance as people age[12]. Sociodemographic characteristics, such as age, gender, educational status, low socioeconomic status, and ethnicity, also influence cognitive impairment[13]. The literature indicates that cognitive impairment is more pronounced in women than in men. Additionally, cognitive well-being declines with age.[14] It has been reported that critical factors such as the disease treatment process and nutrition are affected in individuals with type 2 DM who have a low socioeconomic status, which in turn leads to poorer cognitive performance.[3] It is noted that identifying the degree of cognitive decline in older adults with type 2 diabetes, as well as the sociodemographic characteristics contributing to this decline, is important for guiding diabetes management. The literature indicates that women experience cognitive impairment at higher rates than men. Additionally, cognitive well-being decreases with age.[15] Therefore, determining the cognitive level and sociodemographic characteristics of older adults with type 2 DM is important in guiding DM management.

Enhancing self-efficacy and physical activity levels can help prevent or reduce cognitive decline in individuals with type 2 diabetes. Nurses play a crucial role in managing type 2 diabetes in older adults.[16] We hypothesize that sociodemographic factors, disease-related health characteristics, self-efficacy, and physical activity levels in older adults influence cognitive function. This study aims to assist nurses in identifying high-risk groups based on cognitive levels and to contribute to the development of diabetes education programs for nurses, as well as programs focused on enhancing self-efficacy and physical activity among individuals with the disease.

MATERIALS AND METHODS

Design and setting

This is a descriptive correlational study. The research data were collected in person by the researcher from patients who visited the internal medicine and endocrinology outpatient clinics of a state hospital in central Konya between March 1, 2020, and June 30, 2020. The hospital's endocrinology and internal medicine outpatient clinics operate every weekday from 08:00 to 16:00, with outpatient services provided through an appointment system. Individuals with type 2 diabetes mellitus are hospitalized in the Endocrinology and Internal Medicine Departments for blood glucose regulation, medication dose adjustment, and diagnostic purposes. The manuscript was written according to the STROBE guidelines for observational studies.

Participants

Individuals aged ≥65 years diagnosed with type 2 DM since ≥1 year and who were literate and able to speak The study comprised Turkish participants. The diagnosis of psychiatric disorders and a physical gait impairment were established as exclusion criteria. Since the sample of the validity and reliability study of the Physical Activity Scale for the Elderly (PASE) included independently active individuals without psychiatric and cognitive disorders, elderly individuals with physical disabilities and without psychiatric and cognitive disorders were not included in this study. Diagnoses of psychiatric and cognitive disorders were obtained from the elderly individuals themselves and their relatives. In the study, 24 independent variables were identified as potential determinants of cognitive level. Accordingly, the required sample size was calculated as 170 individuals with 95% power, 0.05 significance level, and 0.15 effect size[17]. The study sample was selected using a convenience sampling method from individuals who applied to a specific institution. According to this sampling method, patients admitted to the endocrinology and internal medicine outpatient clinics and inpatient wards who met the inclusion criteria were included in the sample.

Data collection

The data were collected by the researcher via a survey method between March 1, 2020, and June 31, 2020. Survey data were collected between 08:00 and 16:00, following the examination of individuals in the endocrinology and internal medicine outpatient clinic and after treatment hours in the endocrinology and internal medicine inpatient department.

Outcome measures

Personal Information Form

This form consisted of questions including sociodemographic and disease characteristics of individuals.

Standardized Mini-Mental Test (SMMT)

The SMMT is used to evaluate the cognitive status of older adults. The SMMT was developed by Folstein et al[18] and its validity and reliability in the Turkish population were studied by Güngen et al.[19] The cutoff value of the scale was determined as 23/24, with a specificity of 0.95 and a sensitivity of 0.91. The version for educated folks was employed in this investigation. The lowest score that can be attained on the scale is “0” and the highest is “30.” A "severe cognitive disorder" is indicated by a score between 0 and 12, a "mid-stage cognitive disorder" is indicated by a score between 13 and 22, and an "early-stage cognitive disorder" is indicated by a score between 23 and 24. "No cognitive disorder" is suggested by scores between 25 and 30. [14]

Physical Activity Scale for the Elderly (PASE)

To assess home, work, leisure, and physical activities, as well as the physical activity level of older individuals, Washburn et al. (1999) developed the Physical Activity Scale for Older Adults[20]. PASE evaluates the activities of the older adults in the previous week. A study assessing the validity and reliability of PASE was conducted on the Turkish population, Ayvat et al.,[21] and Cronbach's α coefficient of the scale was 0.714. The activity frequencies and activity weights are multiplied to determine the PASE scores for each activity. On the scale, a person can receive between 0 and 400 points with a maximum [of 21].

Type 2 Diabetes Self-Efficacy Scale

Van Der et al. (1999)[22] developed the self-efficacy scale for diabetes treatment in people with type 2 diabetes.[22] by Western culture to determine the perception of patients with DM regarding their willpower to perform self-care activities[22]. The Cronbach's α value of the original scale was 0.81, and the variance was found to be 55%. Intercultural adaptation of the scale was carried out by Kara et al., 2006[23] and Cronbach's α value was 0.89. The scale consists of 20 items graded using Likert-type scoring ranging from 1 to 5. The scale has a lowest possible score of 20 and a maximum score of 100. Self-efficacy rises as the score does.

Procedure

Ethical approval for the study was obtained from the Non-Interventional Clinical Research Ethics Committee of the Faculty of Health Sciences at Selçuk University (Approval No.2019/14535), dated December 25, 2019. The organization where the study was conducted (No.E.708) granted written consent. After reading the Informed Voluntary Consent Form, each study participant gave their written consent. Between March 1, 2020, and June 30, 2020, a sample of elderly individuals who applied to the outpatient clinic, were examined by the internal medicine and endocrinology units, and were staying in inpatient wards were evaluated. Participants were included in the study after fulfilling the inclusion criteria, undergoing a physician's examination, and volunteering to participate. Questionnaire data were collected between 08:00 and 16:00, following the individual's examination in the endocrinology and internal medicine outpatient clinic and outside of treatment hours in the endocrinology and internal medicine inpatient service. Elderly individuals participating in the evaluation were informed about the purpose of the study. Literate participants were then presented with the Informed Consent Form and asked to read it. The Personal Information Form, Mini-Mental State Examination (MMSE), Physical Activity Scale for the Elderly (PASE), and Type 2 Diabetes Self-Efficacy Scale were completed by the researcher based on participants' responses. On average, survey collection took 15–20 minutes per participant.

Data analysis

The research data was analyzed using the IBM SPSS 22 package application. After the data was moved to a digital setting, descriptive statistics were performed using percentages, means, and standard deviations. The normality of the data was assessed using Q-Q plot charts and the Kolmogorov-Smirnov test. Descriptive statistics included frequency, percentage, mean, standard deviation, and minimum-maximum value. Mann-Whitney U, Kruskal-Wallis, one-way analysis of variance, and the t-test were employed in the data analysis. Given that our dependent variable is categorical, proportional, and continuous, multiple regression analysis was performed. In analyzing the mean scale scores (cognitive level, self-efficacy level, and physical activity level), the independent samples t-test and One-Way ANOVA were used for variables with a normal distribution, while the Mann-Whitney U and Kruskal-Wallis tests were applied for variables not following a normal distribution (in paired groups). Chi-square analysis was used to compare sociodemographic and health-related characteristics, self-efficacy levels, subdimensions of the self-efficacy scale, and physical activity levels between individuals with and without cognitive impairment. Multiple regression analysis was conducted using the backward method to assess demographic and health-related variables that may influence cognitive level. Multiple regression analysis using the backward method was conducted to evaluate the relationships between cognitive level self-efficacy and physical activity scales. Additionally, multiple regression analysis was used to examine the effects of various independent variables on the dependent variable. Variables to be included in the multiple regression were determined based on the significance values from the Mann-Whitney U, Kruskal-Wallis, one-way ANOVA, and t-tests. In this analysis, categorical variables were coded as 1 for groups with risk factors, with risk group coding determined based on the literature and test significance values. A p-value of <0.05 was considered statistically significant. In the correlation (r) values, which is a measure of the change of two variables together, a weak relationship was evaluated between 0.20-0.39; a moderate relationship between 0.40-0.59; a high relationship between 0.60-0.79; and a very high relationship between 0.80-1.0.[24] With a 95% power, 0.05 significance level, and 0.15 effect size, 170 persons were determined to be the necessary sample size.

RESULTS

The participants' average age was 71.17 years (6.27), 64.1% were female, 92.4% were married, 53.5% lived with their spouse, 47.1% were primary school graduates, 94.7% did not work in any job, and 55.9% had moderate economic status. When the health/disease characteristics of older adults were examined, it was found that the mean duration of diabetes was 14.09 years (11.10) ıt has been found that (Table 1).

When cognitive level scores were compared according to the sociodemographic characteristics of the older adults, a statistically significant variation in the mean was discovered. Cognitive level scores concerning age groups, marital status, cohabitants, working status, and perceived economic status ($p < 0.05$). It was determined that individuals who were in the 65-74 year age group who were married, lived with their spouse and children, were working, and perceived their economic situation as good had higher cognitive level scores (Table 1).

Table 1. Partcipant's sociodemographic and health/disease characteristics and mini-mental test score

Variable	n (%)[f]	Mini-mental test score Mean (SD)[e]	p
Sociodemographic characteristics			
Age			0.0001[a, ***]
65–74 years	122 (71.8)	**24.29 ± 4.39**	
75–84 years	36 (21.2)	19.58 ± 6.64	
≥ 85 years	12 (7.1)	20.08 ± 4.79	
Gender			
Female	109 (64.1)	22.52 ± 5.54	0.133[b]
Male	61 (35.9)	23.84 ± 4.95	
Marital status			
Married	157 (92.4)	23.22 ± 5.25	0.040[b ,*]
Single	13 (7.6)	20.31 ± 6.12	
Cohabitants			
Spouse	91 (53.5)	22.99 ± 5.12	0.0001[a, ***]
Spouse and kids	46 (27.1)	**24.98 ± 5.11**	
Living alone	33 (19.4)	20.24 ± 5.29	
Educational Status			
Primary school	80 (47.1)	22.45 ± 5.32	0.305[a]
Middle School	66 (38.8)	23.17 ± 5.25	
High school and above	24 (14.1)	24.33 ± 5.75	
Working Status			
Working	9 (5.3)	25.78 ± 5.23	0.020[b, *]
Not working	161 (94.7)	22.84 ± 5.34	
Economic status			
Good	60 (35.3)	**24.42 ± 4.74**	0.035[a, *]
Moderate	95 (55.9)	22.28 ± 5.60	
Poor	15 (8.8)	21.80 ± 5.28	
Health/disease characteristics			
Diabetes duration			
< 5 years	32 (18,8)	25.56 ± 4.20	0.001[a, *]
5–10 years	50 (29,4)	24.14 ± 5.37	
≥ 11 years	88 (51,8)	**21.41 ± 5.25**	
Diabetes Treatment			
Oral antihyperglycemics	113 (66.5)	**23.73 ± 5.38**	0.029[a, *]
Insulin Oral antihyperglycemics + insulin	28 (16.5) 29 (17.1)	22.07 ± 4.83 21.00 ± 5.31	

Regular use of medications			
Yes	115 (67.6)	**24.20 ± 5.15**	0.001[b,**]
No	55 (32.4)	20.47 ± 4.93	
Frequency of doctor visits for diabetes control			
Once a year	101(59.4)	21.99 ± 5.62	0.011[a, *]
Once every 6 months	45 (26.5)	24.27 ± 5.01	
Once every 3 months	24 (14.1)	**24.83 ± 3.83**	
Frequency of blood glucose measurement			
Everyday	20 (11.8)	22.50 ± 4.71	0.008[a, **]
Sometimes	58 (34.1)	**24.74 ± 4.90**	
Irregular	92 (54.1)	22.00 ± 5.54	
Knowledge of diabetes complications			
Yes	70 (41.2)	25.27 ± 4.61	0.0001[b, ***]
No	100 (58.8)	21.40 ± 5.29	
Hospitalization due to high blood glucose			
Yes	53 (31.2)	19.96 ± 5.16	0.0001[c]
No	117 (68.8)	24.37 ± 4.88	
Hospitalization due to low blood glucose			
Yes	23 (13.5)	19.74 ± 5.04	0.002 [c, **]
No	147 (86.5)	23.50 ± 5.24	
Education about diabetes			
Yes	66 (38.8)	25.15 ± 4.78	0.0001[b,***]
no	104 (61.2)	21.63 ± 5.28	
Regular exercise			
Yes	35 (20.6)	27.29 ± 3.67	0.0001[b, ***]
No	135 (79.4)	21.88 ± 5.17	
Diet			
Only 3 main meals	42 (24.7)	22.12 ± 5.77	0.0001[a, ***]
Regular 3 main meals and 3 snacks	54 (31.8)	26.26 ± 3.19	
Regular 3 main meals and irregular 3 snacks	26 (15.3)	23.04 ± 5.10	
Irregular 2 main means and 3 snacks	48 (28.2)	20.06 ± 5.22	
Another chronic disease			
Yes	81 (47.6)	22.21 ± 5.15	0.069[b]
No	89 (52.4)	23.71 ± 5.47	
Number of chronic diseases			
1	89 (52.4)	23.94 ± 5.33	0.290[d, *]
2	73 (42.9)	21.74 ± 5.32	
3	8 (4.7)	23.88 ± 4.22	
Perceived health status			
Good	36 (21.2)	27.31 ± 3.06	0.0001[a, ***]
Moderate	108 (63.5)	22.53 ± 4.95	
Poor	26 (15.3)	18.96 ± 5.62	
Cognitive level			
No cognitive impairment (≥ 25 points)	89 (52.4)	27.07±2.56	.0001[b],***
Cognitive impairment (≤ 24 points)	81 (47.6)	18.52±3.85	

[a]:one way analysis of variance [b]: Independent samples t test, [c]: Mann–Whitney U test, [d]: Kruskal–Wallis test, [e] SD: standart deviation, [f]n (%):number (percentage), *p < 0.05, **p < 0.01, ***p<0.001

When cognitive level scores were compared according to the health–disease characteristics of the older adults, a statistically significant difference was found in mean cognitive level scores concerning diabetes duration, treatment type, regular use of medications, frequency of doctor visits for diabetes control, frequency of blood glucose measurement, knowledge of diabetes complications, hospitalization due to high and low blood glucose levels, education about diabetes, diet, regular exercise, and perceived health ($p < 0.05$). Those who had diabetes for 11 years or more used regular medication, visited a doctor for diabetes control every 3 months, knew about diabetes complications, were not hospitalized due to high and low blood glucose levels, received education on diabetes, exercised regularly, regularly ate three main meals and three snacks, and perceived their health as good had higher cognitive level scores.

The mean SMMT score of the older adults was 22.99 (5.36) and the mean PASE score was 104.6 (75.46). The mean self-efficacy score of the participants was 62.62 (12.05). The average sub-dimension ratings for medical care, physical activity, diabetic foot control, and food were 36.24 (7.43), 17.57 (3.50), and 8.81 (2.43), respectively (Table 2).

Table 2. Mini-mental test, physical activity, and self-efficacy total and sub-dimension mean scores

Variable	Mean(SD)[a]	Min/Max[b]
Mini-Mental Test Score	22.99 (5.36)	17–30
Physical Activity Scale Score	104.63 (75.46)	22–365.89
Self-efficacy Total Score	62.62 (12.05)	24–88
Diet and diabetic foot control	36.24 (7.43)	15–49
Medical treatment	17.57 (3.50)	6–25
Physical exercise	8.81 (2.43)	3–14

[a]SD: standart deviation, [b] Min/Max: minimum, maximum

It was observed that the self-efficacy sub-dimension, self-efficacy total scores, and physical activity total scores had a high significance with cognitive level ($p< 0.001$). The regression analysis found that diet and diabetic foot ($\beta = 0.405$), medical treatment ($\beta = 0.792$), and physical exercise ($\beta = 0.647$) sub-dimensions of self-efficacy and self-efficacy total scores ($\beta = 0.802$) had a positive effect on predicting cognitive level, and these factors explained 84.9% (Adjusted $R^2 = 0.849$) of the variance in the cognitive level (Table 3).

Table 3. The self-efficacy and physical activity scores as predictors of mini mental test score

Determinants	β	t	p	Collinearity	
				Tolerance	VIF
Physical Activity total score	0.736	4.403	0.000*	0.368	3.256
Self-efficacy total score	0.802	5.185	0.000*	0.495	5.498
Diet and diabetic foot control sub-dimension	0.405	4.607	0.000*	0.725	3.822
Medical treatment sub-dimension	0.792	8.823	0.000*	0.592	4.463
Physical exercise sub-dimension	0.647	7.773	0.000*	0.826	3.863

Dependent Variable: = mini mental test score; *$R^2 = 0.858$ Adjusted $R^2 = 0.849$ F = 4327,208 p < 0.000*

It was found that the age groups of older adults ($\beta = 0.357$), marital status ($\beta = 0.579$), cohabitants ($\beta = 0.498$), employment status ($\beta = 0.684$), perceived economic status ($\beta = 0.729$), duration of DM ($\beta = 0.902$), type of DM treatment ($\beta = 0.812$), regular medication use ($\beta = 0.603$), frequency of doctor visits for DM control ($\beta = 0.723$), frequency of blood glucose measurement ($\beta = 0.823$), knowledge of DM complications ($\beta = 0.568$), hospitalization for high ($\beta = 0.723$) and low blood sugar ($\beta = 0.549$), education about DM ($\beta = 0.364$), regular exercise ($\beta = 0.737$), diet ($\beta = 0.458$), and perceived health status ($\beta = 0.792$) were predictors of cognitive level ($p < 0.001$). These determinants were found to explain 89.2% (Adjusted $R^2 = 0.892$) of the variance in the cognitive level (Table 4).

Table 4. Determinants factors affecting the mini mental test score

Determinants	β[a]	t[b]	p	Collinearity	
				Tolerance	VIF[c]
Age (1 = 75–84 years)	0.357	2.203	0.000*	0.743	4.027
Marital status (1 = single)	0.579	3.546	0.000*	0.634	3.265
Cohabitants (1 = alone)	0.498	1.784	0.000*	0.806	5.623
Working status (1 = not working)	0.684	4.631	0.000*	0.376	4.447
Perceived economic status (1 = poor)	0.729	3.075	0.000*	0.407	3.723
Duration of Diabetes (1 = 11 years and above)	0.902	2.034	0.000*	0.567	2.926
Diabetes Treatment Type (1 = Oral antihyperglycemics + Insulin)	0.812	4.092	0.000*	0.639	4.927
Regular use of medications (1 = no)	0.603	3.025	0.000*	0.712	2.512
Frequency of doctor visits for diabetes control (1 = once a year)	0.723	7.773	0.000*	0.813	5.156
Frequency of Blood Glucose Measurement (1 = Irregular)	0.823	4.046	0.000*	0.631	3.023
Knowledge of diabetes complications (1 = No)	0.568	2.542	0.000*	0.534	4.446
Hospitalization due to high blood glucose (1 = Yes)	0.723	1.027	0.000*	0.638	5.317
Hospitalization due to low blood glucose (1 = Yes)	0.549	1.134	0.000*	0.712	4.677
Education about diabetes (1 = No)	0.364	4.237	0.000*	0.603	5.356
Regular Exercise (1 = No)	0.737	3.921	0.000*	0.775	3.736
Diet (1 = Irregular 2 main meals and 3 snacks)	0.458	4.035	0.000*	0.716	2.354
Perceived health (1 = Poor)	0.792	5.124	0.000*	0.526	3.923
R2 = 0.785 Adjusted R2 = 0.892 F = 4812.427 p < 0.000*					

[a] β: Standardized coefficient beta, [b]t:t value, [c] VIF:Variance inflation factor, *p < 0.001

Table 5. Distribution of physical activity and self-efficacy scores of older adults

Variable	No Cognitive Impairment Mean (SD)[a]	Cognitive Impairment Mean (SD)[a]	p
Physical Activity Scale Score	146.06 (77.06)	56.10 (38.54)	0.000[a, **]
Self-efficacy Total Score	70.73 (6.85)	53.71 (10.08)	0.001*
Diet and diabetic foot control sub-dimension	41.05 (4.36)	30.95 (6.44)	0.000**
Medical treatment sub-dimension	19.55 (2.51)	15.39 (3.14)	0.001*
Physical exercise sub-dimension	10.12 (1.75)	7.37 (2.27)	0.001*

Independent samples t test, [a]SD: standart deviation, *p < 0.01, **p < 0.001

The sub-dimension ratings of older persons with and without cognitive impairment showed a statistically significant difference (p < 0.05) about physical activity, self-efficacy, diet and diabetic foot control, medical treatment, and physical exercise. Compared to people without cognitive impairment, those with cognitive impairment showed lower sub-dimension ratings for physical activity, diet and diabetic foot control, self-efficacy, medical treatment, and physical exercise. (Table 5).

DISCUSSION

The low physical activity and self-efficacy levels in older adults with type 2 DM may cause a decline in their cognitive levels. For this purpose, in this study, physical activity and self-efficacy levels of older adults with type 2 DM were determined, and the factors affecting cognitive status were examined.

An examination of the sociodemographic profile in this study revealed that cognitive level varied significantly by age group, marital status, cohabitants, employment status, perceived economic status, and disease characteristics among elderly individuals. These findings align with the literature from other studies examining these variables.[25,26,27,28,29] In a study, a difference was found in cognitive well-being between women and men, with the men experiencing a higher rate of cognitive decline[25]. It is consistently predicted that scores obtained from cognitive tests decrease significantly with advancing age.[14] The study consistently reported that the scores obtained from cognitive tests decrease significantly as age progresses even if there is no diagnosis of type 2 DM[26]. The health of individuals with lower socioeconomic levels may be adversely impacted by their financial circumstances in numerous ways and to varying extents throughout different stages of their lives[29]. Numerous studies indicate that being single and living alone can weaken social networks, potentially contributing to increased morbidity and poorer cognitive outcomes. As aging is associated with a rise in single living and isolation, these factors may hurt cognitive function, especially as health status declines and the number of chronic conditions increases.[30] In the literature, similar study results show marital status differences in cognitive levels among older adults[31,32]. In the present study, individuals with type 2 DM who were more active because of working, irrespective of the job type, were found to have a higher mean cognitive level score than those who did not work. A similar study by Daimiel vd., (2020)[33] concluded that more active individuals had higher cognitive levels. Older individuals with an active life have better cognitive performance.

When the health status and cognitive function of individuals with type 2 DM were examined, significant differences were found in the type of DM treatment, regularity of medication use, frequency of doctor visits for DM control, frequency of blood glucose measurement, knowledge of complications related to DM, and hospitalization due to high or low blood glucose levels. Nooyens et al. (2010)[34] reported that individuals with type 2 DM experienced 2.6 times more cognitive decline over five years compared to individuals without type 2 DM.[34] Another study by Gatlin et al. (2015)[28] stated that medication use and its frequency positively or negatively affected cognitive function in individuals with DM[28]. Moreover, it was emphasized that individuals with type 2 DM may fail to notice fluctuations in glucose levels, such as hypo- or hyperglycemia when they do not measure their blood glucose regularly, which can lead to complications such as a decline in cognitive levels and a decrease in working memory and attention in the long term[35].

The present study found that individuals with type 2 DM who ate three main meals and three snacks a day had higher cognitive level scores than those who did not eat regularly or did not consume snacks. In a study by Kössler et al. (2020)[36,] it was observed that nutrition influenced cognitive performance in individuals with type 2 DM, with cognitive performance improving when a Mediterranean diet was followed.

In addition, we showed through regression analysis that sociodemographic and disease characteristics were predictors of cognitive level. These determinants were found to explain 89.2% of the variance in the cognitive level. The study also showed that socioeconomically disadvantaged groups and ethnic and cultural changes adversely affect the cognitive level, and factors such as the duration of metabolic disease and inability to provide glycemic control raise a person's chance of experiencing cognitive deterioration with type 2 DM[37]. The current study discovered that people with type 2 diabetes had mean scores on the cognitive level that were significantly lower than those of people without the disease. Approximately half of the participants had a cognitive level score of 24 or below, and cognitive impairments were detected. Other studies in the literature also reported similar findings[38].

The present study determined that the category of the self-efficacy level and its sub-dimensions affected the cognitive level of older adults with type 2 DM and that the mean self-efficacy scores of the individuals were found to be moderate. It was found that individuals with cognitive impairment had lower self-efficacy total scores and sub-dimension scores compared to individuals without cognitive impairment. There are results in the literature that support our findings[8,10]. A study conducted by[39] emphasized that the self-efficacy scores of individuals with DM were low. The self-confidence of individuals with type 2 DM and their self-efficacy decreased, especially in issues related to home care, and this in turn led to an increase in cognitive function complaints. Furthermore, it was reported that individuals with type 2 DM who have cognitive impairment have difficulty performing self-care[40]. In these individuals, having a high level of self-efficacy regarding the disease may translate to better disease management.

The physical activity sub-dimension of the self-efficacy measure had a mean score of 8.81 ± 2.43, and the mean score for older persons was 104.63 ± 75.46, according to the current study. In addition, it was determined that older adults with cognitive impairment had lower physical activity scores compared to those in older adults without cognitive impairment. Physical activity is a component of non-pharmacological treatment for type 2 DM. Findings in the literature indicate that older individuals who engage in physical activity more frequently have better cognitive function than those with type 2 DM who engage in physical activity less frequently.[41,42] When the changes in cognition, executive function, and working memory were examined before and after a 12-week exercise training program in individuals with moderate dementia, it was found that physical activity had a significant benefit on cognitive level[16]. Six months of high-intensity aerobic exercise improved people's glucose metabolism and cognitive function, according to a randomized controlled trial. [43] After six months, the subjects' fasting plasma levels of insulin, cortisol, and brain-derived neurotrophic factor dropped, and they performed better on several executive function tests. [43] As reported in the literature, individuals with type 2 DM who are more physically active have better health.

This study had one limitation important to note. A constraint of the study is that the participants were chosen through convenience sampling, and the sample consisted solely of elderly patients diagnosed with type 2 diabetes mellitus from a nearby hospital. Therefore, the data may be subject to social response bias. Other limitations of the study include the reliance on self-reported measurements, the lack of objective assessment of cognitive level and physical activity, the exclusion of individuals with psychiatric diagnoses, and the inclusion of elderly individuals without a formal diagnosis of cognitive impairment but with potential moderate cognitive impairment according to the MMSE. In light of these limitations, it is recommended that future studies incorporate additional measurement tools (such as ADAS-Cog, electroencephalography, and functional magnetic resonance imaging) to assess HbA1c levels, physical activity (e.g., step count), and cognitive function, all of which are critical in diabetes management. Furthermore, it is suggested that patients with psychiatric diagnoses, especially those in the remission phase, be included in future research.

It was shown that older persons with type 2 diabetes had low average cognitive level scores, moderate average self-efficacy total scores, and low average physical activity scores. It was found that physical activity and self-efficacy total scores, as well as diet and diabetic foot control, medical treatment, and physical exercise sub-dimension scores, are predictors of cognitive level. Compared to older persons without cognitive impairment, those with cognitive impairment had lower sub-dimension scores for physical exercise, diet and diabetic foot care, medical treatment, and self-efficacy, as well as lower physical activity and self-efficacy scores. It is important to identify the factors that affect cognitive function in individuals with type 2 diabetes and to assess how these factors influence their behaviors. Therefore, there is a need to identify individuals with type 2 diabetes at an early stage and to conduct a multidisciplinary study on these individuals. Health professionals need to identify older individuals with type 2 diabetes and cognitive decline and participate in comprehensive geriatric assessments. There is also a need to further investigate the health-promoting factors that may be associated with cognitive function in older individuals with type 2 diabetes and to gain deeper insights into this subject.

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