# Factors associated with the greatest risk of ulceration on the feet of individuals with diabetes *mellitus*

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**ABSTRACT**

**Objective:** Given the high prevalence of Diabetes Mellitus, the study aims to identify the factors associated with a higher risk of developing ulcers in the lower limbs. **Methods:** The work was exploratory-descriptive, transversal and with a quantitative approach. The sample consisted of patients with Diabetes over 18 years of age from a private and a public health service. Data collection occurred through anamnesis, physical examination and search in medical records. Statistical analysis was perform using the SPSS 20.0 program. **Results:** 102 study participants were obtained, of wich 67,6% had diagnostic criteria for Distal Symmetric Polyneuropathy. Factors associated with the risk of ulceration were: aging, longer duration of diabetes, hypertension, peripheral arterial disease and the presence of typical symptoms of polyneuropathy. **Conclusion:** It is necessary to invest in the prevention of ulcers in individuals with Diabetes, through health education and monitoring by health professionals.
**Keywords:** Diabetes *Mellitus*, Diabetic neuropathies, Polyneuropathies, Foot ulcer, Diabetic foot.

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## INTRODUCTION

Diabetes *Mellitus* (DM) is globally epidemic, with a prevalence between 7.2 and 11.3% worldwide. In Brazil, the prevalence of this disease is approximately 8-9% of the population, being the 4th country with the greater number of people with DM[1]. The evolution of this chronic hyperglycemic disorder may generate debilitating complications, such as nephropathy, retinopathy and neuropathy[2]. Neurological damage is the most common chronic complication, with heterogeneous clinical and subclinical syndromes characterized by diffuse or focal damage of peripheral somatic or autonomic nerve fibers[3,4]. The prevalence of these syndromes are reported in 80% of patients with DM, and distal symmetric polyneuropathy (DSPN) is the most common clinical presentation, with studies demonstrating that 60% of patients with DM will develop this condition[4,5,6].

Distal symmetric polyneuropathy is a consequence of chronic decrease or absence of insulin. Insulin-like growth factor (IGF) type I, type II and insulin, play a neurotrophic role throughout the whole neural network; thus, in DM, there is less neurotrophic activity. Moreover, an increase in the glucose flow in peripheral nerves stimulates the aldose reductase enzyme to catalyze the excess of glucose to sorbitol, a compound responsible for reducing the active transportation of myo-inositol, thus compromising the sodium/potassium pump with a consequent reduction in nerve conduction velocity[3,5].

The DSPN is divided into sensory and sensorimotor or may not present symptoms. Studies show that 54% of patients diagnosed with type 1 DM (DM1) and 45% of patients diagnosed with type 2 DM (DM2) are asymptomatic[7]. On the other hand, about 40 to 60% of individuals with DSPN will clinically present painful diabetic peripheral neuropathy (DPN), which is usually insidious and exacerbates at night[2,4]. The onset of sensory neuropathy is slow, usually in the feet and legs, with symmetrical symptoms of numbness (paresthesia), burning sensation, electric-shock pain and increased sensitivity (allodynia), with length-dependent progression and, ultimately, reaching the distal musculature (with symptoms of weakness and hyporeflexia) and the hands, presenting the classic stocking-gloves distribution pattern[4,8].

It is health professionals' responsibility to advise patients about possible complications and the need for screening them right at the diagnosis of DM. Screening for DSPN should be started at the diagnosis of DM2 and after 5 years of diagnosis of DM1, ideally retesting annually. Diabetic polyneuropathy is diagnosed by typical symptoms (allodynia, autonomic symptoms, burning sensation, paroxysmal pain, dysesthesia, worsening at night) and by some abnormality in the neurological physical examination (Pinprick test, Semmes-Weinsten monofilament test, 128hz tuning fork and Achilles reflex). The search for dermatological manifestations (such as hyperkeratosis and nail dystrophy) and bone deformities is essential not only for the diagnosis, but also for follow-up[9,10].

Drugs that act in the pathophysiology of neuropathy are scarce and the scientific evidence is limited, as the case of α-lipoic acid[8,10,11]. Pain is preferably managed with tricyclic antidepressants, serotonin and norepinephrine reuptake inhibitors or GABA analogues[5,10,11,12,13].

Diabetic polyneuropathy can lead to other impactful complications besides the aforementioned symptoms, such as postural instability, arthropathies, foot ulceration (known as diabetic foot when infected) and amputation of the lower limbs. Foot ulcers are responsible for a 2.5 times higher risk of death in comparison to patients without ulcers. The risk of patients with DM developing ulceration throughout their life is estimated at 34%, with an increased probability in the presence of DSPN. Approximately 56% of diabetic foot ulcerations are infected and about 20% of them lead to some type of amputation in the lower limbs. Foot ulcers are the main cause of morbidity in individuals with DM, responsible for a significant number of hospitalizations and hospital readmissions, many of which could be avoided with health education, prevention of risk factors, as well as early recognition and therapy[14].

The well identified risk factors for foot ulcers are DSPN, peripheral vascular disease, foot deformities and previous ulceration. The Brazilian Diabetes Society recommends using the classification of degree of risk for foot ulcers in patients with DM proposed by the International Working Group on the Diabetic Foot, since grading the lesions enables the evaluation of their tendency to develop ulcers, as well as the choice of specific care. The assessment tool categorizes as grade 0 (absence of neuropathy), grade I (presence of neuropathy without deformities), grade II (presence of neuropathy with deformities and/or peripheral vascular disease) and grade III (ulceration or previous amputation).

After the categorization, grade 0 patients must undergo evaluation annually, while grade I need an evaluation every 6 months, grade II every 3-4 months and grade III every 2 months, in addition to medical advice on self-care regarding the feet and prevention of risk factors in order to avert the evolution of the complication[15,16].

Besides impacting individuals' lives, foot ulcers in patients with DM require high health system investments, thus being a public health issue. Knowledge and identification of risk factors, patient awareness and follow-up by health professionals are essential in preventing ulcerations, with the consequent reduction not only of patients' morbidity, but also of resource spending in health systems[17]. Studies diverge on the risk factors for developing foot ulcers in patients with DM, and few address which clinical conditions are the riskiest. Thus, our study consists of identifying the factors associated with a higher risk of lower limb ulcers in diabetics, enabling the optimization of ulcer prevention and its progression.

## METHODS

### *Research design*

Quantitative, exploratory, descriptive and cross-sectional study.

### *Research participants*

The sample group consisted of patients at outpatient follow-up in two healthcare centers: a private one, specialized in DM in Curitiba-PR (CW) and a public one, specialized in Endocrinology care in the city of São José dos Pinhais-PR (CS). We performed convenience sampling and the patients eligible for the study were invited to participate in the research while in the waiting room for their pre-scheduled appointment at the healthcare service. All participants signed the Informed Consent Form for research ethics (under opinion CAAE: 03053318.6.1001.5580) and those who agreed to participate were sent to another room of the service after their appointment, in order for us to perform data collection.

### *Data collection*

The participants were selected according to the inclusion criteria (previous diagnosis of DM and age over 18 years old) and were excluded according to the exclusion criteria (non agreement to participate in the study, unavailability of all information needed for the research, or presence of some abnormality in cognitive functioning observed by means of questions assessing comprehension, temporal and spatial orientation, and memory).

In cases of inaccurate or insufficient information provided by patients, such as the type of diabetes, time of diagnosis, glycated hemoglobin in the previous month, and the presence of high blood pressure and dyslipidemia, all participants' medical records were checked for the missing data; thus, medical records were only assessed when the variables of interest were not properly provided by patients. Data collection was carried out by the research authors, who were previously trained, and was performed with focused anamnesis, neurological and vascular physical examination of the feet, as well as categorization according to the degree of risk for foot ulcer.

The diagnosis of DSPN was made according to the following criteria: a combination of typical signs and symptoms of DSPN or presence of typical signs in the physical examination in the absence of symptoms or in the presence of painless foot ulcer. Typical signs and symptoms were paresthesia, burning sensation, electric-shock and pins and needles pain, reduced or absent vibration sensation, reduced or absent protective sensation in the 10g monofilament test, and reduced or absent Achilles reflex[18]. Moreover, the vascular assessment of the lower limbs was carried out with a hand held Doppler in order to analyze bilateral flows of both the posterior tibial and the dorsalis pedis arteries (considered abnormal when there was mono or biphasic flow in some of the lower limbs arteries), in addition to the calculation of the ankle-brachial index (ABI) (considered abnormal when $<0.9$)[16]. All the evaluations, including the DSPN criteria, were performed by the researchers.

### *Data analysis*

For the descriptive analysis, categorical variables were shown in absolute values (%), numerical variables were tested for normality by means of the Shapiro-Wilk test, finding only non-parametric data (values shown in median and interquartile range).

Chi-square test was performed for categorical variables to compare the results obtained in both groups, while Mann-Whitney test was performed for numerical variables.

The variables of interest were the DM and the social characteristics of participants, lifestyle habits, comorbidities (high blood pressure, dyslipidemia, and peripheral arterial disease (PAD)), typical symptoms of DSPN, and foot care, with an evaluation of degrees of risk for feet ulcers, graded from 0 to 3. In order to identify the main risk factors and to verify the correlation between these variables, we used the Spearman's rank correlation coefficient (for numeric variables, non-parametric data) and the Chi-square test (for categorical variables), considering correlation values weak (r = 0.3 - 0.5), moderate (r = 0.5 - 0.7) or strong (r > 0.7).

The statistical analysis was carried out with the SPSS program, 20.0 version. The significance level was $p<0.05$.

## RESULTS

As presented on Table 1, we included 102 participants in our study, whose age ranged from 19-90 years old and with a median of 64 years old (IQR: 18-49). The majority were in the age group 61-90 years old, corresponding to 55.8% of the participants. The time of DM diagnosis ranged from 6 months to 54 years, with a median of 9.5 years (IQR: 16-53) and the CW group had a longer time of diagnosis in the evaluation of both services, with a significant difference between groups (p=0.04). Older age and time of DM diagnosis were correlated with the risk of developing ulceration.

Diagnostic criteria for DSPN were observed in 67.6% of patients, of which 52% were asymptomatic and 48% presented, in the seven days previous to data collection, one or more of the following typical complaints of DSPN: burning sensation, paresthesia, pins and needles or electric-shock pain. The presence of typical DSPN symptoms in our study was a risk factor for the development of ulcers.

**Table 1.** Characteristics of participants.

| | CW n (%) n = 70 | CS n (%) n = 32 | Total n (%) n=102 | p-value |
|---|---|---|---|---|
| Research participants | 70 (69%) | 32 (31%) | 102 (100%) | |
| Criteria for DSPN | 49 (70%) | 20 (62.5%) | 69 (67.6%) | |
| Type of Diabetes | | | | 0.746 |
| Type I | 14 (20%) | 4 (12.5%) | 18 (18%) | |
| Type II | 56 (80%) | 28 (87.5%) | 84 (82%) | |
| Time of diagnosis | | | | 0.04 |
| ≤ 5 years | 16 (22.8%) | 16 (50%) | 32 (31.3%) | |
| 5-10 years | 9 (12.8%) | 6 (18.7%) | 15 (14.7%) | |
| ≥ 10 years | 45 (65.2%) | 10 (31.2%) | 55 (53.9%) | |
| Sex | | | | 0.0168 |
| Male | 37 (52.8%) | 22 (69%) | 59 (58%) | |
| Female | 33 (47.1%) | 10 (31%) | 43 (42%) | |
| Age | | | | 0.112 |
| 18-40 years old | 9 (12.8%) | 3 (9.3%) | 12 (11.7%) | |
| 41-60 years old | 18 (25.7%) | 15 (46.8%) | 33 (32.3%) | |
| 61-90 years old | 43 (61.4%) | 14 (43.7%) | 57 (55.8%) | |
| Ethnicity | | | | 0.352 |
| Caucasian | 64 (91.4%) | 22 (68.7%) | 86 (84.5%) | |
| African descendant | 5 (7.1%) | 10 (31.2%) | 15 (1%) | |
| Asian | 1 (1.4%) | 0 | 1 (0.98%) | |
| Schooling | | | | 0.198 |
| Incomplete Elementary/Middle School | 12 (17.1%) | 16 (50%) | 28 (27.4%) | |
| Complete Elementary/Middle School | 8 (11.4%) | 3 (9.3%) | 11 (10.7%) | |
| Incomplete High School | 3 (4.2%) | 5 (15.6%) | 8(7.8%) | |
| Complete High School | 10 (14.2%) | 5 (15.6%) | 15 (14.7%) | |
| Complete Higher Education | 35 (50%) | 3 (9.3%) | 38 (37.2%) | |
| Illiterate | 2 (2.8%) | 0 | 2(1.9%) | |

Source: The authors (2020)

Regarding life habits (Table 2) there was no significant difference between the CW and CS groups, although only 22.5% reported practicing physical activity regularly and 41.1% were dieting. Additionally, 11.7% of the study participants were smokers, but this habit did not correlate with a higher risk of foot ulceration.

Table 3 shows the comorbidities evaluated in the study and their correlation with foot ulceration of individuals with DM. In the vascular assessment of the lower limbs, all patients had bilateral pulse in the posterior tibial and dorsalis pedis arteries, while their flow was abnormal (monophasic or biphasic flow) in 43.1%. The ABI was abnormal in 6.8% of the sample. We observed a significant correlation between abnormalities in both arterial flow and ABI with the development of ulcers in the lower limbs. Another comorbidity that was a risk factor for lower limb ulceration was high blood pressure, present in 64.7% of the participants; moreover, only 25.7% of patients with concomitant high blood pressure and diabetes did not fill out the criteria for DSPN.

It was verified that only 35.7% of the individuals in the CW group and 9.4% in the CS group were submitted to foot evaluation, and that 15.6% of the CS group and 50% of the CW group were oriented regarding care, as seen in Table 4. Furthermore, in both groups it was observed poor hygiene (CW of 21.4% and 18.8% in CS), use of Inadequate footwear (CW of 37% and 47% in CS) and hyperkeratosis (CW of 23% and 40.6% in CS).

**Table 2.** Lifestyle habits.

| | CW n (%) n = 70 | CS n (%) n = 32 | Total n (%) n=102 | p-value |
|---|---|---|---|---|
| Diet | 32 (44.4%) | 10 (31.2%) | 42 (41.1%) | 0.491 |
| Physical Activity | 19 (26.3%) | 4 (12.5%) | 23 (22.5%) | 0.146 |
| Smoking history | 9 (12.5%) | 9 (21.1%) | 18 (17.6%) | 0.66 |
| Alcoholism | 8 (11.1%) | 4 (12.5%) | 12 (11.7%) | 0.419 |

Source: The authors (2020).

**Table 3.** Comorbidities and degree of risk for foot ulcer.

| | CW n (%) n = 70 | CS n (%) n = 32 | Total n (%) n=102 | p-value |
|---|---|---|---|---|
| High blood pressure | 43 (61.4%) | 23 (71.8%) | 66 (64.7%) | 0.938 |
| Dyslipidemia | 34 (48.5%) | 22 (68.7%) | 56 (54.9%) | 0.631 |
| ABI < 0.9 | 3 (4.2%) | 4 (12.5%) | 7 (6.8%) | 0.335 |
| Degree of risk for foot ulcer | | | | 0.344 |
| 0 | 21 (30%) | 12 (37.5%) | 33 (32.3%) | |
| 1 | 39 (55.7%) | 13 (40.6%) | 52 (50.9%) | |
| 2 | 6 (8.5%) | 4 (12.5%) | 10 (9.8%) | |
| 3 | 3 (4.2%) | 4 (12.5%) | 7 (6.8%) | |

Source: The authors (2020).

**Table 4.** Foot care.

| | CW n (%) n = 72 | CS n (%) n = 32 | Total n (%) n=102 | p-value |
|---|---|---|---|---|
| Self-care | | | | |
| Poor hygiene | 15 (21.4%) | 6 (18.8%) | 21 (20.6%) | 0.304 |
| Inappropriate footwear | 26 (37%) | 15 (47%) | 41 (40.2%) | 0.388 |
| Hyperkeratosis | 16 (23%) | 13 (40.6%) | 29 (28.5%) | |
| Onychomycosis | 18 (25.7%) | 10 (31.3%) | 28 (27.5%) | |
| Current ulcer | 3 (4.2%) | 0 | 3 (2.9%) | p<0.001 |
| Amputation | 2 (4.2%) | 1 (3.1%) | 3 (2.9%) | p<0.001 |
| Advised about DSPN and foot care | 35 (50%) | 5 (15.6%) | 40 (39%) | 0.131 |
| Advised by | | | | |
| Physician | 20 (28.5%) | 1 (3.1%) | 21 (20.5%) | |
| Nurse | 5 (7.1%) | 0 | 5 (4.9%) | |
| Other | 3 (4.2%) | 3 (9.3%) | 6 (5.8%) | |
| Physician and nurse | 4 (5.7%) | 0 | 4 (3.9%) | |
| Physician, Nurse, Other | 1 (1.4%) | 1 (3.1%) | 2 (1.9%) | |
| Foot examination | 25 (35.7%) | 3 (9.4%) | 28 (27.4%) | 0.497 |

Source: The authors (2020).

## DISCUSSION

Distal symmetric polyneuropathy is an important risk factor for foot ulcers, with a worldwide prevalence of approximately 60%[8,12] in individuals with DM; our research is in agreement with this epidemiological data, since we found a prevalence of 67.6% in the studied sample. However, there is a variation ranging from 10-100% described in the literature. This discrepancy can be justified by the existence of several diagnostic criteria, as well as by the predominant characteristics of the sample group, such as time of DM diagnosis, age, therapeutic conditions and associated comorbidities. Foot ulcers and DSPN are similar in men and women, with no significant difference in the literature between both sexes[19]; in our study, there was also a lack of difference.

Aging is considered a risk factor for diabetic neuropathy, with an increase in DSPN every decade in the general population; moreover, after 60 years of age the incidence is 1.7 times higher than in younger ages[20], in addition to the increased incidence of foot ulcers[21]. In our study, 79% of the individuals over 60 years old had diagnostic criteria for DSPN, corresponding to 70.5% of all the patients with a degree of risk for foot ulcer greater than 1. Regarding age groups, we observed a relationship between aging with the development of DSPN and foot ulcers.

The chance of patients with DM developing DSPN is estimated to increase by 13% each year; thus, the time of diagnosis is an important risk factor for the development of neuropathy[20]. Of all the individuals in the sample, 53.9% were diagnosed with DM 10 years ago or more, of which 73% presented with DSPN. In addition, of all the individuals with grade III risk of foot ulcer, 71.4% have DM diagnosis for 10 years or more. The correlation time of DM diagnosis and the risk of developing ulcers was statistically significant (p= 0.036 r= 0.208) and thus our research is in agreement with data previously reported[22], with the time of DM diagnosis an important risk factor for ulceration in the lower limbs.

When comparing the variables of both healthcare services, there was a difference in the presence of ulcers at the time of data collection, with 3 in the CW and none in the CS group, while in the correlation of lower limb amputation, there was 2 in the CW and 1 in the CS group. Regarding other variables (vascular assessment, sociodemographic characteristics, lifestyle habits, foot care, comorbidities, degree of risk for foot ulcer, characteristics of DM), no significant difference was observed.

Lifestyle habits and comorbidities are essential in the follow-up of individuals with DM, as they may be responsible for the primary etiology of DSPN and ulceration or can contribute to hyperglycemic disorder in the pathophysiology of these complications[22,23]. Smoking triggers adrenergic responses that increase glucose values and suppress insulin production and cause a systemic pro-inflammatory effect, thus being considered a risk factor for the development of ulcers; however, in our sample there was no correlation of smoking history with a higher risk of ulceration. There is evidence that the contribution of smoking in both the development and evolution of DSPN may be weak and not independent in individuals with DM2[20, 23] and 82% of the total sample had such a subtype of diabetes in our study.

Alcoholism may be a primary cause or contribute to the development and progression of neuropathy in patients with DM. Chronic use of alcohol is considered the second most common cause of DSPN since it produces a metabolic intermediate that favors impairment in axonal transport[7,20]. We found that alcohol abuse is a risk factor for the development of foot ulcers in the private healthcare service (p = 0.004/ r=-0.338); however, there was no correlation in the public service (p=0.063 /r =0.333). The difficulty of patients in reporting alcohol use and the low accuracy of the questionnaires in quantifying the use of alcohol may justify the statistical difference between both services, therefore demanding further studies given the relevant contribution of this substance in the pathophysiological process of DM complications[7].

In patients with dyslipidemia, the oxidation and glycation of plasma lipoproteins are able to activate NADPH oxidase, culminating in oxidative stress of the nerve cell and having a greater release of pro-inflammatory cytokines by macrophages and adipocytes, thus contributing to the worst prognosis of DSPN[3,5]. In our study, there was no relationship between dyslipidemia and the risk of developing ulcers, possibly due to the cross-sectional design, in which carriers of hypercholesterolemia where considered who was being treated for this condition or who had this diagnosis in the medical record, thus being necessary to evaluate the time and control of the comorbidity.

High blood pressure has a high prevalence in the worldwide population, especially in individuals with older age and with comorbid DM, also known to play an important role in the development of macro and microvascular complications.

Some studies show that high blood pressure is the main predictor of DSPN, increasing the relative risk approximately four times over a 6-year period; nonetheless, other studies reported that strict blood pressure control does not decrease the deterioration by DSPN[23]. In our study, only 25.7% of patients with high blood pressure and diabetes did not present criteria for DSPN. In the assessment of the degree of the risk for foot ulcers, all the individuals in grade III had this comorbidity and in grade II only 30% did not have it. Of all the patients with PAD, 71% had high blood pressure.

Diet and glycemic control are essential in preventing both DSPN and lower limb ulceration. Previous studies reported that glycated hemoglobin (HbA1c) greater than 6.5% in patients with DM was associated with 16.9 times greater chance of developing neuropathy. The United Kingdom Prospective Diabetes Study (UKPDS) shows that HbA1c below 6% is related to a lower risk of diabetic complications and that a 1% decrease in HbA1c decreases by 37% the chance of developing microvascular complications[24]. No significant correlation between the risk of developing ulcers and HbA1c was found in our study. Of the total sample, 13.7% had HbA1c ≥ 9%, of which 57.1% had diagnostic criteria for DSPN. None of the patients who had ulcers at the time of data collection had HbA1c ≥ 9%.

DM is an important risk factor for PAD and together they increase the incidence of ulcers in the lower limbs[25]. In our study, PAD was an important risk factor for the development of foot ulcers in individuals with DM, not only by its correlation with posterior tibial and dorsalis pedis arterial flows ($p<0.01$ $r= 0.366$), but also by an abnormality in the ABI ($p=0.002$ $r= 0.309$).

DSPN can be clinically asymptomatic or present debilitating symptoms[4,8]. The patients in our study were asked about the presence of symptoms in the lower limbs and, when present, they were asked to specify the sensations as burning, paresthesia, pins and needles and/or electric-shock. Of all the patients with DSPN criteria, 52% were asymptomatic and 48% had one or more of the sensations aforementioned, with burning (57.5%) and paresthesia (45%) being the most reported sensations. In the analysis of patients who presented any complaints in the seven days previous to data collection, we observed that they presented a higher risk of developing ulcers in comparison to asymptomatic patients ($p=0.01$ $r= 0.515$).

In addition to the annual physical examination by health professionals, health education with advising on the evolution of the disease and lower limbs care is essential in the treatment of patients with DM, being crucial in the prevention and in early diagnosis of both DSPN and ulceration[26,27]. In our study, advice ($p=0.005$ $r=0.279$) and foot examination ($p=0.023$ $r=0.224$) were prevalent in individuals at higher risk of developing ulcers. Of all the individuals without diagnostic criteria for DSPN, 27.2% were advised and 21.2% had their feet examined. Regarding the evaluation of patients without DSPN in each healthcare service, 33.3% of patients in the private service were advised and 28.5% of them had their feet examined, while in the public service, 16.6% of patients were advised and 8.3% had their feet examined.

Overall, 39% of patients in our total sample were advised and 27.4% had their feet examined. When analyzing each group separately, a discrepancy was observed: 15.6% of participants from the CS and 50% of the CW group were advised. Moreover, 9.4% of the CS group and 35.7% of the CW underwent foot examination. This finding is similar to what was already described in the literature. Previous research conducted in public health services showed that 53% of patients were unaware of the lower limb complications of DM, 78% did not know what diabetic foot was or denied having been advised for its prevention, and 67.3% claimed that they did not have the habit of examining their feet frequently[28,29].

There are scientific reports that recognize the difficulty of adjusting the physical examination of the feet in the clinical practice, possibly due to the predetermined short time for the appointments and the need for proper equipment for vascular and neurological assessment. However, the impacts of diabetic ulcers on the life of the affected patients and healthcare systems are extremely deleterious; moreover, health education and follow-up by a multidisciplinary team are crucial for prevention[26,27]. In order to contribute to this issue, there are studies that address how to perform a foot examination in patients with DM in just 3 minutes, consisting of focused anamnesis, physical examination and health education; when necessary, there is also a strategy for adequate patient referral[30].

## CONCLUSION

Diabetic neuropathies are the most common chronic complications of DM, with DSPN being the most prevalent of them. In our study, we found a DSPN prevalence of 67.6% in the diabetic patients evaluated. Prevention and early diagnosis of DSPN are public health issues, given its high prevalence and the impact of its evolution on the development of ulcers. Ulceration in the lower limbs and subsequent evolution to diabetic foot and amputations are the most worrying complications for patients and healthcare systems; thus, identification of risk factors, follow-up by health professionals and health education are essential. The following factors associated with the higher risk in the development of ulcers in the lower limbs were observed in our study: aging, time of DM diagnosis, comorbidities such as high blood pressure and PAD, and the presence of typical DSPN symptoms.

We observed the need for greater engagement of healthcare services and healthcare professionals in advising patients with DM and examining their feet. In the public service, 15.6% of the participants had undergone advising, while in the private service 50% were advised. Regarding foot examination, 9.4% of the public service sample underwent this physical evaluation, while in the private service 35.7% had their feet examined. Both variables were prevalent in patients who already were at a higher risk for foot ulcers. Health education and multidisciplinary follow-up by healthcare professionals are essential for preventing DSPN and forestalling its evolution into lower limb ulceration. Thus, we emphasize the need for greater investments in prevention, significantly reducing the negative impact on the lives of patients with DM and health systems.

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