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Original Paper

Fall Risk and Its Determinants in Community-Dwelling Older Adults with Type 2 Diabetes: A Cross-Sectional Study

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Abstract

Objective: *To quantify fall risk among community-dwelling older adults with type 2 diabetes and to identify its associated factors.*

Methods: *A cross-sectional study was conducted among 370 older adults with type 2 diabetes recruited from a community health service center in Shenzhen, China, from January to August 2024. Data were collected using standardized instruments, including the Fall-Risk Self-Assessment Questionnaire (FRQ), the Berg Balance Scale (BBS), the Generalized Anxiety Disorder Scale (GAD-7), and the Geriatric Depression Scale (GDS-15). Multivariable linear regression was performed to identify independent predictors.*

Results: *Overall, 43.2% of participants were classified as being at risk of falling. Fall risk scores differed significantly across demographic, clinical, and psychological variables. Multivariable analysis identified age (β=0.177), visual status (β=0.149), hypoglycemia in the past year (β=0.124), falls in the past year (β=0.287), anxiety (β=0.163), depression (β=0.119), and balance ability (β=−0.389) as independent predictors (all $P < 0.05$). Balance ability showed a moderate negative correlation with fall risk ($r = -0.592$, $P < 0.001$).*

Conclusion: *Fall risk is highly prevalent among older adults with type 2 diabetes in community settings. Both physiological and psychological factors contribute to this risk, highlighting the need for a multidimensional assessment and targeted interventions.*

Keywords

type 2 diabetes, older adults, falls, community, risk factors

1. Introduction

The prevalence of diabetes continues to rise globally. According to the data of the International Diabetes Federation (IDF), by 2021, there are about 537 million adults aged between 20 and 79 in the world with diabetes, of which China accounts for about 141 million cases, ranking first in the world [1]. The huge number of patients has brought huge and continuous challenges to the management of diabetes-related complications. Microvascular complications, such as diabetic nephropathy, peripheral neuropathy, and retinopathy, may impair visual, motor, sensory, and balance functions [2]. These dysfunctions significantly increase the risk of falls in diabetic patients. Previous studies have shown that elderly people with diabetes are about three times more likely to fall than those without diabetes [3]. In addition, studies have shown that more than half of the elderly living in the community have a misunderstanding of the risk of falling [4]. This kind of misunderstanding may lead to two situations: one is to lead to risk behaviors beyond the scope of physical endurance, and the other is to excessively limit physical activity. Both of these conditions may eventually increase the risk of falls [5].

As a chronic disease, diabetes is mainly managed in the community and family environment. Therefore, fall prevention measures for elderly people with diabetes should be included in routine community-based health management. The purpose of this study is to evaluate the current status of fall risk in community-dwelling patients with type 2 diabetes, and to explore its influencing factors, so as to provide a basis for early identification and targeted intervention.

2. Methods

2.1 Study Design and Participants

This cross-sectional study was conducted at a community health service center in Bao 'an District, Shenzhen City, China from January to August 2024. A total of 370 elderly people with type 2 diabetes were recruited using a convenient sampling method. The inclusion criteria are as follows: (1) Type 2 diabetes was diagnosed according to the " Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes in the Elderly " (2022). [6] Exclusion criteria include: (1) diagnosed with mental disorders or dementia ; and (2) diseases that affect balance assessment, such as Parkinson 's disease or stroke sequelae. The sample size was estimated to be 27.5% based on the previously reported prevalence of fall risk among community-dwelling elderly. [7] Using the standard formula for cross-sectional studies, the minimum sample size required was calculated to be 307. Taking into account the non-response rate of 10%, the final sample size required is 341. Finally, a total of 370 valid questionnaires were included.

2.2 Data Collection Instruments

Data were collected using standardized questionnaires and scales: Sociodemographic variables: gender, age, body mass index (BMI), educational level, marital status, living arrangement, and monthly income. Clinical variables: duration of diabetes, glycated hemoglobin (HbA1c; cutoff of 6.5% [6]), number of medications (cutoff ≥5 [8]), number of comorbidities (cutoff ≥2 [9]), visual status, hearing, hypoglycemia in the past year, and fall history in the past year.

The Fall-Risk Self-Assessment Questionnaire (FRQ) [7] was used to assess fall risk. The scale consists of 12 items with a total score of 14. Score ≥ 4 indicates that there is a risk of falling. The Berg Balance Scale (BBS) [10] [11] was used to assess static and dynamic balance (scoring range: 0-56). According to the previous classification criteria, the scores were divided into three levels: poor (0-20), moderate (21-40), and good (41-56). [12] The degree of anxiety was assessed using the Generalized Anxiety Disorder-7 Scale (GAD-7) [13] [14]. Score ≥ 5 indicates the presence of anxiety symptoms. Depression was assessed using the 15-item Geriatric Depression Scale (GDS-15) [15] [16] [17] Score ≥ 9 indicates the presence of depressive symptoms.

2.3 Data Collection Procedure

After obtaining the approval of the community health service center, a face-to-face survey was conducted using a standardized procedure. Participants fill out the questionnaire on their own if conditions permit ; for people with limited literacy or physical ability, trained investigators provide assistance through structured interviews. A total of 370 questionnaires were distributed, all of which were effectively recovered, and the response rate was 100%.

2.4 Statistical Analysis

The data were analyzed using SPSS version 26.0. Categorical variables are expressed as frequencies and percentages. Continuous variables were described as mean ± standard deviation or median (interquartile range) according to data distribution. Differences between groups were evaluated by Mann-Whitney U test or Kruskal-Wallis H test. Spearman correlation analysis was used to evaluate the association between balance ability and fall risk. Variables with statistical significance in univariate analysis were included in the multivariate linear regression model to identify independent predictors. $P < 0.05$ was considered statistically significant.

3. Results

3.1 Participant Characteristics

A total of 370 participants were included, with a mean age of 69.0 ± 5.0 years (range: 60–87 years). Among them, 46.8% were male and 53.2% were female. Most participants had an education level of middle school or below (92.5%). The median duration of diabetes was 7.0 years (IQR: 3.0–12.0). The mean HbA1c level was 7.2 ± 1.6%. The median number of medications was 3, and most participants (81.9%) used fewer than five medications. A total of 66.8% of participants had two or more comorbidities.

3.2 Prevalence of Fall Risk

The median FRQ score was 2.0 (IQR: 1.0–5.0; range: 0–12). Overall, 43.2% (160/370) of participants were classified as being at risk of falling.

3.3 Univariate Analysis

Fall risk scores differed significantly across multiple variables, including gender, age, educational level, marital status, monthly income, visual status, hypoglycemia in the past year, fall history in the past year,

anxiety, and depression (P < 0.05). No statistically significant differences were observed for BMI, diabetes duration, HbA1c level, number of medications, or number of comorbidities (P > 0.05). Detailed results are presented in Table 1.

Table 1. Comparison of Differences in Fall Risk Scores among Elderly Patients with Type 2 Diabetes across Different Groups (*n*=370)

Variable	Group	Frequency (*n*)	Score $M(P_{25},P_{75})$	Median Rank	*Z/H*	*P*
Gender	Male	173	3(1,4)	169.09	-2.792	0.005
	Female	197	3(2,5)	199.91		
Age (Years)	60~69	229	2(1,4)	153.38	60.992	<0.001
	70~79	126	4(3,5)	230.25		
	≥80	15	5(5,6)	299.90		
BMI ($kg/m^{2)}$	<18.5	4	6(5,7)	277.00	6.635	0.084
	18.5~23.9	177	3(1,5)	186.93		
	24~27.9	140	3(1,4)	173.77		
	≥28	49	4(2,5)	206.39		
Educational Level	Illiterate or semi-literate	31	4(3,6)	241.98	11.440	0.010
	Elementary school	121	3(1,5)	187.87		
	Middle school/ Vocational high school	190	3(1,5)	178.73		
	College/University	28	2(1,4)	158.68		
Marital Status	Married	307	3(1,4)	172.51	33.388	<0.001
	Divorced	11	3(2,4)	176.05		
	Widowed	52	5(3,6)	264.20		
Living Arrangement	Living alone	11	2(1,6)	181.36	7.571	0.056
	Living with spouse and children	241	3(1,4)	177.07		
	Living only with spouse	37	3(1,5)	179.08		
	Living only with children	81	4(2,5)	214.08		
Monthly Income	Less than 1000	58	4(3,5)	214.10	16.752	0.001
	1001-3000	117	3(2,5)	194.27		
	3001-5000	95	3(2,5)	194.33		
	More than 5000	100	2(1,4)	150.26		
Duration of Diabetes (Years)	≤5	144	3(1.5,5)	180.38	4.784	0.091

	5～10	117	3(1,5)	174.77		
	＞10	109	4(2,5)	203.79		
HbA1c (%)	<6.5	120	3(1,5)	183.14	-0.464	0.643
	≥6.5	259	3(1,5)	186.63		
Number of Medications	<5	303	3(1,5)	185.36	-0.054	0.957
	≥5	67	3(1,5)	186.13		
Number of Comorbidities	<2	123	3(1,5)	176.75	-1.121	0.262
	≥2	247	3(1,5)	189.86		
Visual Status	Clear vision	180	2(1,4)	154.32	-5.509	<0.001
	Blurred vision	190	4(2,5)	215.04		
Hypoglycemia in the Past Year	Yes	140	4(2.5,5)	226.93	-5.868	<0.001
	No	230	3(1,4)	160.28		
Falls in the Past Year	Yes	49	6(4,6)	288.70	-7.320	<0.001
	No	321	3(1,4)	169.75		
Anxiety	No anxiety	318	3(1,4)	174.35	-5.005	<0.001
	Anxiety	52	5(3.5,5.5)	253.68		
Depression	No depression	334	3(1,4)	173.38	-6.699	<0.001
	Depression	36	5(5,6)	297.90		

3.4 Correlation Analysis

Spearman correlation analysis showed that balance ability was negatively correlated with fall risk ($r = -0.592$, $P < 0.001$), indicating that better balance was associated with lower fall risk.

3.5 Multivariate Analysis

Multiple linear regression analysis revealed that age, visual status, hypoglycemia within the past year, fall history within the past year, anxiety, depression, and balance ability were independent predictors of fall risk ($P < 0.05$). The model explained 58.4% of the variance ($R^2 = 0.584$), indicating good explanatory power. Among all variables, prior falls and balance ability showed the strongest associations with fall risk. Detailed results are shown in Tables 2 and 3.

Table 2. Table of Independent Variable Categories for Factors Influencing Fall Risk

Variable	Assignment Method
Gender	Male=1; Female=2
Age (years)	60–69 = 1; 70–79 = 2; ≥80 = 3

Educational Attainment	Illiterate or semi-literate = 1; Elementary school = 2; Middle school/vocational school = 3; College/university = 4
Marital Status	Dummy variables set with "married" as the reference; Divorced = (1,0); Widowed = (0,1)
Monthly Income	Less than 1,000 = 1; 1,001–3,000 = 2; 3,001–5,000 = 3; More than 5,000 = 4
Visual Status	Clear vision = 1; Blurred vision = 2
Hypoglycemia in the Past Year	No = 0; Yes = 1
Falls in the Past Year	No = 0; Yes = 1
Anxiety	No anxiety = 0; Anxiety = 1
Depression	No depression = 0; Depression = 1
Balance Score	Quantitative variable; raw data included

Table 3. Multiple Linear Regression Analysis of Factors Influencing Fall Risk (*n*=370)

Variable	Unstandardized Coefficient		Standardized Coefficient	*t*	*P*	Multicollinearity Diagnostics	
	B	Standard Error	*Beta*			VIF	Tolerance
Constant	10.605	1.171	-	9.058	0.000**	-	-
Age	0.677	0.147	0.177	4.614	0.000**	1.276	0.784
Visual Status (Reference group: Clear vision)							
Blurred vision	0.653	0.154	0.149	4.238	0.000**	1.082	0.925
Hypoglycemia in the Past Year (Reference group: No)							
Yes	0.557	0.159	0.124	3.512	0.001**	1.079	0.927
Falls in the Past Year (Reference group: No)							
Yes	1.848	0.225	0.287	8.218	0.000**	1.060	0.943
Anxiety (Reference group: No anxiety)							
Anxiety	1.025	0.253	0.163	4.053	0.000**	1.410	0.709
Depression (Reference group: No depressive symptoms)							
Depression	0.875	0.305	0.119	2.870	0.004**	1.490	0.671
Balance	-0.194	0.020	-0.389	-9.804	0.000**	1.369	0.731

R^2	0.584
Adjusted R^2	0.575
F	*F* (7,362)=72.457, P=0.000
D-W	1.964

Note. Dependent variable = FRQ

* $p<0.05$ ** $p<0.01$

4. Discussion

In this study, it was discovered that 43.2% of diabetic elders residing in the community were at risk of falling; this is more than the number found in non-diabetics (27.5%) [7]. Diabetes can therefore be seen as having a role in being an independent risk factor for falls. Chronic hyperglycemia can result in neuropathy, impaired vision, and muscle atrophy, which increases the risk of falls by a number of physiological routes.

Age was deemed to be a considerable influence. With age increasing, people would have more obvious physical changes like muscle loss, joint degeneration, and slower response time; also, it is possible for them to be worsened because of diabetes. And the results are in line with what Cheng et al. have said. Furthermore, it has also been proven by other evidence as falling being a predictor for age ≥80 yrs [19], [20]. The effect on age could possibly be due to the combined effect of weakening musculoskeletal strength, sensory loss, and central nervous system integration. Lower limb weakness, decreased grip strength, etc., are all considered important risk factors for falls in patients with type 2 diabetes [21]. In addition to this, with the increasing age of an individual, there would be a decline in visual acuity, vestibular system function, and cognitive processing speed; all of these can affect sense of balance indirectly and hence may cause increased risk of falls [22]. Fear of falling also seems to increase with age, thus creating another reinforcing cycle that will increase the risk of falls [23]:

And also we have visual impairment as a major one. In our study, over half (51.4%) said they had trouble seeing with their eyes, and it seems like when someone's vision is blurry, they are more likely to fall down. This is in line with findings from previous work done in Singapore [24], showing that there exists an association between visual impairment and fall risk, which can be applied to many different groups of people. And as far as the reasons go, there's a loss of depth sensing and also decreased contrast and visual ranging, which makes you more likely to fall (25-26), so possibly routine vision screening at the diabetes care community level would work too.

The presence of hypoglycemia and a fall in the last year is associated with a high risk of falls. If there is hypoglycemia, it can cause dizziness, fatigue, and disturbance of consciousness directly and increase the risk of falls. [18] Longitudinal studies have shown that patients who have experienced severe hypoglycemia are also more likely to fall compared to those who did not experience such a condition. [26] In addition, insufficient monitoring of glucose levels as well as lack of recognition about hypoglycemia remains a problem among patients living in the community, which increases the

probability of negative outcomes [27]. Thus, we should set up personalized glucose target control and enhance our detection strategy in order to lower the chance of falling down. Similarly, there is also a previous fall history as one of the powerful predictors for future falls as stated in prior works [28], [29], and [30]. It could also bring about some kind of danger due to causing injuries physically, lowering mobility ability, or even causing mental issues like being afraid to fall again [31].

Psychological factors are very important as well. Anxiety and depression are linked to the risk of falling as well. Anxiety could have an impact on visual search strategy and gait. [32] In comparison to depression, it is related to poor attention, worse executive function, and processing speed—all things that increase chances of falling. [33]. Therefore, we propose psychological evaluation and intervention should also be part of fall prevention in older people with diabetes.

Finally, it is also significantly negatively associated with balance ability and fall risk, as we previously mentioned, and the outcome is similar. Diabetes can affect some inputs going to your brain to process everything and control certain movements (s), leading up to that being done poorly or the wrong way. So instead, we could do things that are very specific, like balancing exercises and having an exercise program where people don't fall over as much.

Those who might possibly not do it themselves could influence each other through their physiology and behavior. For example, visual impairment, imbalance, and fear of falling, etc., can also lead to less mobility, and fall risk is also higher. Also, just like with hypoglycemia and stress, which can make things worse, also adding to our risk: And it will be helpful as well to assist community-based fall prevention programs for older adults with T2DM.

5. Strengths and Limitations

5.1 Strengths

This study is very good. Firstly, it assessed the fall risk for elderly people with type 2 diabetes residing in the community from all kinds of demographics, clinical, functional, and psychological aspects totally. The second is that some tools for measuring fall risks, balance abilities, anxieties, and depressions are proven by validation, so the research results will be more reliable. Thirdly, it got a very high reply rate of 100%, so as to minimize any reply bias. In the end, it includes some physiological and psychological variables for doing multiple analyses; maybe it can be more true to the situation in the community.

5.2 Limitations

We need to see that there are some limitations. First up is a cross-section, which can't do causation, but long-term gives you some idea about time orders. Secondly, all the subjects came from only one community health service center, and there is a limited representativeness for generalization of this research. The third reason is that some variables (fall history, hypoglycemia) are reported by the participants themselves and may therefore be biased by their own recollection. And fourth is there could have been other confounders, like activity and environmental hazard factors. Finally, even with many variables included, there might still be unmeasured things affecting the chance of falling.

Ethics approval and consent to participate

This study is conducted in accordance with the ' Declaration of Helsinki '. It has been approved by the Ethics Committee of Medical College of Jinan University (approval No.: JNUKY-2024-0013). Prior to data collection, all participants signed written informed consent. For participants with limited literacy skills, the research process was explained in detail and their consent was obtained with the assistance of trained researchers. All participants were informed that their participation was voluntary and could withdraw from the study at any time without any impact.

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