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## Ulceration risk in diabetic feet: a cross-sectional study

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### ABSTRACT

**Aim:** To identify the prevalence of ulceration risk in the feet of people with diabetes mellitus (DM) living in rural areas. **Methods:** This is a cross-sectional study, conducted with 293 people suffering from type 2 diabetes mellitus and older than 40 years, considering their socio-economic, demographic and clinical characteristics and lifestyle. Data collection was carried out through interviews, medical record analysis and clinical examination of the feet. **Result:** There was a risk of ulceration on the right foot in 37.2% of the cases and 35.8% in the left foot, and degree 2 risk was predominant. Complications such as greater age, low levels of education, the use of insulin and other chronic issues related to DM were factors associated with a higher prevalence of ulceration risk with regard to the feet. **Conclusion:** The need to implement action that considers the specifics of rural populations was evident, especially with regard to changes in lifestyle in order to control the DM.

**Descriptors:** Diabetes Mellitus; Diabetic Foot; Life Style; Rural Population; Nursing.

## INTRODUCTION

Type 2 diabetes mellitus (T2DM) accounts for 90% to 95% of cases and is characterized by an insulin-resistant state associated with a defect in ITS secretion. The treatment involves behavioral changes and lifestyle, but some people need oral and/or hypoglycemic agents or insulin for proper metabolic control<sup>(1-3)</sup>.

T2DM is associated with a high risk of developing microvascular and macrovascular complications, as well as of neuropathies<sup>(4)</sup>. The peripheral diabetic neuropathy mainly affects the lower limbs and, when associated with a peripheral vascular disease and infection factor, is defined as a pathophysiological condition called diabetic foot<sup>(4-5)</sup>.

Diabetic foot is one of the most serious complications of diabetes, since many cases progress to amputation. The impact on the lives of these people is great, in that it generates physical and social disabilities such as loss of employment and reduced productivity, as well as affecting their self-image and self-esteem<sup>(6)</sup>.

Due to the serious consequences of T2DM for the individual, family and society, the prevention and control of this disease are two of the priorities of primary health care services in Brazil. However, epidemiological data show that in most regions most of the basic health units are not structured to provide the necessary treatment for people with T2DM. This reality is even worse in rural areas, where people live geographically distant from public health services<sup>(7)</sup>.

Prevention is the most effective way in which to prevent foot ulcers in the case of diabetic patients. Studies have shown that education programs that include regular foot examination, risk assessment and therapeutic education, may reduce the incidence of foot injuries by 50%<sup>(1,8)</sup>.

This study aimed to determine the prevalence of risk of ulcerated feet on the part of peo-

ple with DM living in rural areas of a municipality in southern Brazil.

## METHOD

This is a descriptive exploratory cross-sectional study involving 293 patients with T2DM, registered in all the Basic Health Units (BHU) of the rural area of a large city in southern Brazil.

The sample was calculated using Epi Info version 3.5.3 software, considering the estimated prevalence of 11% of diabetics in the population aged 40 or older<sup>(9)</sup>, adopting a confidence level of 95% and a sampling error of 5 %.

Participants were selected by random drawing and were invited to participate in the study by telephone or through home visits by the community health agents.

We excluded diabetic patients under dialysis treatment, those who had active foot ulcers and those who did not present logical thinking ability and the ability to make reasoned judgments.

Data collection took place in February and March 2014 and was carried out by one of the researchers. This allowed for a uniformity of assessment and greater reliability with regard to the data obtained.

We used an instrument involving sociodemographic and clinical data, information relating to lifestyle, and associated diseases. In addition, items related to the clinical examination of the feet were recorded, as well as the classification of ulceration risk<sup>(10)</sup>.

To calculate the body mass index (BMI) we checked the weight with as little clothing as possible and height without shoes. Subsequently, we calculated the BMI by dividing weight by the squared height and classified it the individuals as underweight (BMI <18.5kg/m<sup>2</sup>), eutrophic (BMI between 18.5 and 24.9kg/m<sup>2</sup>), overweight

(BMI between 25 and 29.9kg/m<sup>2</sup>) and obese (BMI ≥ 30kg/m<sup>2</sup>)<sup>(2)</sup>. Blood pressure was checked after 5 minutes of rest by placing the cuff on the bare arm. The arm was positioned at the heart level, supported, with the palm facing upward and the elbow slightly flexed, and respondents were silent during the procedure. The values were considered normal when the systolic blood pressure was <140mmHg and diastolic blood pressure was <90mmHg<sup>(11)</sup>.

In the examination of the feet, we evaluated the neurological and vascular aspects. The evaluation of any vascular change was made by palpation of the dorsal pedis and posterior tibial pulses. For the evaluation of diabetic neuropathy we used the Semmes-Weinstein 10g monofilament test<sup>(4)</sup>. The risk of ulceration of the feet was classified as degree 0 when there was no loss of protective sensation (LPS) nor peripheral arterial disease (PAD); degree 1 related to the presence of LPS with or without deformity; degree 2 related to the presence of DAP with or without LPS; and degree 3 related to cases of prior ulceration<sup>(1)</sup>. Furthermore, the risk of ulceration was categorized as being low risk, including degrees 0 and 1, and high risk for degrees 2 and 3.

The existence of programs or systematic actions with regard to individual diabetic patients, such as risk assessment and classification to ulceration of the feet, or involving groups of diabetic individuals, was evaluated in each BHU.

Data analysis was performed using SPSS 20 software. To identify associations between variables, we used the chi-square test with the Yates correction when necessary. In all tests, we operated to a significance level of 5% (p<0.05).

The study was approved by the Ethics Committee in Research Involving Human Subjects of a public university under the opinion number 139/2013 and the Ethical As-

essment Presentation Certificate - CAAE No. 19292513.9.0000.5231.

## RESULTS

The study included 293 people with T2DM; 64.5% were female and 72% lived with a partner. With regard to skin color, 64.5% self-reported themselves as white and 25.3% as brown. The mean age was 63.7 years, the minimum age was 40 years, and the maximum was 88 years. As far as schooling was concerned, the average time in education was three years; 27.6% were illiterate; 36.5% had between one and three years of schooling; and only 12.3% had more than eight years of education.

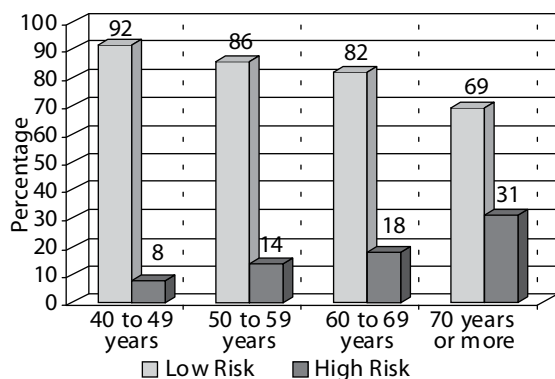
The presence of some risk of ulceration on the feet was found in 37.2% of the study participants, predominantly alterations in degree 2, followed by changes in degree 1 and degree 3, as shown in Table 1. When the degrees 0 and 1 for low risk and degrees 2 and 3 for high risk were grouped, it was found that 24.9% of the participants were at high risk in the right foot and 23.2% were at high risk in the left foot.

**Table 1.** Rating of ulceration risk in the feet of people with T2DM living in rural areas. Brazil, 2014.

Level of Ulceration Risk	Right Foot		Left Foot	
	N	%	n	%
Degree 0	184	62,8	188	64,2
Degree 1	36	12,3	37	12,6
Degree 2	56	19,1	53	18,1
Degree 3	17	5,8	15	5,1
Total	293	100	293	100

Source: authors

The high risk of ulceration was directly proportional to the age factor (p=0.048). This means that 31% of the population over 70 years of age had a high risk of foot injury, while only 8% of people under 50 fell into this category, as shown in Figure 1.



Furthermore, the educational level was inversely proportional to the risk of developing diabetic foot, in that we found that the lower the educational level, the greater the risk of ulceration ( $p=0.040$ ). However, the risk of ulceration in the feet showed no statistical significance when related to gender, race and marital status in this study ( $p>0.05$ ).

As for the habits related to lifestyle, among the respondents, 54.3% reported as being engaged in some type of diet to control T2DM, and 34.8% practiced physical activity, including 23.2% who practiced it regularly. Despite this fact, 37.2% of the sample were overweight and 47.1% were obese, according to BMI<sup>(1,4,9)</sup>.

The consumption of alcoholic beverages was reported by 31.4% of the study population and 9.6% of these individuals reported consuming too much alcohol regularly. As for smoking, 10.2% reported being active smokers and 36.2% ex-smokers.

The average T2DM diagnostic time was 9.4 years, ranging from zero to 32, and in 56% of cases the diagnosis time was less than 10 years, while 44% had been diagnosed for 10 years or more. Regarding the type of treatment, the majority of the participants (62.5%) made use of oral hypoglycemic agents as a treatment, 9.9% were insulin dependent, and 25.3% used oral hypoglycemic agents and insulin associated medication.

The type of treatment was statistically associated with risk of injury to the foot

( $p=0.024$ ), and 50.7% of those who used oral hypoglycemic agents and 28.1% of those who used oral hypoglycemic agents and insulin had a high risk of foot ulceration. The treatment was also significantly associated with loss of protective sensation of the feet: 46.3% of patients who experienced loss of sensation made use of oral hypoglycemic agents and 35.2% hypoglycemic and insulin associated medication ( $p=0.037$ ).

Systemic arterial hypertension (SAH) was identified in 86.3% of the cases. Moreover, at the time of interview and evaluation, blood pressure was elevated in 39.6% of the study participants.

Among the chronic complications found in T2DM, 29.7% had diabetic retinopathy, 8.5% said that they have had acute myocardial infarction (AMI), 6.5% had a cerebrovascular accident (CVA) and 5.8% had nephropathy. Nephropathy, retinopathy and CVA were the chronic complications associated with increased risk of ulceration in the feet, with the  $p$ -value being equal to 0.043, 0.023 and 0.015 respectively. Among the people who were at high risk of ulceration, 43.7% had diabetic retinopathy and 14% had already had a stroke.

During the clinical examination of the feet, it was identified that 11.3% of participants had a decrease in the dorsalis pedis pulse in the right foot and 10.2% has such a decrease in the left foot. In addition, 17.7% of the sample had a decrease in the tibial pulse in the right foot, and 16.7% in the left foot. The capillary refill was abnormal in 2.7% of the individuals. There was loss of protective sensation of the feet in 18.1% of the diabetic individuals. Moreover, 8.5% of the sample had already had ulceration in the feet, and the midfoot was the most frequently injured region (48%).

## DISCUSSION

The majority of the participants in this study had a low level of education. The average of three years of education is below the national average which is 8.8 years<sup>(12)</sup>. This finding corroborates other studies in rural areas, which showed one to four years of education for the majority of the participants<sup>(13-14)</sup>.

The number of years of education proved to be statistically associated with a higher prevalence of risk with regard to ulceration of the feet. This means that the lower the educational level, the greater the risk of ulceration. The low level of education is an important factor to be considered in the planning of educational activities that are necessary for controlling T2DM, as it may interfere with the understanding of the individual with regard to the prescribed care, and hence their adherence to any therapeutic plan<sup>(1,4,10)</sup>.

In addition, the low educational level can restrict the acquisition of information due to impairment in terms of reading, writing and speaking skills, as well as the understanding of the disease mechanisms and the necessary care and treatment<sup>(15)</sup>. Thus, this factor becomes a challenge for health teams, for this population requires action in terms of promoting health education that uses accessible language.

The prevalence of the risk of foot ulceration was identified in 37.2% of the sample, with a predominance of degree 2 changes, followed by degree 1 and degree 3 changes, as these numbers are higher when compared to a study in the urban area of the same municipality, which found that 12.3% of participants carried a risk of ulceration of the feet<sup>(10)</sup>. In addition, in another study carried out in a municipality in Spain, the results showed that 14.5% of the patients had degree 1 risk of ulceration, 26% degree 2 and 14.5% degree 3<sup>(16)</sup>.

These results indicate disparities in terms of urban and rural areas. The highest prevalence of change in terms of the feet of rural residents can be associated with the working life of this population which is exposed to trauma and injuries due to the activities on the land and with animals, and poor adherence to self-care.

Another issue is the constraints related to accessing health services. These arise due to distance, transportation difficulties and problems accessing these institutions. In this context, the envisaged assistance for controlling the disease, including specialized medical consultations and periodic examinations, is impaired, and is still excluded from monitoring and self-care education programs. Many of these individuals only receive some assistance during home visits involving Family Health Strategy teams. However, the limited human and structural resources of the BHU do not allow such action to be regular and effective in the control of T2DM in this population.

When the low-risk and high-risk results were grouped, there was a high prevalence of people at high risk in terms of foot ulceration. This value was higher than that identified in another study conducted in the urban area of the same municipality, in which it was found that 8.8% of the diabetic individuals aged 40 or older, living in urban areas, were at high risk for ulceration<sup>(10)</sup>, which again shows that the rural population is more vulnerable to risks of ulceration and subsequent amputation.

During the research we have also identified that the evaluation of the feet and the classification of risk for ulceration were not performed in any BHU of the rural municipality studied. Most participants demonstrated a desire for continuity in terms of such assessments, allowing them to understand the meaning of these actions in such a way that it can reduce the risk of ulcers and consequent amputation. The classification of risk for ulceration should be considered in

scheduling returns for assessment of these feet in primary care<sup>(1,4,9)</sup>.

In relation to lifestyle, although more than half of the participants mentioned the adoption of some sort of diet or food control, and the fact that 34.8% of cases are associated with physical activity, overweight and obesity rates are still high. It is believed that, since these are self-reported conditions, some participants, even those who are not on a diet or performing physical activities, said that they are doing so. The lifestyle of people with T2DM needs to be reconfigured to prevent the complications of the disease. This is a key activity focus, and it is one of the biggest challenges for nurses, as they are modifiable factors; however, there is still much resistance to change, especially related to food, physical activities and smoking<sup>(2,6,8)</sup>.

Obesity is considered a major risk factor in terms of developing T2DM, hypertension and dyslipidemias, given that in communities with low income and education, and in rural areas, this is a prevalent condition<sup>(17)</sup>. Another relationship with obesity is the power of culture in the countryside which, from the start, meant that diet had to be more calorific and always prepared with a lot of animal fat, to maintain strength for the heavy physical labor required by rural activities.

As far as the smoking habit is concerned, the results of a study conducted in northeastern Brazil showed that 24% of individuals were smokers. Another study developed in Pernambuco found 12% of smokers. Smoking is a cause of increased morbidity and mortality, and contributes to the high number of lower extremity amputations related to diabetes. Studies report that the amputation risk for smokers is increased by 4.6 times compared to non-smokers. In this sense, it is essential that health professionals contribute to the educational guidance that may not only provide support for smoking cessation,

but also clarify the harm tobacco may cause to individuals<sup>(18-19)</sup>. The percentage of former smokers draws attention to the awareness of smoking risks in this population. The smoking groups are now a reality in urban areas; thus, there is now the need to target these groups in the countryside, so that more people can quit smoking.

The average T2DM diagnostic time for this study was similar to that of other studies where most participants had T2DM diagnosis time of less than 10 years<sup>(15-16,18-19)</sup>.

Disease duration is a factor that should be considered in diabetic foot prevention actions, since studies have found that there is a greater propensity to develop lesions in patients who have been sick for over 10 years. These data are relevant, because the diagnosis of T2DM can be delayed, bringing numerous complications that contribute to the increased risk of ulceration and lower limb amputation. Another factor to consider is that the longer the time before diagnosis, the lower the adherence to treatment. That is, the variable time of diagnosis has an inverse relationship to treatment adherence, which increases the risk of complications from poor metabolic control<sup>(15,16,18)</sup>.

Hypertension was identified as a factor associated with T2DM. At the time of interview and evaluation, blood pressure was elevated in 39.6% of the study participants. These data are similar to those of another study in which 84.6% of patients were hypertensive, and 22.5% had high blood pressure on collection of the data<sup>(19)</sup>. The prevalence of hypertension is two to three times higher in diabetic patients than in the general population. About 70% of the diabetic individuals are hypertensive<sup>(20)</sup>.

When ineffective glycemic control is associated with hypertension, obesity and dyslipidemia, it becomes a predisposing factor for the aggravation and/or appearance of lesions

in diabetic individuals' feet. These factors are amenable to change through interventions that promote adherence to the treatment of these pathologies, associated with periodic monitoring and nursing care, in order to prevent complications in the feet<sup>(2,21)</sup>.

The chronic complications of T2DM, such as diabetic retinopathy, nephropathy and CVA also showed a statistical significance regarding the prevalence of a high risk for ulceration. Retinopathy is considered a risk in terms of visual impairment, which can disrupt self-care practices and nephropathy, and these can cause dryness and cracking of the feet<sup>(19)</sup>.

The results relating to changes in dorsal pedis and tibial pulses, loss of protective sensation of the feet and previous ulceration, were similar to the data study conducted in Spain, which identified the reduction of pulses in 16.6% of the population studied, and the loss of protective sensation in 20.83%. Besides that, 14.5% also reported previous ulceration<sup>(16)</sup>.

The presence of dorsalis pedis pulse or reduced posterior tibial pulse, altered the capillary refill, and a history of previous ulcers is directly related to the presence of a high risk of ulceration<sup>(5,21)</sup>. Sensory changes can affect pain sensitivity, perception of pressure, temperature and proprioception. The loss of protective sensation exposes diabetic patients to extrinsic factors, insensitivity to foreign bodies, and traumas<sup>(1)</sup>.

Considering equity as one of the main guidelines of the Brazilian health system, the population of rural areas, which is vulnerable to various types of diseases due to limited access to health programs, should be the focus of discussions related to public policies in terms of health prevention, promotion and rehabilitation<sup>(8)</sup>.

Diabetic foot can be prevented by means of glycemic control and other simple measures such as periodic evaluation of feet in search for injuries, hydration, cutting nails and adequate

drying between the interdigitals to prevent mycoses<sup>(8,21)</sup>.

Due to the fact that nursing staff are responsible for care education, they have a fundamental role to play in the prevention and early detection of foot injuries among diabetic patients. The current protocol, determined by the Ministry of Health, focuses on the importance of the evaluation of the lower limbs of people with diabetes during the consultation with the nurse as an intervention measure to prevent diabetic foot<sup>(3)</sup>.

A study in southern Brazil found that most people with diabetes who were hospitalized for complications, had low knowledge and a negative attitude towards DM<sup>(22)</sup>. These data would be more appropriate if the lack of knowledge was tackled by the formation of diabetic groups in primary care.

Nevertheless, there was no practice of any systematic activity to promote the health of people with DM assisted by BHU who participated in this research. Similarly, there was no such activity with regard to setting up diabetic and hypertensive groups, which certainly would contribute to the spread of self-care strategies.

## CONCLUSION

A high prevalence of risk in terms of the ulceration of the feet of people with T2DM living in rural areas was identified in this study. Moreover, most of the individuals in the sample were overweight, and suffered from hypertension and other complications related to T2DM.

The primary care services in rural areas need to be structured in such a way that they can meet the needs of diabetic individuals at risk of ulceration of the feet, and also those without risk at the moment, who also need at least an annual assessment of the feet.



It is important that professionals are trained so that they are in a position to implement a care program for T2DM and other chronic diseases encountered in primary health care services, with actions for assessing feet and for classifying ulceration risks in such a way as to meet the specifics of those living in rural areas.

The ulceration risk stratification of the feet, performed during nursing consultations or home visits is an important tool for organizing the assistance and allocation of resources for the prevention and early treatment of diabetic feet.

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