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Assessment of the Fall Risk in Patients with Diabetes

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Abstract

Research Article

This study was designed to assessment the fall risk in patient with diabetes patients and to ascertain the extent to which diabetic complications and diabetic foot might be contributing factors to this risk. The sample of this descriptive, cross-sectional study consisted of 300 patients with diabetes who had been referred to department of diabetes and endocrinology at a university hospital in the south of Turkey. Data were collected using, the "Patient Information Form," "Turkish - Morse Fall Scale," and the "Diabetes Foot Risk Assessment Tool." Balance was assessed using the modified "Flamingo balance test." The mean age of the patients was 59.7±16.5 years, 58.7% of which were women. The mean number of years since the onset of diabetes was 13.3±10.0 years, while mean HbA1c levels were 9.0±2.3%. For most of the patients (64.3%), the risk of falling was high. The patients scored poorly on the Flamingo balance test. A significant relationship was found between the risk of falling and insulin use, obesity, neuropathy, nephropathy, high risk of developing diabetic foot, cardiovascular and cerebrovascular illness, foot deformation, reduction of sensation in the foot, and the absence of peripheral pulse ($p<.001$). A moderately positive relationship was found between falling risk and age ($r = .427$, $p<.001$) and number of years since the onset of diabetes ($r=.409$, $p<.001$), and a weak positive one between falling risk and weight ($r=.159$, $p<.01$). This study determined that most diabetic patients had a high risk of falling and that the micro and macrovascular complications of diabetes increasing falling risk. Moreover, patients with diabetic foot risk had a high risk of falling. Consequently, it is recommended that complications be delayed by achieving metabolic control, foot health be improved, and strength and balance exercises be performed.

INTRODUCTION

Diabetes Mellitus is an increasingly frequent metabolic disease with systemic and chronic complications. Diabetes is one of the fastest growing health challenges of the 21st century, with the number of adults living with diabetes having more than tripled over the past 20 years. The latest edition of the *IDF Diabetes Atlas* shows that 463 million adults are currently living with diabetes[1]. According to TURDEP-II's Turkish Diabetes, Hypertension, Obesity and Endocrine Disorders Study, in 2010, the incidence of diabetes in the adult Turkish population had reached 13.7%, while that of prediabetes was 23.7%[2].

Poor diabetes control, highly visible both in the world and in our country, may result in such serious complications as cardiovascular problems, retinopathy, nephropathy, neuropathy, delayed wound healing, and erectile dysfunction[3]. Due to complications associated with diabetes, changes occur in the body composition of people with the disease; muscle strength and endurance decline as a result of insulin resistance. Flexibility deteriorates as a consequence of obesity and visceral fat. Postural instability occurs with the development of peripheral neuropathy. All of these changes contribute to an elevated risk of falling[4,5]. Falls leading to serious injuries are more common in patients with diabetes and result in higher healthcare costs and longer hospital stays [6, 7].

Diabetic peripheral neuropathy patients tend to develop unsteadiness, and decreased sensation and proprioception, particularly in the lower extremities [8]. The damage caused by diabetes to the neuromuscular system results in losses in mobility and a decline in gait and balance parameters. Therefore, an increase in patients' risk of falling is inevitable[9]. In addition, the length of time since initial diagnosis of diabetes, the severity of peripheral neuropathy, the presence of foot deformity, body mass index (BMI), gender, claudication pain and peripheral arterial disease have a direct impact on the risk of falling [9,10]. According to the Standards Subcommittee of the American Neurology Academy, peripheral neuropathy falls on the B plane, while gait and balance impairment fall on the A plane regarding the risk of falling[11]. Most studies conducted on diabetic patients in Turkey have been done over the past five years and have been concerned with assessing the risk of falling in geriatric diabetic patients [12, 13]. However, there have been no studies on the relationship between the complications of diabetes and diabetic foot risk on the risk of falling. Understanding and acting on these risk factors could help to reduce the burden of falls in the population with diabetes.

The main aim of this study was to assessment of the fall risk in patients with diabetes. The secondary target

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included assessment to see the extent to which diabetic complications and diabetic foot might be contributing factors.

MATERIAL and METHODS

Design

This is a descriptive and cross-sectional study.

Sample and data collection

The study consisted of 300 diabetic patients from among the patients being monitored at a university hospital's Endocrinology and Diabetes Department between September-November 2019 who met the sampling criteria. The criteria for inclusion in the study were having had a diagnosis of diabetes for at least six months, having no diagnosis of psychiatric illness, and having no hearing or communication problems. The data were collected by the researcher through face-to-face interviews after having received the required institutional authorization. Medical information was obtained from patient files and recorded by the researcher.

Data Collection Instruments

Based on a literature review, the researcher chose three data collection instruments to use for the study[6-10]. These were the "Patient Information Form," the "Turkish-Morse Fall Scale" and the "Diabetes Foot Risk Assessment Tool." The Flamingo balance test was used to determine balance performance.

Patient Information Form: This form consists of two parts. Part one contains patient sociodemographic data and information on their diabetes and their diabetes control status. Part two comprises questions regarding falling (e.g., falling history, where and when falling occurred, way in which falling occurred, injury resulting from falling, measures taken to prevent falling).

Turkish-Morse Fall Scale (MFS): This scale was developed by Janice M. Morse in 1985 and revised in 2008. It is a short and easily usable scale having six components (fall history, secondary illness, walking assistance, IV treatment, gait, and mental status). The individual's risk of falling is determined according to the total points accumulated on the scale. Scores of 0–44 and 45 and above are assessed as "low/no risk of falling" and "high risk of falling," respectively. The fall risk numeric range on the MFS can range from 0 to 125 [14, 15]. The scale was adapted to Turkish society by Uymaz (2012), Cronbach's alpha was found to be 0.57.[16] In a study done by Bayram in 2017, the sensitivity of the Morse Fall Scale in patients with diabetic neuropathy was found to be high[17].

Diabetic Foot Risk Assessment Tool: Based on the findings of physical examination, risk assessment was done by using the "Best Practice Guideline Shaping the Future of Nursing; Reducing Foot Complications for People with Diabetes" prepared by Registered Nurses Association of Ontario (RNAO). The assessment criteria for this tool are "a history of foot ulcers, loss of protective sensation, structural or biomechanical disorders of the foot, circulation evaluation, and foot care information and behavior." It can be used for all diabetics 15 years of age and older[18].

Flamingo Balance Test: An examination of balance was performed with the use of the "Flamingo balance test." The subjects stood on a beam which was 50 cm long, 5 cm high and 3 cm wide. While balancing on the preferred leg, the free leg was flexed at the knee and the foot of this leg held close to the buttocks. Then the instructor started the stopwatch and the subjects tried to stand in this position for one minute. The stopwatch was stopped each time the subjects lost the balance. It was started again until they lost the balance again. When the time was over, the subjects' attempts after they fell were counted and this score was recorded [19]. The Balance Test used the following scoring system: No falling (5 points), 1-4 falls (4 points), 5-8 falls (3 points), 9-12 falls (2 points) and 15 or more falls (0 points).

Data analysis

The data obtained in this study were analyzed using Statistical Package for Social Sciences version 22.0 program. To analyze the data, numbers, percentage distributions, arithmetic mean, *t* test, one-way ANOVA and Pearson correlation were used. $P < 0.05$ was accepted as statistically significant in all analyses.

Ethical considerations

Hatay Mustafa Kemal University Ethical Committee approved this study (27.06.2019/12). Before the study began, all participants were informed of objectives and procedures of the study. Written informed consent was obtained from all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki. Participation in this study was voluntary.

RESULTS

This study assessing the risk of falling in diabetic patients included a total of 300 individuals. Table 1 contains the patients' sociodemographic profiles and information regarding their illness and falls. The mean age of the diabetics participating in the study was 59.7±16.5, with 58.7% of them being women, 72.7% married, 80.3% having primary school-level of literacy, and 44% of them living with their spouses. The mean length of time since having been diagnosed with the disease was 13.3±10.0 years. Most of the participants used insulin. The mean HbA1c level was 9.0±2.3%, demonstrating poor glycemic control. 18.3% of diabetics were at a high risk for developing diabetic foot (Table 1).

Table 1. Baseline and clinical characteristics of participants (n=300)

Variables	n	%	Variables	n	%
Gender			**Using walking aids**		
Female	176	58.7	Canes	54	18.0
Male	124	41.3	Walker	30	10.0
Marital status			Crutches	11	3.7
Married	218	72.7	No use	205	68.3
Single	82	27.4	**Fall**		
Education level			Yes	87	29.0
Primary school-Literacy	241	80.3	No	213	71.0
Secondary school	42	14.0	**Frequency fall***		
High school/University	17	5.7	One	38	43.7
Living status			Two ≥ 2 (recurrent fall)	49	56.3
Alone	42	14.0	**Location of the fall***		
Spouse	132	44.0	Street	31	35.6
Family	90	30.0	Home	46	52.9
Not close family	36	12.0	Hospital	10	11.5
Treatment type			**How it fell***		
Oral hypoglycemic drug	96	32.0	Stumble	25	28.7
Insulin	152	50.7	Slipping	26	29.9
Insulin, oral medications	52	17.3	Loss of balance	37	42.5
Diabetic foot risk			Dizziness	32	36.8
Low risk	245	81.7	Syncopal	14	16.1
High risk	55	18.3	Not sure	10	11.5
Morse fall risk			**Injury after fall***		
Low/no risk of falling(0-44)	107	35.7	No	34	39.1
High risk of falling (≥45)	193	64.3	Fractures	28	32.2
Walking aid			Bruising	23	26.4
No use	205	68.3	Muscle tear	2	2.3
Use	95	31.7			

	n	Mean±SD	min	max
Age (years)	300	59.7±16.5	16	105
Diabetes Duration (years)	300	13.3±10.0	1	67
HbA1c	176**	9.0±2.3	5.0	16.9
Flamingo Balance Test	300	1.6 ± 1.9	0	4
Morse Fall Risk Score	300	53.26 ± 26.20	0	125

SD = Standard deviation *n=87, patient with fell **n=176, patient with HbA1c

Of the subjects included in this study on falls in diabetic patients, 31.7% use a walking aid. The aids used include canes (18.0%), walkers (10.0%) and crutches (3.7%). According to the Morse Fall Scale, most of the patients were at high risk of falling (64.3%).The patients' mean score on the scale was 53.26±26.20. 29.0% (n=87) of the subjects had a history of falling within the previous year. Of these, 43.7% had fallen once, while 56.3% had fallen repeatedly. Of the patients who fell, 52.9% had fallen at home, 35.6% on the street, and 11.5% in the hospital. Most of the patients (42.5%) had fallen due to loss of balance, 36.8% due to dizziness, and 29.9% due to slipping. Fractures occurred in 32.2% and bruising in 26.4% of the cases where falling had occurred. Flamingo balance test scores of the patients were in the "poor" range (Table 1).

Diabetics that have fallen within the previous year (t=10.272, p<.001), use walking aids (t=10.332, p<.001), experience incontinence (t=4.729, p<.001), and take four or more medications each day (t=9.284, p<.001) have a higher fall risk than those that do not fall into these categories. The risk of falling also climbs with increased Body Mass Index. The same is true for diabetics that were also obese (F=3,429; p<.01) (Table 2). However, the study did not find a significant risk of falling in the case of patients with osteoarthritis (t=1.928, p>.05), different types of anti-diabetes treatments (F=2,672, p>.05), a history of hypoglycemia (t=1.689, p>.05) or an absence of peripheral pulses (Table 2, Table 3).

Table 3 compares the means of the risk of falling for patients having diabetic complications and diabetic foot risk. The study found that the mean risk of falling was greater in patients with retinopathy (t=5.438, p<.001), nephropathy (t=5.626, p<.001), neuropathy (t=3.181, p<.01), cerebrovascular disease (t=4.315, p<.001), and cardiovascular disease (t=5.327, p<.001) than in patients that do not fall into these categories (Table 3).

Comparing diabetic foot risk factors, patients with a high diabetic foot risk (t=-6.125, p<.001), reduced protective sensation (t=2.423, p<.01), amputations (t=3.932, p<.001), diabetic foot wounds (t=6.362, p<.001), a history of foot wounds (t=4.357, p<.001) and foot deformities (t=5.817; p<.001) have a higher risk of falling than those that do not fall into these categories (Table 3).

In addition, in diabetic patients, there was a modest positive relationship between risk of falling scores and age (r = .427, p<.001) and length of time since having been diagnosed with diabetes (r=.409, p<.001), and a weak positive relationship between these scores and weight (Table 4).

Table 2. A comparison of participant characteristics and mean scores on the Morse Fall Risk Scale (MFS) (n=300)

	n	MFS Mean score ±SD	Test statistics p value
Gender *			
Female	176	54.71±25.94	p >.05
Male	124	51.20±26.52	
≥ 4 Medication use *			
Yes	149	65.73±23.28	t=9,284
No	151	40.96±22.94	p<.001
Fall in the last year *			
Yes	87	74.19 ± 21.81	t=10,272
No	213	44.71 ± 23.11	p< .001
Walking aid use*			
Yes	95	73.00±20.33	t=10,332
No	205	44.12±23.45	p<.001
Osteoarthritis *			
Yes	22	60.90±19.06	p >.05
No	277	52.49±26.51	
Incontinence*			
Yes	76	65.13±24.73	t=4,729
No	224	49.24±25.50	p<.001
Body Mass Index (BMI) (kg/m^2)**			
Underweight	10	32.21±21.88	
Normal weight			
Overweight	72	49.93±25.22	F=3,429
Obesity			
	101	53.51±26.57	p< .01
	117	56.92±25.97	

SD = Standard deviation *Student t test,

**One-Way ANOVA

Table 3. A comparison of diabetes characteristics and mean scores on the Morse Fall Risk Scale(MFS) (n=300)

	n	MFS Mean scores±SD	Test statistics p value
Insulin use *			
Yes	204	55.83±28.07	t=2,773
No	96	47.81± 20.78	p < .01
Antidiabetic Drug using**			
OAD	96	48.22±21.12	
İnsulin	152	55.36±27.96	p >.05
Combine(insulin, OAD)	52	56.44±28.39	
Retinopathy *			
Yes	162	60.21±24.97	t=5,438
No	131	44.23±25.04	p< .001
Nephropathy *			
Yes	91	65.54±22.96	t=5,626
No	209	47.91±25.76	p<.001
Experience of hypoglycemia *			
Yes	203	54.87±25.15	p >.05
No	96	49.42±27.86	
Cerebrovascular disease *			
Yes	20	77.00±27.30	t=4,315
No	280	51.57±24.76	p< .001
Cardiovascular disease (CVD)*			
Yes	118	62.66±25.37	t=5,327
No	181	46.90±26.02	p< .001
Peripheric pulses			
Absent	22	59.31±32.34	p >.05
Present	278	52.78±25.66	
Diabetic foot risk *			
Low risk	245	49.12 ± 24.64	t=-6,125
High risk	55	71.72±25.11	p<0.001
Loss of protective sensation (using with 10g monofilament)*			
Yes			
No	209	55.90±23.65	t=2,423
	91	47.19±30.54	p< .01
Diabetic peripheral neuropathy (DPN) *			
Yes	187	56.95±24.46	t=3,181
No	113	47.16±27.90	p< .01
Amputation*			
Yes	20	75.00±22.00	t=3,932
No	280	51.71±25.81	p< .001
Diabetic foot wound *			
Yes	83	67.89±24.67	t=6,362
No	217	47.67±24.60	p< .001
Previous diabetic foot wound*			
Yes	97	62.52±24.67	t=4,357
No	203	48.84±25.80	p< .001
Foot Deformities *			
Yes	75	67.73±24.49	t=5,817
No	225	48.44±24.99	p< .001

SD = Standard deviation * Student t test, **One-Way ANOVA

Table 4. Relationship between the participants' risk of falling and their age, length of time since having been diagnosed with diabetes, and weight (n=300)

	Age (year)	Diabetes Duration	Weight
Fall Risk*	r = 0.427	r = 0.409	r = 0.159

* Pearson correlation

DISCUSSION

This study, which assessed the risk of falling in diabetic patients by using the Morse Fall Scale and the relationship between diabetic foot and this risk, found that the risk of falling in most of the diabetics was high. Falling is an undesirable situation having many causes. One of these involves the problems created by chronic illnesses[12, 20, 21]. Diabetic complications can result in disabilities that produce risk factors for falling[22]. Studies report that there is a relationship between diabetes and

the risk of falling and that falling is more prevalent in elderly diabetics[7, 22-24]. Our study found a moderately positive relationship between age and the risk of falling and that this increased with advancing age. However, there are also studies in the literature that have not found a relationship between age and the risk of falling [25].

Yau et al. (2013) reported that persons with poor glycemic control (HbA1c ≥8%) and long-term diabetes (≥16 years) tended to be hospitalized more due to falls more often and that they fell three times more often than persons who did not use insulin. This has been attributed to frequent fainting, poorer balance, reduced kidney function and multiple prescription drug use[7]. Another study, done in Scotland, found that serious injury due to falling in diabetic patients being treated with insulin was much higher than in the general population [26]. This study supports the conclusions of other studies in the literature that found that the risk of falling was higher in diabetics that used insulin, had diabetes-caused nephroplasia, and used four or more medications. Similarly, hypoglycemia is frequently seen in patients using insulin. Studies have shown that hypoglycemia is one of the major factors increasing the risk of falling[27,28]. Nevertheless, there are also ones that have found a weak relationship between hypoglycemia and falling[7]. Our study did not find a significantly meaningful difference between patients with and without hypoglycemia and the risk of falling. Despite this, the risk of falling was high in both groups. Kukidome et al. (2017) reported that patients with a history of falling had diabetes for longer periods of time [25]. This can be attributed to the emergence of complications the longer a person has had diabetes. Our study found a moderately positive relationship between the length of time a person had had diabetes and the risk of falling.

The complications of diabetes mellitus include diabetic peripheral neuropathy (DPN) and retinopathy, both of which can lead to balance impairments. Studies have shown that other important risk factors for falling include impaired vision and peripheral neuropathy [22, 25, 29]. Diabetic peripheral neuropathy (DPN) is the most frequently seen complication in diabetics, affecting approximately half of this population. DPN impairs vibratory sensitivity, proprioception and reflexes, as well as causes osteotendinous, all of which result in compromised sensory and motor skills[30]. A systemic review done in 2016 supported the hypothesis that the diabetic peripheral neuropathy had an impact on foot biomechanics[31]. The damage in the neuromuscular system produced by diabetes causes impaired mobility, walking and balance. Therefore, an increase in patients' risk of falling is inevitable[9, 22, 32-34]. Studies have shown that compared to healthy adults, persons with DPN have 23 times the risk of falling, and 15 times the risk of injury[30]. This study similarly found that persons with diabetic neuropathy, reduced protective sensation in the foot, and foot deformities, present or past foot ulcers, or amputations had a high risk of falling ($p<.001$). In addition, the study assessed the patient's risk of diabetic foot using the RNAO guide and compared their risk of falling. It found that patients at high risk for diabetic foot were also at a high risk for falling. The subjects also received poor balance scores on the Flamingo balance test used in the study. Those needing walking assistance were also at an increased risk of falling ($p<.001$). Studies have shown that there are certain parameters that have a direct impact on walking in diabetes [9]. For example, the length of time an individual has had diabetes and the presence of foot deformity play important roles in walking impairment. BMI, gender and peripheral arterial disease are also factors having an impact on such disability[10]. Studies have shown that elderly women are more like to seek hospital treatment after a fall than elderly men[35]. Osteoporosis, which is seen more frequently in women, is a major reason for this[36]. The current study did not find differences on the basis of gender, osteoarthritis, or the absence of peripheral pulse. Obesity, however, is one of the factors contributing to the risk of falling[28]. Kukidomeda (2017)[25] and Chiba et al. (2015)[28] found no significantly meaningful relationship between the risk of falling and BMI. The current study determined that the risk of falling was higher in patients with high BMI. It found a weak positive relationship between weight and risk of falling scores ($r=.159$; $P< .01$). In addition, studies have shown patients with a history of prior falls in the previous 12 months[37] and cardiovascular diseases[28] have a higher risk of falling [6, 7, 38]. The current research support these findings.

This study found that the risk of falling was high in diabetic patients, the complications of diabetes increased the risk of falling, and patients with a risk of developing diabetic foot also had a high risk of falling. Given the research findings, in order to reduce fall-related mortality in diabetics and improve their quality of life, it is recommended that the factors contributing to falls in these patients be determined early and measures be taken to prevent them; complications be delayed

by achieving metabolic control, foot health be improved, and strength and balance exercises be performed.

Conflicts of Interest

The authors declare that they have no conflict of interests.

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