Original Article

The Association between Fear of Falling and Functional Tests in Older Adults with Diabetes Mellitus

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ABSTRACT

Background: The number of older adults with diabetes mellitus (DM) is increasing. Falling during walking and the fear of it are prevalent in older adults with DM. **Objective:** This study aimed to examine the association between fear of falling (FoF) and functional tests in older adults with DM and to determine other factors affecting functional tests in these people. **Methods:** A cross-sectional study was conducted on 134 older adults with DM who had referred to the diabetes clinic of Matini Hospital in Kashan, Iran. The participants were selected through sequential sampling and then were categorized into two groups of "with" and "without FoF." In addition to responding to a demographic questionnaire, the participants were assessed by the Mini-Mental State Examination, Diabetic Neuropathy Symptom Score, and Falls Efficacy Scale-International version. Walking performance of the participants was also measured using the Timed Up-and-Go, 5-Sit-to-Stand, and 50-Foot Timed Walk tests. Data were analyzed using the Chi-square, *t-*, and Mann–Whitney U-tests and linear regressions analysis. **Results:** Significant associations were found between FoF and education level, body mass index, waist-to-hip ratio, and having neuropathy ($P < 0.05$). In addition to FoF, a number of demographic, anthropometric, and clinical variables affected the patients' performance in all functional tests; however, gender was the variable that affected the results of all three tests ($P < 0.05$). **Conclusion:** FoF is associated with the performance of older adults with DM in functional tests. Thus, the FoF should be assessed in older adults with DM in order to provide better health care for them.

KEYWORDS: *Diabetes mellitus, Fear, Geriatric assessment*

INTRODUCTION

Falling is one of the most important concerns of older adults. One-third of people over the age of 65 experience falling at least once a year.[1] Falling is the fifth cause of death[2] and the main cause of disability and dependence in older adults. It induces them a fear of falling (FoF) and decreases their self-esteem.[3]

Excessive FoF can decrease people's physical activities, balance, and social participation.[4,5] Concern about falling may restrict older adults' physical activity, decrease their confidence, and predict subsequent falls.[6] Health-care providers face challenges in identifying older adults who are at risk of falling during walking and providing effective interventions to reduce that risk.[7] However, it is possible to identify these people using some physical performance assessment tests such as Timed Up-and-Go (TUG), and 5-Sit-to-Stand (5-STS).[1] These tests can evaluate the people's balance, mobility, and muscle strength and predict if they are at risk of falling.[8]

FoF can affect older adults' performance in function tests.[9] FoF is associated with weaker performance in

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TUG[9,10] and handgrip tests.[10] Furthermore, 5-STS[1] and Narrow Path Walking Test[7] can identify older adults who are at risk of falling while walking, particularly those with chronic diseases, who are increasingly prone to falling.

Diabetes mellitus (DM) is a common chronic disorder.[11,12] Its prevalence is predicted to be 10.4% in 2040 compared to 8.8% in 2015.[13] A study reported that the prevalence of falls in older adults with diabetes was twice that of nondiabetics, and hypoglycemia was a risk factor for falling among these patients.[14] Older adults with DM also have poorer performance in functional tests such as TUG[15] and are more likely to experience falling during walking.[16] Motor and balance disorders,[15] taking more drugs, reduced cognitive functioning,[17] obesity, depression, and other diabetes-related problems can also reduce physical performance and increase the risk of falling in older adults with DM.[15,17]

Psychological and emotional factors can affect the consequences of DM.[18] Evidence shows that FoF is common in older adults with DM, reduces their physical functions, causes serious problems with their mobility and balance, and increases their chance of falling.[15] A study also found that FoF was inversely correlated with walking speed and step length in older adults with DM.[5] Perhaps, diabetic neuropathy impairs the walking performance of patients[19] which, in turn, leads to a higher number of falls. However, a study reported that although neuropathy and numbness impair the walking performance, they are not necessarily accompanied by a greater FoF in older adults.[7] In other words, neuropathy might not be considered as a risk factor for FOF.

In the last two decades, a dramatic change has been occurred in the number of older people in Iran, which has increased from 7.22% in 2006 to 8.20% in 2011,[20] and this rate will exceed 20% by 2020.[21] Furthermore, diabetes has the fastest growth rate among older adults in Iran.[22] With regard to the rising rate of DM among this population, and the growing rates of falling and FoF among older adults with DM,[14,15] and given the controversies about the association between DM and FoF, more studies are needed to investigate the relationship between FoF and performance in functional tests in older adults with DM.

Objectives

This study aimed to examine the association between FoF and performance in functional tests in older adults with DM and to determine other factors influencing functional tests in these people.

Methods

Study design and participants

This cross-sectional study was conducted in 2018, on older adults with DM, who had referred to the diabetes clinic of Matini Hospital in Kashan, Iran, for outpatient health-care checking. About 60% of the clients who refer to this center are older adults with DM, and all of them are registered in the SIB health record system which is the comprehensive electronic health record system of Iran's Ministry of Health and Medical Education. The sample size was calculated based on a former study in which the average duration of the 5-STS test was 15.9 ± 5 s in people with FoF.[23] With an alpha of 5%, and a measurement error (i.e. d) of 0.9 s, the needed sample size was estimated at 119. However, we increased the required sample size to 134 to attain more reliable results.

The inclusion criteria were as follows: being at least 60 years old, having a diagnosis of type II DM for at least 6 months, obtaining a score of 22 or higher on the Mini-Mental State Examination (MMSE),[24] being treated with at least one antidiabetes medication, lack of any dependence on other family members for daily activities, ability to walk without help, and the ability to read and write in Persian. Referring to the diabetes clinic of Matini Hospital, we recruited the participants through a sequential sampling method.

Measurements

1. Questionnaires
   a. A demographic, clinical, and anthropometric questionnaire was used which included questions on the participants' age, sex, education level, marital status, history of falling in the past year, neuropathy (yes/no), duration of DM, the latest fasting blood sugar (FBS), the latest HbA1c, weight (kg), height (m), waist circumference (cm), hip circumference (cm), waist-to-hip ratio (WHR), and body mass index (BMI) (kg/m^2)
   b. The MMSE was used to identify older adults with cognitive impairments. It is a 30-point questionnaire in which a score of 22 is considered a cutoff point to screen for people with cognitive problems. The questionnaire has 10 points for orientation, 6 points for memory, 5 points for attention and calculation, 8 points for language, and 1 point for visuospatial abilities.[24,25] The validity and reliability of this questionnaire were measured by Seyedian *et al*. in Iran in 2007.[26] In this study, the MMSE was pilot tested with 20 older diabetic patients and

its reliability was demonstrated by Cronbach's alpha of 0.86

c. Diabetic Neuropathy Symptom Score was used to identify older people with neuropathy. This scale consists of four yes/no items for measuring neuropathic pain, paresthesia, numbness, and unsteadiness in walking. Items are scored from 0 to 4. A total score of 0 indicates no neuropathy and a score of ≥1 indicates neuropathy. Validity and reliability (r = 0.64) of this scale have been confirmed and also showed high sensitivity (79%) and specificity (78%).[27] In the present study, this scale was pilot tested in 20 older adults with diabetes and its Cronbach's alpha was 0.89. The content validity of the scales was also confirmed by 10 nursing faculty members

d. Falls Efficacy Scale-International (FES-I) version was used to measure FoF in performing 16 activities of daily living. This scale has 16 items about "how concerned individuals are about the possibility of falling." All items are scored on a four-point Likert scale ranging from 1 "not at all" to 4 "very concerned." The total score ranges from 16 to 64, and lower scores indicate less FoF. Its cutoff point is 23. Then, people with a score <23 or ≥23 were categorized in two groups of without and with FoF.[28] Khajavi assessed the reliability and validity of the FES-I in a sample of Iranian older adults and reported its Cronbach's alpha and test–retest reliability coefficient as 0.89 and 0.7, respectively.[29] In the present study, the FES-I was pilot tested with 20 older adults with DM and its Cronbach's alpha was 0.86.

2. Functional tests

TUG, 5-STS, and 50-Foot Timed Walk (50-FTW) tests were used to evaluate the physical function of the participants.

1. The TUG test measures the time that a person takes to rise from a standard chair, walk 3 m, turnaround, walk back to the chair, and sit down. It is a valid and reliable test[23] with high specificity (87%) and sensitivity (87%) for prediction of falling in older adults.[30] In the present study, the reliability of this test was confirmed by a correlation coefficient of 0.90
2. The 5-STS test was used to measure the time taken to stand up from a standard chair (i.e. 46 cm height, with a backrest, and without handles) and return to sitting position 5 times. The 5-STS test is a valid and reliable test for quantifying the functional lower extremity strength.[23,31] The reliability of this test has been confirmed by a correlation coefficient of 0.89.[32,33] In this study, the reliability of the 5-STS test was demonstrated by a correlation coefficient of 0.87
3. In the 50-FTW test, the time required for the participants to walk for 50 steps was calculated (i.e. 25 steps forward and 25 steps back). The validity of this test was confirmed in previous studies.[34] In this study, the reliability of this test was demonstrated by a correlation coefficient of 0.86.

Data collection

Data gathering was done by the first researcher (S.J.A.) from June to August 2018. First, MMSE was used to assess the patients' cognitive status. The questionnaire was filled out by the patients. Patients who obtained scores higher than 22 were then completed the demographic and clinical questionnaire. Next, the researcher measured the patients' anthropometric indices and neuropathy and recorded them on the datasheet. Then, eligible patients entered the study and answered to the FES-I questionnaire. Those obtained scores lower than 23 and those with scores equal or above 23 were assigned in "without fear" (n = 65) and "with fear" (n = 69) groups, respectively.[23] Afterward, the three functional tests (i.e. TUG, 5-STS, and 50-FTW) were measured for the two groups. All functional tests were repeated three times for each patient, and the best results were taken into consideration.[7] For safety preservation, all tests were done while the researcher walked near participants to protect them in case of imbalance.

Ethical considerations

We obtained ethical approval from the Research Ethics Committee of Kashan University of Medical Sciences (Code of Ethics: IR.KAUMS.NUHEPM.REC.1396.17). Official permission was also obtained from the University Vice Chancellor for Research in order to conduct the study and to refer to the diabetic clinic of Matini Hospital in Kashan. The researchers informed all older adults who attended the clinic about the purpose and design of the study, and they were invited to take part in the study. The participants were assured that all information about them would remain strictly confidential. Participation in the study was voluntary, and written informed consent was obtained from all of the participants.

Data analysis

Data analysis was performed using the SPSS software version 16 (IBM corporation, Armonk, New York, United States). Frequency and percentage were calculated for nominal and categorical variables and mean, median, and standard deviation for numerical

Table 1: Distribution of fear of falling and the results of functional tests in older adults based on their demographic, clinical, and anthropometric variables

Variable		Fear of Falling		*P*	TUG, (Mean±SD)	*P*	5-STS, (Mean±SD)	*P*	50- FTW, (Mean±SD)	*P*
		Yes, *n* (%)	No, *n* (%)							
Gender										
	Male	36 (45)	44 (55)	0.07[a]	9.30 ± 2.74	<0.001[c]	14.01 ± 4.23	<0.001[c]	11.68 ± 3.86	<0.001[c]
	Female	33 (61.1)	21 (38.9)		10.88 ± 2.46		16.98 ± 4.36		14.0 ± 3.6	
Education										
	Primary and elementary	61 (59.8)	41 (40.2)	<0.001[a]	10.36 ± 2.57	<0.001[c]	15.75 ± 4.31	0.008[c]	12.97 ± 3.85	0.055[c]
	High school and above	8 (25)	24 (75)		8.60 ± 2.84		13.39 ± 4.73		11.45 ± 3.97	
Marital status										
	Married	65 (50)	65 (50)	0.12[a]	9.84 ± 2.64	0.018[c]	14.99 ± 4.17	<0.001[c]	12.51 ± 3.89	0.093[c]
	Single/ Widowed	4 (100)	0		13.11 ± 4.19		22.24 ± 9.30		15.85 ± 3.57	
History of Falling										
	No	46 (46.5)	53 (53.5)	0.05[a]	10.40 ± 2.95	0.25[c]	15.49 ± 5.02	0.66[c]	13.07 ± 3.80	0.41[c]
	Yes	23 (65.7)	12 (34.3)		9.77 ± 2.65		15.11 ± 4.33		12.45 ± 3.96	
Neuropathy										
	Yes	59 (62.1)	36 (37.9)	<0.001[a]	10.37 ± 2.77	0.004[c]	16.10 ± 4.41	<0.001[c]	13.23 ± 3.78	0.004[c]
	No	10 (25.6)	29 (74.4)		8.88 ± 2.37		13.04 ± 4.02		11.10 ± 3.88	
Age (year), Median (P5-P95)[e]		66 (60-75)	63 (60-77)	0.13[b]	*r*=0.46	0.21[d]	*r*=-0.048	0.58[d]	*r*=0.10	0.21[d]
Duration of Diabetes (year)		12 (2.5-32.5)	12 (1.3-31.4)	0.93[b]	*r*=0.13	0.10[d]	*r*=-0.12	0.15[d]	*r*=0.15	0.07[d]
Median (P5-P95)										
FBS (mg/dl), Median (P5-P95)		158 (97.5-323)	158 (91.93-300)	0.74[b]	*r*=-0.021	0.81[d]	*r*=0.051	0.55[d]	*r*=-0.006	0.94[d]
HbA1c (%), Median (P5-P95)		7.78 (5.8-10.9)	7.6 (5.13-11)	0.66[b]	*r*=-0.006	0.94[d]	*r*=0.01	0.85[d]	*r*=0.002	0.98[d]
BMI (kg/m^2), Mean±SD		30.78 ± 5.0	28.0 ±3.80	<0.001[c]	*r*=-0.29	0.001[f]	*r*=0.25	0.003[f]	*r*=0.26	<0.002[f]
WHR, Mean±SD		0.87 ± 0.06	0.85 ± 0.05	0.04[c]	*r*=-0.039	0.65[f]	*r*=0.25	0.003[f]	*r*=0.09	0.28[f]

[a]Chi-square test, [b]Mann–Whitney test, [c]*t*-test, [d]Spearman test, [e]Percentile, [f]Pearson test. FBS: Fasting blood sugar, HbA1c: Hemoglobin A1c, BMI: Body mass index, WHR: Waist-to-hip ratio, SD: Standard deviation

ones. The Kolmogorov–Smirnov test was carried out to examine the normal distribution of the numerical variables. The Chi-square test was used to assess the association between nominal and categorical variables with FoF. Furthermore, independent-samples *t*- or Mann–Whitney U-tests were, respectively, used to examine the between-group differences of quantitative variables with and without normal distribution. Mann–Whitney U- and *t*-tests were also used to examine the difference between the mean scores of functional tests in the two groups. Linear regressions analysis was used to estimate the simultaneous effect of demographic, anthropometric, and clinical variables and FoF on functional tests. First, the enter method was used for each functional test. All variables that in univariate relationship with functional tests had $P < 0.25$ were entered into the linear regression model. In the next step, the backward method of regression was used for development of the model. $P < 0.05$ was considered statistically significant.

Results

More than half of the participants were men (59.7%), and their age range was between 60 and 90 years. A majority of the participants had primary or elementary education (76.1%) and were married (97%). Nearly three-quarters of the participants had no history of falling (73.9%) and neuropathy (70.8%). Most of the patients have had diabetes for 12 years. The mean BMI and WHR of the patients were 29.44 ± 4.66 and 0.86 ± 0.054, respectively.

FoF was more prevalent in older adults with neuropathy ($P < 0.001$) and lower education ($P < 0.001$). Moreover, the mean BMI ($P < 0.001$) and WHR ($P =$

Table 2: Comparison of the functional tests between the groups with and without fear of falling

Variable	Fear of falling		Total	*P*
	Yes	No		
TUG (s), mean ± SD	11 ± 2.62	8.81 ± 2.39	9.94 ± 2.73	<0.001[a]
5-STS (s), mean ± SD	16.75 ± 4.96	13.57 ± 3.29	15.21 ± 4.51	<0.001[a]
50-FTW (s), median (P_5-P_{95})	13.56 (8.76-21.82)	10.45 (7.45-19.91)	12.15 (7.74-21.18)	<0.001[b]

[a]*t*-test, [b]Mann–Whitney U-test. TUG: Timed Up-and-Go, 5-STS: 5-Sit-to-Stand, 50-FTW: 50-Foot Timed Walk, SD: Standard deviation

Table 3: Results of linear regression model for Timed Up-and-Go, 5-Sit-to-Stand, and 50-Foot Timed Walk as dependent variables in terms of demographic, anthropometric, and clinical variables

Functional test/predictors	Unstandardized rate		Standardized rate β	*T*	Significant	95% CI for *B*	
	SE	*B*				Upper bound	Lower bound
TUG[a]							
Constant	3.070	−2.081		−0.678	0.492	3.994	−8.158
Age	0.039	0.101	0.201	2.603	0.010	0.178	0.024
Sex	0.444	1.222	0.220	2.752	0.007	2.101	0.344
BMI	0.048	0.097	0.164	1.996	0.048	0.192	0.001
Fear of falling	0.436	1.644	0.301	3.767	0.000	2.508	0.781
5-STS[b]							
Constant	2.374	14.969		6.305	0.000	19.667	10.272
Sex	0.703	2.194	0.239	3.118	0.002	3.586	0.802
Neuropathy	0.792	2.035	0.206	2.570	0.011	3.601	0.468
Marriage	2.028	−5.420	−0.205	−2.673	0.008	−1.408	−9.431
Fear of falling	0.732	1.906	0.212	2.604	0.010	3.354	0.458
50-FTW[c]							
Constant	2.103	4.297		2.043	0.043	8.457	0.136
Sex	0.650	1.652	0.208	2.544	0.012	2.937	0.367
Diabetes duration	0.034	0.088	0.206	2.631	0.010	0.155	0.022
BMI	0.071	0.130	0.154	1.813	0.072	0.271	−0.012
Fear of falling	0.638	1.960	0.251	3.072	0.003	3.222	0.697

[a]Male, and without fear were considered as basic groups, [b]Male, without neuropathy, single, and without fear were considered as basic groups, [c]Male, and without fear were considered as basic groups. CI: Confidence interval, BMI: Body mass index, TUG: Timed Up-and-Go, 5-STS: 5-Sit-to-Stand, 50-FTW: 50-Foot Timed Walk, SE: Standard error

0.04) were significantly greater in older adults with FoF. However, no significant differences were found between the patients with and without FoF in terms of gender, marital status, history of falling, age, duration of DM, FBS, and HbA1c ($P > 0.05$) [Table 1].

Older adults with FoF performed the TUG, 5-STS, and 50-FTW tests in a longer time than those without FoF ($P < 0.001$) [Table 2].

The regression model demonstrated that variables such as age, sex, and BMI, along with FoF, influence the mean time of the TUG test. It means that those with FoF performed the TUG test in 1.64 s, on average, longer than those without FoF. Similarly, for the 5-STS test, variables such as gender, neuropathy, and marital status, along with FoF, significantly affected the duration of this test. Those with FoF did the 5-STS test in 1.91 s, on average, longer than those without FOF. Results also showed that gender, duration of DM, and FoF could significantly influence the time of doing the 50-FTW test. However, BMI had a borderline effect on the time of doing this test. Accordingly, the time of doing the 50-FTW test was, on average, 1.96 s longer for those with the FoF [Table 3].

Discussion

More than half of the older adults in this study had FoF. Although FoF is prevalent among healthy older adults,[35] some studies reported that falling while walking and FoF are more prevalent in older adults with DM.[15,16] The increased prevalence of FoF in DM might probably be attributable to the impairments in their balance and mobility and other diabetes-related complications such as poor vision and sensory perceptions.[15,17]

Findings also indicated that diabetic patients without FoF had a better performance in the TUG test than those with FoF. A number of earlier studies have also reported that older adults with FoF spent more time on the TUG test than those without FoF.[9,10] A study on older adults with DM also showed that both the groups of with and

without FoF demonstrated a weak performance in the TUG test.[23] Another study also reported that in addition to FoF, variables such as advanced age, female gender, and high BMI can negatively affect the outcome of the TUG test in older adults with DM.[36] Evidence showed that the TUG test is a good predictor for successive falls even if confounding factors such as age and gender are eliminated.[37] It has also been shown that FoF is significantly correlated with BMI and the TUG test time, which is consistent with the results of the present study.[10]

This study showed that older adults with FoF did the 5-STS test in a longer time than those without FoF. The 5-STS test is a valid test for measuring the strength of the lower limbs and for predicting recurrent falls in healthy community-dwelling older adults.[38] The optimal time for performing the 5-STS test is 10 s for young people and 14.2 s for older adults. Spending more time on this test may suggest an imbalance.[39] However, in the present study, older adults with FoF did the test in 16.75 s that is longer than the proposed limit. It can be concluded that the dynamic balance has been impaired in this group of the participants and puts them at risk of falling. Older adults with DM seem to be at high risk of imbalance, gait impairment, and falling while walking due to the diabetes-related complications such as neuropathy, peripheral arterial disease, vision loss, and fluctuations in blood sugar.[15]

The current study also showed that older adults with FoF did the 50-FTW test slower than their counterparts without FoF. It appears that FoF not only affects the balance of older adults but also significantly reduces their gate speed[40] and consequently diminishes their physical and social functions.[41] The decrease in the walking speed might be attributed to aging, defects in the integrated functioning of organic systems such as the central nervous system, sensory system, peripheral nervous system, muscles, bones and joints, and the production or delivery of energy.

Given the results of the 50-FTW test, and if every step length is considered to be about 30 cm, older adults with FoF walked a distance of 1500 cm in 13.56 s (i.e. a walking speed of 110.6 cm/s). Therefore, the walking speed in the patients with FoF was slower by about 20% compared to those without FoF (143.5 cm/s). An earlier study measured the walking speed of older adults with and without FoF on an average of 108.2 cm/s and 120.1 cm/s, respectively,[23] which are consistent with the results of this study. In another study, decreases of 4.15 cm/s and 10.38 cm/s were, respectively, considered as small and substantial changes in gait speed.[42] Thus, the difference in walking speed between the groups "with" and "without FoF" in the present study (i.e. 143.5–110.6 = 32.9 cm/s) can be considered significant. Since slow walking is a sign of disability and cognitive impairment and also is a risk factor for staying at home and falling, this finding must be taken into serious consideration.

According to the regression models, in addition to FoF, other variables also affected the patients' performance in functional tests; however, gender was the variable that affected the results of all three tests.

This study examined the effects of a number of variables on the FoF in adults with DM. However, the effect of the type of neuropathy (either with pain or numbness) has not been considered, which can be regarded as a limitation and can be investigated in future studies.

Conclusion

We found significant associations between FoF and variables such as education level, neuropathy, BMI, and WHR, whereas other demographic, anthropometric, and clinical variables had no significant association with FoF. The findings also showed that FoF is strongly associated with the performance of older adults with DM in functional tests. Older adults with FoF, especially females, did the TUG, 5-STS, and 50-FTW tests over a longer timescale than those without FoF. This indicated that psychological factors such as FoF can lead to weakness in lower limbs and poor dynamic balance.

It is highly recommended that nurses and other health-care providers become familiar with the various factors associated with falls and take the FoF into serious consideration as one of the factors which causes weak performance in older adults and especially in those with DM. Health-care providers, especially nurses, need to employ methods to reduce FoF and prevent its consequences.

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Conflicts of interest

There are no conflicts of interest.

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