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# Risk of Falls in People with Diabetes Mellitus

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**Abstract**

**Aim:** To identify the risk of falling through a functional mobility test in non-diabetics, individuals with diabetic neuropathy and individuals with diabetic neuropathy and vasculopathy.

**Methodology:** The study was composed of 61 subjects of both genders divided into the control group CG (n=32), diabetic neuropathy group DNG (n=18) and diabetic neuropathy-vasculopathy group (DNVG) (12). The participants underwent initial an evaluation through somatosensory sensitivity tests, diagnosis of polyneuropathy for Diabetic Distal Scale and ankle/brachial index. The "Time Up and Go Test" (TUGT) was used to assess the dynamic balance.

**Results:** The three sample groups presented homogeneity within group. The values for the fasting glycemic indices were higher in the diabetic groups. The increase in the postprandial glycemic index was significant in the DNVG when compared to the CG. The postprandial glycemic index was higher in the DNG in relation to the CG, but not significantly. A progressive and significant increase in the time taken to perform the TUGT mobility test was observed between the three groups, with higher values for the DNVG compared to the DNG and CG and the DNG compared to the CG.

**Conclusion:** The confirmation of a predisposition to risk of falling could contribute to greater focus on early intervention, with activities directly or indirectly related to body balance, contributing to fall prevention in this population.

**Keywords**

Diabetes mellitus, Diabetic neuropathy peripheral, Fall hazard

## Introduction

Diabetes mellitus (DM) type 2 is one of the most frequently diagnosed chronic diseases, affecting more than 300 million people worldwide and is independent of the degree of development of the country. Approximately 20% of adults between 65 and 76 years have a diagnosis of DM2 [1].

The increase in life expectancy, combined with behavioral changes in lifestyle, resulting from urbanization, has led to an increased prevalence of chronic degenerative diseases [2]. In contrast, chronic diseases such as diabetes mellitus accelerate the aging process. This complex process, inherent in all structures and functions of the body, is continuous, triggering changes that may culminate in a decline in agility and dynamic body balance [3].

Thus, chronic complications of diabetes are more pronounced with age. Diabetic peripheral neuropathy (DPN), the most common complication, is present in up to half of the people with diabetes, leading to sensory and autonomic motor impairment, and possibly increasing the risk of falling [4].

Moreover, when DPN is associated with peripheral vascular disease, motor sensory changes such as decreased mobility and decreased muscle mass and strength, more evident in the lower limbs, may be more pronounced, resulting in greater predisposition for bodily imbalances [5].

In turn, the risk of falling due to the decrease in reaction time to external stimuli, such as changes in decubitus or shifts in gait [6], may be associated with changes in insulin action which lead to constant changes in blood glucose concentrations, affecting cerebral function [3].

Given the above and the implications that may exist in fall situations in individuals with diabetes, especially when associated with aging, since the majority of diabetic complications arise at later stages of disease development, this study aimed to identify the risk of falling by means of a functional mobility test in non-diabetics, individuals with diabetic neuropathy and individuals with diabetic neuropathy and vasculopathy.

## Methodology

This is an observational cross-sectional controlled study, developed in the Clinical Studies department of the Physical Therapy Laboratory (LECFisio), Science and Technology College –

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**Table 1:** Anthropometric data of the Control (CG), Diabetic neuropathy (DNG) and Diabetic neuropathy and vasculopathy (DNVG) groups, n=61

| | CG (n=32) | DNG (n=18) | DNVG (n=12) | f | p-value |
|---|---|---|---|---|---|
| Age (years) | 64.77 ± 6.86 | 64.33 ± 6.45 | 60.64 ± 7.84 | 1.503 | 0.231 |
| Body Mass (kg) | 69.47 ± 14.22 | 76.71 ±16.37 | 77.03 ± 16.09 | 1.782 | 0.177 |
| Height (m) | 1.58 ± 0.11 | 1.61 ± 0.08 | 1.65 ± 0.09 | 1.762 | 0.181 |
| BMI (kg/m$^2$) | 27.53 ± 4.01a | 31.52 ± 6.92b | 28.52 ± 6.15ab | 3.171 | 0.049* |

**Note:** BMI: Body Mass Index. Different letters in the lines indicate significant differences between groups (p<0.05).

**Table 2:** Values of the fasting and postprandial glycemic index in mg / dl, and time of completion of the mobility test, in seconds, for the Control (CG), Diabetic neuropathy (DNG) and Diabetic neuropathy and vasculopathy (DNVG) groups, n=61

| | CG (n=32) | DNG (n=18) | DNVG (n=12) | F | p-value |
|---|---|---|---|---|---|
| Postpradial glucose | 134.91 ± 33.91a | 164.55 ± 43.34ab | 181.73 ± 104.79b | 3.581 | 0.034* |
| Fasting glucose | 93.64 ± 18.97a | 154.82 ± 48.46b | 165.55 ± 96.48b | 7.464 | 0.002* |
| TUGT (s) | 10.58 ± 1.81a | 13.88 ± 2.79b | 16.44 ± 5.19c | 18.532 | <0.000* |

**Note:** TUGT: "Time Up and Go Test". Note: Different letters in the lines indicate significant differences between groups (p<0.05).

**Table 3:** Linear regression between glycemia and Timed Up and Go Test (TUGT) of the Control, Diabetic neuropathy and Diabetic neuropathy and vasculopathy groups, n=61

| TUGT (adjusted by the degree of commitment) | | | |
|---|---|---|---|
| **Variables** | **B** | **CI (95%)** | **p-value** |
| Pre meal blood glucose | 0.263 | 0.001; 0.035 | 0.043 |
| Fasting glucose | 0.520 | 0.016; 0.047 | ≤0.001 |

Pre meal blood glucose: postprandial glycemic index, Fasting glucose: glycemic index fasting.

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This study is in accordance with the guidelines of the Research Ethics Committee of the FCT / UNESP (protocol number: 10/2011). All participants signed an "Informed Consent", of which the procedures adopted comply with the ethical principles for medical research on human beings.

## Population and Selection Criteria

The participants come from the city of Presidente Prudente, SP, Brazil (midsize city) and region and the population was allocated by convenience. Diabetic patients, specifically, were referred by doctors and clinics to participate in the study because it was necessary medical diagnosis of diabetes mellitus and all of them were being treated. The sample was divided into three groups: Diabetic neuropathy Group (DNG), Diabetic neuropathy and vasculopathy Group (DNVG) and Control group (CG). The participants of DNVG presented the history of ulcer and/or amputation, characteristic of his clinical condition which fit into higher levels of peripheral diabetic complication. All participants underwent an initial assessment to obtain personal and anthropometric data (body weight, height and body mass index).

For inclusion in the DNG and DNVG groups, the following were required: a medical confirmation of diabetes, DPN confirmed by insensitivity to a Semmes-Weinstein 10g monofilament [7] (I smiled at Bauru®, Brazil) and a diagnosis of polyneuropathy on the Diabetic Distal Scale [8]. In addition, for inclusion in the DNVG confirmation of a change in circulation and peripheral blood perfusion was required, detected by the ankle/brachial index and oximetry respectively [9]. To exclude neuropathic subjects from the control group sensitivity to a 2g monofilament was required, confirming the normal somatosensory sensitivity of the feet [7]. In all groups the absence of other neurological or neuropathic disease and a good ability to understand the tests was mandatory.

## Procedures

### Initial assessment

The subjects underwent an initial assessment to obtain personal, anthropometric and postprandial blood glucose data. Fasting blood glucose was collected through patients' reports of their last measurement. An inspection of the feet was conducted to verify skin condition and the presence of ulceration and/or amputation, and the somatosensory sensitivity test was performed to confirm the presence or absence of DPN [7].

Confirmation of vasculopathy was made possible by evaluating the peripheral circulation through the ankle/brachial index (ABI) between the upper and lower limbs. The ABI was calculated from the ratio between the greatest systolic pressure value and the brachial systolic pressure at the ankle. Values of less than 0.90 were considered indicative of peripheral arterial disease [9-11]. The assessment of blood perfusion was obtained using a finger oximeter (NonimOnix®, USA). The saturation was collected in the hallux of both feet, and the results were compared with average values in the index fingers of both hands. The oximetry results of the halluces were considered abnormal when the oxygen saturation was less than the index finger by more than two percentage points [9].

### Dynamic equilibrium assessment

The "Time Up and Go Test" (TUGT) [12] was used to assess dynamic balance. The individuals were positioned sitting in a chair and at a sign from the examiner, were required to get up, walk three meters, return and sit down again, as quickly as possible without running. The time taken, in seconds, to perform the task was recorded.

### Statistical analysis

The Kolmogorov-Smirnov and Shapiro-Wilk tests were conducted, which confirmed the normality of the data. The variables were compared between groups using one-way ANOVA with the aid of Tukey's post-test. To investigate the relationship between the other variables with the TUGT a partial correlation test set by the degree of commitment was used. Finally, significant relationships were submitted to linear regression analysis. The tests were performed using SPSS software version 13.0.

## Results

The sample consisted of 61 subjects. The CG (n=32) consisted of 18.75% males and 81.25% females, the DNG (n=18), of 22.22% males and 77.78% females and the DNVG (12), of 72.73% males and 27.27% females. The characterization of the sample is described in table 1 and the results of the TUGT and glucose measurements in table 2.

In the correlation test it was noted that the TUGT was related to postprandial blood glucose (r=0.325, p=0.038) and fasting plasma glucose (r=0.420, p=0.006), the latter being more significant. These relationships were adjusted by the degree of detectable impairment in the groups, which may indicate that the relationship persists regardless of the degree of complication. Next, this relationship was submitted to linear regression, and the data is presented in table 3.

Upon inspection of the feet of the CG and DNG groups, no ulceration and/or amputation was observed. However ulcers and amputations of toes or more were observed in the DNVG group.

## Discussion

This study aimed to verify the risk of falling, through a dynamic balance test, in diabetics with neuropathy and whether this risk was compounded when associated with vasculopathy. DPN is characterized by a clinical or sub-clinical syndrome that affects

different types of nerves, and presents manifestations ranging from silent to the occurrence of signs and symptoms, such as decreased somatosensory sensitivity, proprioception and increased postural instability or body oscillation [5]. When associated with peripheral vascular disease, these symptoms may be more evident [13].

The three groups containing the sample presented homogeneity within them. The values for the fasting glycemic indices were higher in the diabetic groups. The increase in the postprandial glycemic index was significant in the DNVG when compared to the CG. The postprandial glycemic index in the DNG was superior to the CG, but not significantly. This lack of significance could be related to large glycemic oscillations frequently observed in the diabetic population, generating high standard deviation. Corroborating this study, some authors relate postprandial hyperglycemia to increased vascular dysfunction in DM2 [14].

A progressive and significant increase in the time taken to perform the TUGT mobility test was observed between the three groups, with higher values for the DNVG in relation to the DNG and CG and the DNG compared to the CG. It can be inferred that the higher the peripheral involvement, the greater the test performance time and therefore the greater the risk of falling. Ghanavati et al. observed a direct correlation between the rate of progression of severity in the advancement of neuropathy and postural instability. The more severe the neuropathy becomes, the more difficult the execution of daily living tasks is [15].

It is believed that the diabetic condition in itself predisposes to a risk of falling, independent of the neuropathic condition [16]. However, neuropathy associated with diabetes further contributes to increasing the risk of falls [15]. In addition, the concurrent development of vasculopathy, predominantly in the lower limbs, increases this risk [13,15].

Therefore, as the interaction between the vestibular system and cerebellum is compromised, the body balance is also altered, further increasing the risk of falling. Data indicate that the fall risk rate is 1.5 times higher in patients with diabetic neuropathy than in normal individuals [5].

There was a positive correlation between the TUGT and glycemic indices, both fasting and postprandial. The TUGT, adjusted by the degree of commitment, presented a higher association with the fasting glucose than the postprandial. Thus, the higher the glycemic index, the longer the walking time in the TUGT. A slower gait is likely to offset the balance difficulties and the risk of falling.

As higher glycemic index values are directly related to greater predisposition to impaired vascular function [13], the greater risk of falling in the DNVG group may be related to increases in this index, associated with the neuropathic and vasculopathy conditions. Accordingly, in this study can be seen the relationship between values of fasting and postprandial glucose with the result in TUG test adjusted by the degree of impairment, this can be interpreted as a predictor for a change as cascading in several tissues, especially neuropathic and vascular, which impairs the patient's performance on the test.

However, the possibility that the presence of ulceration and amputation of the feet in the individuals with DNVG may be a confounding variable cannot be ruled out, possibly due to the longer ambulation time in the TUGT in this group. Still, another limitation of the study is the lack of information on the levels of glycosylated hemoglobin (HbA1C) future studies could include this information.

This study analyzed the peripheral neurovascular impairment with the risk of falling, in neuropathic diabetics and individuals with diabetic neuropathy and vasculopathy, believing that the confirmation or not of a predisposition to risk of falling can contribute to increased focus on early intervention, with activities directly or indirectly related to body balance, contributing to fall prevention in this population. In the DNVG group one individual presented ulceration, three amputation, four ulceration and amputation and four were unchanged.

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