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ORIGINAL ARTICLE

FACTORS ASSOCIATED WITH THE RISK OF DEVELOPING FOOT INJURY IN PEOPLE WITH DIABETES

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ABSTRACT

Objective: To identify the factors associated with the risk of foot injury in people with diabetes mellitus. **Methodology:** A cross-sectional study with individuals with diabetes mellitus treated in two Family Health Units of a capital city in the Brazilian Midwest. Data collection took place in the months of March to November 2023. For statistical analysis, the SPSS program (version 26) was used. To analyze the association between the variables of clinical factors and the risk of foot ulceration, the chi-square test with Yates correction was applied, considering a significance level of 5%. In addition, dispersion measurements with standard deviation and 95% confidence intervals were calculated. **Results:** 55 individuals with diabetes mellitus participated in the study. The time of diagnosis greater than 10 years, inadequate glycemic control and dyslipidemia showed a statistically significant association with the risk of foot injuries. **Conclusion:** The results of this study provide subsidies for the prevention and management of complications in people with diabetes and elucidate the need to implement prevention strategies, improve screening and monitoring, promotion of lifestyle changes and multiprofessional integration in care.

Keywords: Primary health care. Nursing. Diabetes mellitus. Diabetic foot.

INTRODUCTION

Diabetes mellitus (DM) is a chronic disease characterized by metabolic disorders that can lead to several complications over time. It is estimated that, by 2045, approximately 232 million individuals between 20 and 79 years of age will have diabetes in Brazil, with Type 2 Diabetes Mellitus (DM2) being the most prevalent form, accounting for about 90% of cases in the adult population[1].

When not controlled, DM2 can cause microvascular and macrovascular complications, affect target organs and compromise the quality of life of individuals. Among these complications, peripheral neuropathy is one of the most frequent and can evolve silently, leading to progressive loss of sensitivity in the lower limbs[1]. This condition significantly increases the risk of foot injury, a condition known as diabetic foot[2], which, if not properly managed, can result in severe infections and amputations[3]. Studies conducted in the Northeast[4] and Southeast[5] regions of Brazil highlight that the lower limbs are the areas most susceptible to non-traumatic amputations of vascular origin.

Despite the severity of this condition, studies point to failures in the knowledge and practice of self-care with feet among people with DM, compromising the prevention of complications[6]. The Chronic Care Model (CCM) emphasizes the importance of education and interdisciplinary monitoring to promote effective self-care practices in diabetes management[7]. In this context, a randomized clinical trial demonstrated that interventions aimed at supported self-care improve patients' level of knowledge, strengthening their autonomy in injury prevention[8]. Similarly, a

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study conducted in China showed that education programs for early symptom recognition and lifestyle management were more effective and cost-effective than conventional educational approaches[9].

In Brazil, nurses play a key role in assisting people with DM2, especially in the ongoing monitoring and promotion of self-care. Studies indicate that most self-care interventions in chronic conditions, including DM2, are conducted by nurses, compared to other health professionals[10,11]. This is because, in Primary Health Care (PHC), nurses are responsible for the screening of complications, guidance on foot care and early detection of risk factors, contributing to the reduction of the incidence of injuries and amputations[7].

The prevention of foot injuries should include regular assessments of protective sensitivity, skin integrity and circulation, as well as early identification of conditions such as callosities and interdigital mycosis that may increase the risk of ulcerations[12]. However, data from the 2013 National Health Survey showed a low proportion of foot examinations performed by health professionals in Brazil, with the Midwest region showing the lowest percentage[13]. A recent study conducted in Rio Grande do Sul (2023) reinforces this reality, showing that only 20.5% of the participants reported having their feet examined by professionals, with only 12.5% being at the Basic Health Unit (BHU)[14].

Although there are studies on the prevention and care of feet of people with DM in different regions of the country, few studies analyze the local factors that influence foot health in the diabetic population of the Midwest. Understanding these factors is essential to support more effective prevention strategies, reduce serious complications and improve the clinical management of patients.

Given this scenario, this study seeks to answer the following question: What are the clinical and behavioral factors associated with the risk of foot injuries in individuals with DM2? Thus, the objective of this study is to identify the main factors associated with the risk of developing foot injury in individuals with DM2.

METHODOLOGY

Cross-sectional study, guided by the research report Strengthening the Reporting of Observational studies in Epidemiology (STROBE). The study is part of a matrix research funded by the State Foundation in which the research was developed, entitled: "Self-care supported in the management of Diabetes Mellitus in Primary Care: intervention and evaluation". The general objective of this matrix project was to carry out evaluation and intervention focusing on diabetes management and stimulation of self-care among users registered in two Family Health Units (FHUs) in a capital city in Midwestern Brazil.

At the time of the study, the FHUs selected by convenience, called unit "A" and unit "B", had respectively 315 and 270 registered users with DM2. Participants in the matrix project (people with self-reported DM2 aged over 18 years) were included in this study stage. In turn, those who presented verbal comprehension problems that hindered or prevented communication and, consequently, participation in the study were excluded. However, there was no case.

To select the participants, initially, a list containing the telephone contact of individuals registered with DM2 was requested to the coordination of each health unit and, subsequently, an active search was carried out together with the Community Health Agent. After the acceptance, the scheduling for data collection was carried out, which occurred in the FHUs, according to the days and times of preference of the participant.

Data collection occurred in the months of March to November 2023 through the instrument used by the Municipal Health Department (SESAU) of the municipality of Campo Grande, MS, developed for use by nurses in the health units of the city as a script in the evaluation of the feet of people with DM. This form was structured from the materials[15,16], with the following information: (1) sociodemographic data - age, sex, marital status, occupation, schooling; (2) anamnesis – time since DM diagnosis, tobacco use, presence of arterial hypertension, history of acute myocardial infarction, stroke, use of medications

for diabetes, hypertension or neuropathy, glycemic control, among others; (3) clinical history of the feet - risk factors for diabetic foot and precursor signs of foot ulcers; (4) a script for physical examination of the feet - assessment of amputation, presence of corns, cracks, hygiene, temperature of the feet, pallor, presence of ulceration, among others; (5) sensitivity assessment - figure of two feet with circular sites to indicate the presence or absence of local sensitivity, by means of 10 g monofilament of Semmes-Weinstem; (6) vascular palpation evaluation of the presence of the pedious pulse; and (7) risk classification and referral (Figure 1)[16].

Figura 1. QR code for the Foot Assessment Instrument for Users with Diabetes.
Source: SESAU File.

Thus, in the FHU to which the participant was linked and on the day and time previously scheduled, the main researcher collected sociodemographic information, anamnesis and clinical history of the feet. Moreover, participants were asked about physical activity for at least 150 minutes per week of moderate intensity, as recommended by the World Health Organization[17].

At the same time, the researcher carried out a physical examination of the feet, which included: inspection (to identify amputation, presence of corns, cracks, hygiene conditions, according to the physical examination schedule of the feet) and palpation of the pedious pulses[16]. Hygiene was considered adequate when the feet were clean and dry, and the minimum presence of dirt, such as dust from walking to the collection site, was not considered.

For sensitivity evaluation, 10 g monofilament of Semmes-Weinstem were used in the plantar region. Subsequently, there was the classification of the Degree of risk for the development of foot ulcers: Grade 0, with absent neuropathy; Grade 1, with present neuropathy, with or without deformities; Grade 2, with peripheral arterial disease, with or without present neuropathy; and Grade 3, with history of ulcer and/or amputation, according to the form prepared by SESAU (figure 1)[16] .

Blood was collected from all participants who were part of the matrix survey to perform the following laboratory tests: glucose, lipid profile, urea, creatinine and glycated hemoglobin. In the present study, the results of glycated hemoglobin and lipid profile were used. Lipid and glycemic control parameters were considered. The altered lipid fraction was classified as dyslipidemia, either in isolated hypercholesterolemia, isolated hypertriglyceridemia, mixed hyperlipidemia and/or low HDL-c[18]. For adequate glycemic control, HbA1c values below 7% were considered, a value recommended for the prevention of microvascular complications in individuals who already have DM[19].

For statistical analysis, the program Statistical Package for the Social Sciences (SPSS), version 26, was used. The data were tabulated in Microsoft Office Excel® and analyzed by means of descriptive and bivariate analysis. To analyze the association between the variables of clinical factors and the risk of foot ulceration, the chi-square test with Yates correction was applied, considering a significance level of 5%. Furthermore, dispersion measurements with standard deviation and 95% confidence intervals were calculated.

The study followed the norms of the Resolutions n. 466/2012 and n. 510/2016, thus being submitted on the Brazil Platform and obtaining approval from the Human Research

Ethics Committee of the Federal University of Mato Grosso do Sul, opinion n. 4.321.389, CAAE: 37530720.7.0000.0021, in addition to the consent of all participants, by reading and signing the Informed Consent Form. For each participant, an identification number was assigned in order to maintain the confidentiality of individuals.

RESULTS

The participants were 55 individuals with DM2, being 67.3% elderly. Of these, 69.1% were female, and 90.9% did not use tobacco. Regarding marital status, 54.5% had a stable union. In addition, 47.3% of the participants were retired, 30.9% housekeeper and 21.8% had another type of occupation.

Regarding schooling, 94.6% attended school; however, 56.3% had incomplete elementary education and 18.2% had incomplete secondary education. The time since diabetes diagnosis ranged from five months to 38 years, with an average of 8.85 years. In addition, 12.7% have a history of acute myocardial infarction, 3.6% cerebrovascular accident and 1.8% both incidents. Table 1 shows the clinical changes verified on the physical examination of the feet.

Table 1. Clinical changes in the feet and self-care practices in patients with DM2 observed during physical examination

Variables	N	%
Presence of corns	31	56,40%
Presence of onychomycosis	29	52.7%
Presence of cracks	9	16.4%
Thin, shiny skin	8	14.5%
Decreased pedious pulse	5	9.1%
Decreased anterior tibial pulse	12	21.8%
Altered sensitivity to monofilament	31	56.4%
Habit of walking barefoot		
Yes	6	10.9%
No	49	89.1%
Suitable shoes to avoid deformities		
Yes	5	9.1%
No	50	90.9%
Proper hygiene		
Yes	53	96.4%
No	2	3.6%
Total	**55**	**100%**

Source: The author.

Concerning the physical examination and self-care practice with feet, no finding was statistically associated with the risk of foot injury. Nevertheless, the high prevalence of corns, onychomycosis and the habit of wearing inappropriate shoes are highlighted as risk factors for developing foot injury[20]. However, most participants, 89.1%, do not have the habit of walking barefoot.

As for the classification of the degree of risk, 53.8% of the individuals were classified with Grade 0, 34.6% classified with Grade 1 and 11.6% with Grade 2. Therefore, it was identified the presence of predisposing factors for foot ulceration, with a risk of ulceration in 60% of the participants. In the evaluation of clinical aspects, hypertension was identified in 81.8% of the participants and dyslipidemia in 76.4% of the participants. In addition, 52.7% presented inadequate glycemic control. Furthermore, 56.4% of the participants reported practicing some type of physical activity regularly.

Variables related to clinical aspects and life habits, such as diagnosis of diabetes above 10 years, glycemic control, arterial hypertension, dyslipidemia and practice of physical activity, showed associations with the risk of foot ulceration. However, only some of these associations were statistically significant. The diagnosis of diabetes above 10 years (p=0.039), inadequate glycemic control (p=0.002) and dyslipidemia (p=0.014) were significant, indicating a greater likelihood of foot injury, as shown in Table 2.

Table 2. Distribution of participants with DM2 according to the risk of foot injury according to clinical factors and lifestyle habits

Variables	Risk of foot injury			
	No	Yes	p-valor	
	N (%)	N (%)		OR-95%
Diabetes for more than 10 years			***0,039**	
Yes	3 (13.6%)	13 (39.4%)		b
No	19 (86.4%)	20 (60.6%)		4.117 (1.011-16.755)
Glycemic control			***0.002**	
Yes	16 (72.7)	10 (30.3)		b
No	6 (27.3)	23 (69.7)		0.163 (0.049-0.539)
Systemic arterial hypertension			***1.000**	
Yes	18 (81.8)	27 (81.8)		
No	4 (18.2)	6 (18.2)		
Dyslipidemia			***0.014**	
Yes	13 (59.1)	29 (87.9)		b
No	9 (40.9)	4 (12.1)		5.019 (1.305-19.309
Physical activity			***0.375**	
Yes	14 (63.6)	17 (51.5)		
No	8 (36.4)	16 (48.5)		

OR- Odds ratio
b- baseline
*Chi-square test, with Yates correction, at 5% level
Source: The author

DISCUSSION

The results of the present study suggest that the time since diabetes diagnosis, inadequate glycemic control and dyslipidemia are factors associated with the development of foot injuries. These results corroborate a study conducted in Piauí, in which people with DM presented inadequate glycemic control, dyslipidemia and, in the clinical examination of the feet, showed dry skin and/or corns[21].

A study conducted in a municipality of the state of Maranhão, as well as participants of this study, showed mostly female participants, 65.8%, retired, 49.1%, with stable union, 51.1%, incomplete elementary school, 42.4% and less than half of the participants had been diagnosed with DM for more than ten years[20]. Other studies also showed a predominance of females[21,22]. The prevalence of female sex may be related to the fact that men tend to use health care units late and may encounter cases of exacerbation of the condition, which leads them to seek emergency services[23].

Although the number of participants with DM for more than ten years represents just under half of the respondents, it is important to note that this condition was presented as a risk factor for the appearance of foot injury in this study. A similar result was evidenced in a cross-sectional study with 284 interviewees[20]. The complications of DM are directly linked to the time of diagnosis and glycemic control, since peaks in hyperglycemia for long periods affect nerves and peripheral vessels, increasing the risk of amputations[1].

In relation to the physical examination of the feet, the main clinical changes observed were the presence of corns, onychomycosis and altered sensitivity to monofilament, which, despite not statistically associated with the risk of foot injury, constitute a risk factor for the appearance of injuries[20]. These findings corroborate a study that also evaluated the factors associated with the risk of developing foot injury, in which dry skin and/or corns were the most common complications. However, it diverged from the sensitivity preserved to monofilament, 68.3%[21].

Regarding the practice of self-care with feet, most participants in this study reported not having the habit of walking barefoot. These findings are in line with the results of a study conducted in a municipality in the state of Ceará, whose objective was to identify the knowledge and ways of adherence to self-care practices with feet, in which 96.1% of participants reported avoiding walking barefoot. Nevertheless, while the participants in this study reported not wearing appropriate shoes to avoid

deformities, most of the participants in the study in Ceará stated adopting this practice[24].

It should be noted that the habit of walking barefoot and the use of inappropriate shoes can contribute to the appearance of corns, areas that must be evaluated for the need to remove them in order to reduce plantar pressure. Moreover, habits such as the continuous evaluation of feet, daily hydration, hygiene and adequate drying between fingers are configured as protective and preventive habits for the appearance of this complication[20]. Actions that should be guided by nurses and/or doctors of the Primary Health Care with a view to promoting comprehensive care for people with DM2.

In addition, the altered sensitivity to monofilament, present in more than half of the participants, highlights the need for fundamental care. Among the preventive measures, it is important to evaluate the water temperature during bathing, avoid the use of foot warmers and reduce exposure to heat sources, in order to prevent possible burns[12].

Among the comorbidities found, dyslipidemia was shown to be a risk factor for foot injury. Although, in the present study, Arterial Hypertension did not show a statistically significant association with the risk to develop foot lesions, a study conducted in Piauí found that both dyslipidemia and hypertension were statistically associated with the risk of foot injury[25]. It is emphasized that the control of blood pressure and cholesterol can prevent complications, among them, the appearance of foot injury[1].

Concerning the classification of the risk of foot injury, the present study indicated a predominance of low risk, that is, absent neuropathy. Similar results were observed in Brazilian studies[26,27] and in international studies, such as a study conducted in Portugal[28]. Although in different percentages, both studies rated the majority of participants at low risk. We can infer from this that the screening of factors predisposing to foot injury enables early interventions, reducing the number of amputations in lower limbs.

Furthermore, studies have shown that the evaluation of the feet of individuals with diabetes by health professionals is low[13,14]. Given this, the evaluation of feet should be integrated into the care routine and follow-up to people with diabetes by professionals of Primary Health Care in order to identify early possible clinical changes, observed during the physical examination of the feet and thus ensure appropriate interventions.

Among the participants in this study, 60% presented predisposing factors for foot ulceration, a higher result than that found in a study conducted in Paraná with 71 individuals with DM2, which identified 35.2% of the participants at risk for foot ulceration[29]. Overall, the annual incidence of foot ulcers in people with diabetes varies between 2% and 4%. Moreover, it is estimated that 25% of diabetic people will develop foot ulcers throughout their lives[30], which reiterates the need for comprehensive and quality care offered by Primary Care teams[31]. The higher prevalence of participants in this study suggests that there are more pronounced risk characteristics or that environmental factors and access to care influence this rate, which leads to gaps for future studies.

The findings of this study may contribute to clinical practice, especially by presenting possible regional variables (access to health services, epidemiological profile, socioeconomic conditions) associated with the risk of developing foot injuries in people with DM. This information allows the planning and implementation of effective preventive interventions, minimizing serious complications such as infections, ulcers and amputations that, in addition to consequences for the individual, have a social and economic impact on the Health System.

However, we point out the need for studies that assess the local challenges in performing foot examinations in individuals with diabetes by health professionals. In addition, we highlight the need to develop strategies that promote self-care with feet and regular foot assessment in the routine follow-up of people with DM2 in Primary Health Care.

The limitations of the study concern the performance of foot assessments by more than one researcher, although they were trained, in addition to the origin of self-reported data on the actions of self-care with the feet, which may be subject to memory bias or social desirability

(participants may report more appropriate practices than they actually perform).

CONCLUSION

The main risk factors associated with the development of foot injury in people with DM2, compared to clinical factors, were the diagnosis of diabetes above 10 years, inadequate glycemic control and dyslipidemia. Furthermore, clinical changes such as corns and onychomycosis were prevalent in the study participants.

When evaluating the degree of risk, most participants presented Grade 0, with no neuropathy.

Although other risk factors are not statistically significant, they should not be discarded by professionals, since they are considered as risk factors according to the literature. Therefore, it is suggested to perform physical examination of the feet, educational interventions aimed at self-care and the classification of the degree of risk of foot injury as routine in the assistance, aiming to reduce clinical complications and serious foot injuries.

FATORES ASSOCIADOS AO RISCO DE DESENVOLVIMENTO DE LESÃO NOS PÉS DE PESSOAS COM DIABETES

RESUMO

Objetivo: Identificar os fatores associados ao risco de lesão nos pés de pessoas com Diabetes Mellitus. **Metodologia:** Estudo transversal com indivíduos com Diabetes Mellitus atendidos em duas Unidades de Saúde da Família de uma capital do Centro-Oeste brasileiro. A coleta de dados ocorreu nos meses de março a novembro de 2023. Para a análise estatística, foi utilizado o programa *SPSS (v*ersão 26). Para analisar a associação entre as variáveis de fatores clínicos e o risco de ulceração dos pés, foi aplicado o teste qui-quadrado com correção de yates, considerando um nível de significancia de 5%. Além disso, foram calculadas medidas de dispersão com desvio-padrão e intervalos de confiança de 95%. **Resultados**: Participaram do estudo 55 indivíduos com Diabetes Mellitus. O tempo de diagnóstico superior a 10 anos, controle glicêmico inadequado e a dislipidemia apresentaram associação estatisticamente significativa com o risco de lesões nos pés. **Conclusão:** Os resultados do presente estudo oferecem subsídios para a prevenção e o manejo de complicações em pessoas com Diabetes e elucidam a necessidade de implementação de estratégias de prevenção, melhoria do rastreamento e monitoramento, promoção de mudanças no estilo de vida e integração multiprofissional no cuidado.

Palavras-chave: Atenção primária à saúde. Enfermagem. Diabetes mellitus. Pé diabético.

FACTORES ASOCIADOS AL RIESGO DE DESARROLLAR LESIONES EN LOS PIES DE PERSONAS CON DIABETES

RESUMEN

Objetivo: analizar el uso de las redes y/o medios sociales y su interfaz con las buenas prácticas de atención al parto y identificar los factores asociados al riesgo de lesión en los pies de personas con Diabetes mellitus. **Metodología**: estudio transversal con individuos con Diabetes mellitus atendidos en dos Unidades de Salud de la Familia de una capital del Centro-Oeste brasileño. La recolección de datos ocurrió en los meses de marzo a noviembre de 2023. Para el análisis estadístico, se utilizó el programa *SPSS* (versión 26). Para analizar la asociación entre las variables de factores clínicos y el riesgo de ulceración de los pies, se aplicó la prueba de chi-cuadrado con corrección de Yates, considerando un nivel de significancia de 5%. Además, se calcularon medidas de dispersión con desviación estándar e intervalos de confianza de 95%. **Resultados**: participaron en el estudio 55 individuos con Diabetes mellitus. El tiempo de diagnóstico superior a 10 años, control glucémico inadecuado y la dislipidemia presentaron asociación estadísticamente significativa con el riesgo de lesiones en los pies. **Conclusión**: los resultados del presente estudio ofrecen aportes para la prevención y el manejo de complicaciones en personas con Diabetes y elucidan la necesidad de implementar estrategias de prevención, perfeccionamiento del rastreo y monitoreo, promoción de cambios en el estilo de vida e integración multiprofesional en la atención.

Palabras clave: Atención primaria de salud. Enfermería. Diabetes mellitus. Pie diabético.

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