Comparative analysis of risk for falls in patients with and without type 2 diabetes mellitus

Patricia Pereira de Oliveira[1], Silvia Maria Fachin[2], Joana Tozatti[3], Mari Cassol Ferreira[4], Lizanka Paola Figueiredo Marinheiro[5]

[1]PhD in Sciences (Children's and Women's Health Care); Full Professor, Medical School, Universidade Comunitária Regional de Chapecó (Unochapecó), Chapecó, SC, Brazil
[2]Scholarship Student in Scientific Initiation, PIBIC/CNPQ; Undergraduate Student in Medicine, Unochapecó, Chapecó, SC, Brazil
[3]Scholarship Student in Scientific Initiation, FUNDESTE; Undergraduate Student in Medicine, Unochapecó, Chapecó, SC, Brazil
[4]Endocrinologist; Full Professor, Medical School, Unochapecó, Chapecó, SC, Brazil
[5]PhD em Public Health, Instituto Fernandes Figueira – Fundação Oswaldo Cruz (IFF/Fiocruz); Endocrinologist and Full Professor, IFF/Fiocruz, Rio de Janeiro, RJ, Brazil

Summary

Objective: To compare frequency and risk of falls based on a functional mobility test in diabetic and non-diabetic individuals. **Methods:** Cross-sectional study involving patients with and without type 2 diabetes mellitus (DM2) selected by convenience sampling. Men and women between the ages of 50 and 65 were included and divided as group 1 (G1) – with DM2 diagnosis for < 10 years fasting blood glucose at interview/test time, as well as prior > 200 mg/dL; and group 2 (G2) – no diabetes, same age group, and fasting blood glucose < 100 mg/dL. Both groups responded to a structured questionnaire about their health, fall risk, and underwent a physical exam and a mobility assessment test (Timed Up and Go – TUG). The results were analyzed by the software SPSS, with TUG being categorized in ranges of risk for fall. We considered that the risk was positive for all those who fit into medium- and high-risk range. **Results:** Fifty patients with DM2 and 68 patients without DM2 were assessed. There were no statistical differences in the number of falls between the groups, however non-diabetic subjects obtained a higher performance in TUG test ($p = 0.003$) as the risk categories were observed. Reduced visual acuity and difficulty in getting up were more frequently reported in G1 ($p < 0.05$). **Conclusion:** There appears to be an association between hyperglycemic status and poorer mobility, with an increased fall risk even in younger patients and in those with shorter disease duration.

Keywords: Diabetes mellitus; elderly; mobility limitation; postural balance.

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Correspondence to:
Patricia Pereira de Oliveira
Rua Senador Atílio Fontana, 59-E
Efapi
CEP: 89809-000
Chapecó – SC, Brazil
patriciapoliveira@hotmail.com

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Introduction

Type 2 diabetes mellitus (DM2) is a prevalent disease, affecting over 300 million individuals all over the world[1]. About 20% of adults aged between 65 and 76 years already have a DM2 diagnosis, and this prevalence is supposed to further rise with age[2]. In Brazil, 9.7% of individuals older than 35 are diabetic[3].

In addition to the disease impact on renal, neurological, and cardiovascular systems, the association of DM2 with complications that can lead to physical disability is known[4]. A number of changes in physical adaptation usually occur with aging; however, the coexistence of a chronic disease, such as DM2, contributes to hastening this process[5].

Patients with DM2 are considered at risk for falls and their harmful consequences, mainly because they develop peripheral neuropathy and reduced visual acuity, use multiple drugs, have dizziness, hearing disorders, and hypoglycemic events resulting from poor medication use, among others[2,6-8]. In addition, there is evidence that diabetic women are more likely to fall, regardless of other existing risk factors[9].

Falls are the main cause for fatal or non-fatal injuries in the elderly[10], representing 10% of emergency room visits for people older than 65 years. A study identified falls as the most prevalent external cause for hospital admissions in the elderly, mainly among old women (34%)[11]. Following falls, injuries occur in 40% to 60% of episodes, with fractures (5%) mainly affecting the vertebrae, the femur, and the humerus[12]. Functional disability, reduced mobility, and risk of premature death may also occur[12].

Falls can result from intrinsic and extrinsic factors. Poor environmental conditions are among the extrinsic factors, while physiological or pathological changes, medication adverse effects, or concomitant use of multiple drugs are some of the intrinsic factors[13]. Most falls occur at home or nearby, usually during daily activities, such as walking, during position changes, or when using the toilet[14], with the majority of injuries at home being a consequence of intrinsic causes[12].

The significant prevalence of DM2 in the Brazilian population (mostly in older individuals)[3], and the evidence of higher risk of falls among older diabetic women[9] urge the screening of this group. Screening individuals at risk of falls and early intervention could aid in reducing resulting injuries[15]. Thus, the use of clinical tools for selecting the population at a higher risk would be a plausible option as the task would be easy and the cost would be low. The identification of more accurate tests to establish practical algorithms to predict falls has been targeted by recent studies[16]. Among the available tests, obtaining the history of falls[17] and applying the Timed Up and Go (TUG) test[18] could be simple and effective strategies to identify individuals at risk for falls in the community.

Thus, this study aims to compare the frequency and risk of falls based on the functional mobility test in non-institutionalized diabetic and non-diabetic subjects in a southern Brazilian city.

Methods

This was a cross-sectional observational study conducted in a medium-sized city in Southern Brazil from June 2009 through July 2010. The population was divided into two groups, the first group consisting of patients with DM2 and the second group of patients without DM2. Both groups were selected by convenience non-probability sampling.

To calculate the sample size, an event probable prevalence (falls in the elderly) of 38%[19] was adopted, based on the DM2 prevalence in the Brazilian population (9,7%)[3], with a confidence interval of 95% (95% CI) and a tolerance error of 5% for a potentially eligible population of 22,049 individuals (subjects aged 50 to 65 years residing in the city)[20]. From the result, 50 diabetic subjects and 68 non-diabetic subjects were surveyed, a total of 118 subjects.

The inclusion criterion was: men and women aged 50 to 65 years looking for medical care as outpatients in a public healthcare facility in Chapecó, SC. Later, the patients were divided into two groups. Group 1 consisted of patients diagnosed with DM2 < 10 years ago; fasting blood glucose > 200 mg/dL at the interview/test time, as well as prior fasting blood glucose > 200 mg/dL. Group 2 consisted of patients without any diabetes diagnosis, of the same age group, with fasting blood glucose < 100 mg/dL at the interview/test time. Only patients diagnosed with DM2 less than 10 years before were selected, as the purpose was to verify whether the risk for falls is increased in early disease, with abnormal blood glucose at the time of interview to characterize hyperglycemic status while undergoing mobility tests. Glycated hemoglobin was not used due to the variability of methods used in Chapecó, some of them unreliable.

Illiterate patients, smokers, alcoholics, psychoactive drug users, those with severe visual or hearing disorders, and those unwilling to participate were excluded.

The initial contact for inclusion in the study was held in a reference center while patients were waiting to be seen by physicians from several medical specialties over two shifts per week for six months. In this stage, all of the non-diabetic subjects were selected, but as the required number of diabetic patients had to be met, patients were also selected in a basic healthcare unit (n = 10), based on the criteria expressed above, after reviewing the medical records of patients registered into the Programa Hiperdia of the Ministry of Health (hiperdia is a registration and follow-up system for hypertensive and diabetic patients).

At the inclusion into the study, the fasting capillary glucose was assessed by glucometers (Accu-Chek Go™), and two questionnaires were applied. The first questionnaire was previously structured with data about general characteristics, current and past medical history (self-reported diseases), and continuous medication use. Race was self-reported by the subjects. Using three or more drugs/day was considered multidrug use. The second questionnaire consisted of 30 multiple choice objective questions about history and risk factors for falls, in accordance with a previously reported study[17], and only questions related to intrinsic risk factors were used in the analysis (dizziness, reduced hearing acuity, reduced visual acuity, and difficulty in getting up from a chair with no support). The occurrence of a fall in the last year was also questioned (after a positive answer, the next question would be "how many episodes").

The patients underwent blood pressure, weight, and height measurements, and the body mass index (BMI) was calculated from the formula: weight/height^2 (kg/m^2). The serum levels of triglycerides, total cholesterol, and HDL-cholesterol from the patients' medical records were also reviewed.

The TUG test was performed after the approach and questionnaire application. This is a test commonly used to assess functional mobility in older individuals[18,21], and is considered to have good sensitivity (87%) and specificity (87%) to identify non-institutionalized individuals at risk for falls[21]. The test aims to assess sitting balance, transfers from sitting to standing, walking stability, and gait course change without using compensatory strategies[22]. A chair, a stopwatch, and a measure tape are all that is needed in this test. The result is measured in seconds, as the time it takes the subject to get up from a chair, walk a 3-meter distance course, turn around, walk back to the chair, and sit down again[18]. A 40-cm high chair was used in the test.

Although TUG has been used for many years to assess functional mobility, there is no consensus on its reference values, and categorized parameters/limits are used according to the age group when possible. Thus, in a recent meta-analysis[23], the authors suggested that the higher limit of the confidence interval for each age group could be used as a comparative parameter to find whether or not the patient was worse than the average (9; 10.2; and 12.7 seconds for age groups 60-69, 70-79, and 80-99, respectively). In this study, it appeared that the higher age groups took longer to finish the test, but there are no data for subjects aged under 60 years, which constitutes a limitation of this study.

For analysis purposes, the parameters suggested by a Brazilian study on falls and mobility were used[22]: times < 10 seconds would be related to independent individuals with no balance changes, considered as low risk for falls; times between 10 and 20 seconds would be related to individuals independent for basic transfers, considered as medium risk for falls; finally, times > 20 seconds would be related to individuals dependent in many activities of daily living and mobility, presenting increased risk for falls (high risk). Patients classified as medium and high risk were considered at positive risk according to this categorization set for the test.

Statistical analysis

Independent variables included in the analysis were: gender (female or male), age (in years), occurrence of a fall in the last year (yes or no), presence of dizziness (yes or no), reduced hearing acuity (yes or no), difficulty in getting up from a chair with no support (yes or no), number of drugs/day, weight, height, BMI (in kg/m^2), TUG time (in seconds), and risk for falls assessed by TUG (low, medium, and high risk).

Continuous quantitative variables underwent descriptive statistical analysis (mean and median). The chi-square test was used to compare the following qualitative variables between groups: fall occurrence, presence of dizziness, reduced visual or hearing acuity, and difficulty in getting up from a chair with no support. The groups were compared for age, number of drugs/day, systolic and diastolic blood pressure, levels of triglycerides, total and HDL-cholesterol, weight, height, BMI, and TUG time using Student's *t*-test. The TUG time was also analyzed by the receiver operating characteristic (ROC) curve. The risk categories of TUG were calculated by the ANOVA test.

This study followed ethical criteria dictated by the Resolution no. 196/96 of the National Health Council (Conselho Nacional de Saúde – CNS) of the Ministry of Health, was submitted to the Ethics in Research Committee of the Universidade Comunitária Regional de Chapecó (Unochapecó) for approval before being conducted, and received funding support through Scientific Initiation Scholarships from PIBIC/CNPq and FUNDESTE.

Results

One hundred and eighteen subjects were assessed, with 50 of them having DM2 (G1), and 68 not having DM2 (G2). The mean age was 57.86 ± 4.9 years (ranging from 53 to 62 years) in G1, and 56.21 ± 4.3 years (ranging from 53 to 59 years) in G2. The majority of the sample was female and white in both groups, although the ratio was significantly higher in G2. General and anthropometric characteristics of the population are depicted in Table 1.

Table 1 – Sociodemographic and anthropometric characteristics of the study population (n = 118)

Sociodemographic and anthropometric characteristics	With DM2 (n = 50)	Without DM2 (n = 68)	p
Gender*			
Female	54.0 (27)	82.4 (56)	0.001
Male	46.0 (23)	17.6 (12)	0.063
Race*			
White	72.0 (36)	83.8 (57)	0.029
Non-white	28.0 (14)	16.2 (11)	0.549
Marital status*			
Married	88.0 (44)	72.1 (49)	
Widowed	6.0 (3)	14.7 (10)	
Single	–	2.9 (2)	0.119
Divorced	4.0 (2)	10.3 (7)	
Education*			
Incomplete Elementary School	76.0 (38)	73.5 (50)	
Complete Elementary School	14.0 (7)	13.2 (9)	
Incomplete Secondary School	6.0 (3)	4.4 (3)	0.768°
Complete Secondary School	4.0 (2)	8.8 (6)	
BMI (kg/m^2)	29.4± 7.2	27.0 ± 4.5	0.076
Weight (kg)	79.6 ± 19.5	71.7 ± 13.3	0.013
Height (m)	1.6 ± 0.9	1.6 ± 0.7	0.174

DM2, type 2 diabetes mellitus; *values expressed in % (n). The remaining values are expressed as mean ± standard deviation; °as the difference between groups was not significant, no additional test is required to compare the groups individually.

The most frequent conditions were cardiovascular diseases (18%) in G1, and musculoskeletal diseases (27.9%) in G2. A higher prevalence of self-reported systemic arterial hypertension was observed in G1 (72%, p = 0.06). Other reported comorbidities were lung diseases, thyroid diseases, dyslipidemias, and depression, none presenting a significant difference between groups.

Regarding blood pressure measurements, a significant difference was observed in systolic pressure (p < 0.001), ranging from 130 to 160 mmHg in G1, and from 120 to 140 mmHg in G2. The baseline capillary glucose values in the study also reveal a significant difference, as expected: they ranged from 212 to 345 mg/dL in G1, and from 77 to 88 mg/dL in G2 (p = 0.000). Multidrug use was found in 82% (n = 41) of G1, and in 47% (n = 32) of G2 (p < 0.05).

A fall rate in the last year of 42% was found in patients with DM2, and 33.8% in patients without DM2 (p = 0.364). The mean number of falls between the groups was 1.57 ± 1.07 in G1, and 2.09 ± 1.97 in G2 (p = 0.058).

For the analysis of fall rate in the population with DM2, its relationship with insulin use or nonuse was assessed. Among those using insulin, 53.85% (n = 14) reported falls, whereas 29.17% (n = 7) of nonusers fell in the last year (p = 0.07, PR: 2.8, 95% CI: 0.87-9.13).

In the fall risk questionnaire, intrinsic risk factors with a statistically significant difference were: reduced visual acuity, and difficulty in getting up from a chair with no support (42.0% *versus* 61.8%, p = 0.03, and 22.0% *versus* 4.4%, p = 0.004 between G1 and G2, respectively). The presence of dizziness and reduced hearing acuity had a higher prevalence in G1, but the difference was not statistically significant.

In TUG test, G1 had a worse performance than G2 (p < 0.05) (Table 2), with the majority of diabetic subjects found in the medium-risk range, whereas the risk for non-diabetic subjects was considered low. The mean test time was 11.27 seconds in G1, and 9.52 seconds in G2 (p = 0.013). The ROC curve indicated the most characteristic time for the group with DM2 was 10 seconds (area under curve [AUC] accuracy = 0.69 ± 0.52).

The groups were separated as having a risk for falls or not, according to a prior categorization, and it was observed that 28% of diabetic subjects and 53% of non-diabetic subjects did not show such a risk (p < 0.05), as demonstrated in Table 3.

Multidrug use was associated with a positive risk for falls in the sample (76.1% risk for those using, and 23.88% for those not using multiple drugs [p = 0.001]). The difference for multidrug use in each group was not statistically significant (p > 0.05).

Table 2 – Functional mobility assessed by the Timed Up and Go (TUG) test in the study population stratified with or without DM2 (n = 118)

Categories	With DM2 (n = 50)	Without DM2 (n = 68)	p
Low risk	30.0 (15)	52.9 (36)	0.013
Medium risk	68.0 (34)	45.6 (31)	
High risk	2.0 (1)	1.5 (1)	

Values are expressed in % (n). DM2, type 2 diabetes mellitus.

Table 3 – Risk for falls assessed by TUG. Patients with or without DM2 are compared (n = 118)

Risk for falls	With DM2	Without DM2	p
Yes*	72.0 (36)	47.0 (32)	0.714
No**	28.0 (14)	53.0 (36)	0.003

Values are expressed in % (n). TUG, Timed Up & Go test; DM2, type 2 diabetes mellitus; *medium- and high risk by TUG; **low risk by TUG.

Discussion

The present study found a higher frequency of falls in patients with DM2 than in those without DM2 (42% *versus* 33.8%, p = 0.364), although a statistical significance was not observed. Gregg et al.[24] assessed 6,588 non-institutionalized subjects of both genders for the presence of diabetes and comorbidities, self-reported physical disability, and performance in physical tests, and observed more disability in subjects with DM2. These data suggest a higher probability of falls in diabetic people, which was confirmed in further studies[4,9,25]. Likewise, a higher prevalence of falls in diabetic patients is found when elderly patients residing in nursing homes are assessed[2].

A study conducted in 878 non-institutionalized women (15% of them diabetic) showed that women with diabetes have a higher probability of falls (OR, 1.38; 95% CI: 1.04-1.81), and recurring falls (OR, 1.69; 95% CI: 1.18-1.43), regardless of the presence of other risk factors[9]. In this study, the presence of muscular pain, insulin therapy, overweight, and poor lower limb performance were associated regardless of the falls even after adjustment for other risk factors. Although not all of these factors were studied, insulin therapy showed no influence on fall rate in the present study, in contrast with previous findings in the literature[6,26]. This may be due to the poor glycemic control in this population (all subjects were hyperglycemic). Thus, the suggested mechanism of insulin therapy as a factor increasing the risk for falls (from the higher chance of hypoglycemia in this group) could not be confirmed. On the other hand, there were no DM2 complication reports (e.g., neuropathies) associating the studied group with a worse disease status, a situation in which insulin therapy would be initiated due to a more severe disease (another suggested mechanism of increased falls from insulin therapy).

A worse performance in TUG test in diabetic patients ($p < 0.05$) was observed, similarly to other Brazilian studies[5,27]. The study conducted by Cordeiro et al.[27], with 97 outpatient elderly from the city of São Paulo, reported that the mean test time was 15.7 ± 6.5 seconds, and most patients (67.8%) took between 10 and 20 seconds, and 21.1% of patients took over 20 seconds to complete the test. Although the population mainly consisted of females diagnosed with DM2 less than 10 years ago, as in the present study, the TUG time (15.7 ± 6.5 seconds) and the mean age (74.4 ± 5.9 years) were higher. Since the test time increases as the age group increases[23], the difference found between studies is within the expected range. The authors concluded that elderly diabetic patients have impaired balance and mobility possibly related to older age, limitation in daily activities, absence of balance strategies, impaired proprioceptive sensitivity, and orthostatic hypotension.

Alvarenga et al.[5] compared 20 elderly diabetic patients with 20 elderly non-diabetic patients in the city of Belo Horizonte and, although they found a longer TUG time in diabetic patients (10.46 seconds *versus* 8.95 seconds, p = 0.01), the mean test time in diabetic patients was lower than the conventional threshold[23] (12.7 seconds for the 70-79 age group), and the test time found in the present study with younger women. These findings, although demonstrating that differences in mobility tests for diabetic and non-diabetic patients also occur in the Brazilian population, show that the described values are heterogeneous, suggesting that other factors may be influential, or that regional thresholds should be developed.

Concerning intrinsic risk factors for falls, reduced visual acuity (higher in non-diabetic patients, $p < 0.05$) and difficulty in getting up from a chair with no support (higher in diabetic patients, $p < 0.05$) were statistically significant in the present study. From the literature, reduced visual acuity seems to be more prevalent in diabetic patients[2,9,24]. The present results may be different because of the self-reported answers, which were thus liable to misinterpretation. The difficulty in getting up from a chair with no support only confirms DM-related reduced functional mobility[5,9,23,25,27].

One variable with high clinical significance regarding falls and already mentioned in prior studies[13,19,28-30] was multidrug use. However, no difference was observed between diabetic and non-diabetic patients. Using many drugs may increase the risk for falls due to the occurrence of drowsiness, muscle weakness, balance change, hypotonia, vertigo, and hypotension[29,30]. Multidrug use also increases the risks of interaction of three or more drugs[29]. It is also important to acknowledge that people using multiple drugs usually have more comorbidities, and consequently higher possibility of falls[31]. In a study conducted in Ribeirão Preto, SP, aiming to investigate histories of falls reported by elderly patients attended to in public healthcare units, most cases occurred with women in their own households and had environment-related factors. Although the relationship between falls and drugs has not been found, 42% of the elderly patients used multiple drugs, with 34% and 14% using antihypertensive and antidiabetic drugs, respectively[29].

The present study's population predominantly showed cardiovascular diseases among diabetic patients, similarly to that previously described in literature[2,9,19,24,29]. The prevalence of cardiovascular diseases concomitantly with DM2 seems to be a frequent finding, and certain drug interactions could lead to disability and falls in this group[29].

Thus, it could be concluded that impaired functional mobility appears to be more prevalent among diabetic patients than in non-diabetic patients, even in younger groups. Knowledge regarding the reduction of functional mobility in patients with DM2 allows the design of prevention strategies of great importance to public health programs. These measures include preemptive education for patients and their family, warning about physical disability signs, and instruction about the care aimed at preventing falls and accidents.

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