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ORIGINAL ARTICLE

Altered touch perception and associated risk factors in individuals with diabetes mellitus

Percepção do tato alterada e fatores de risco associados em indivíduos com diabetes mellitus

Percepción alterada del tacto y factores de riesgo asociados en individuos con diabetes mellitus

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ABSTRACT

Objective: To evaluate the prevalence of altered touch perception in the feet of individuals with diabetes *mellitus* and the associated risk factors. **Method:** Cross-sectional study with 224 individuals with diabetes *mellitus* conducted in an endocrinology clinic at a public hospital in Campina Grande, Paraíba. The evaluation used touch sensitivity and perception, and a descriptive and multivariate analysis with Poisson regression was performed. **Results:** We found the prevalence of altered touch perception to be 53.1%. The risk factors that had a significant and joint impact on its occurrence were: female gender; previous ulcer; diabetes *mellitus* type 2; burning sensation, cracks, fissures, calluses, and Charcot foot. **Conclusions:** This study found a high prevalence of altered perception of touch, and this should support the planning of actions aimed at preventing the problem. The study showed the relevance of the phenomenon as a nursing diagnosis that could be included in NANDA-International.
Descriptors: Touch Perception; Diabetic Neuropathies; Diabetes *Mellitus*; Risk factors; Nursing care.

RESUMO

Objetivo: Avaliar a prevalência da percepção do tato alterada nos pés de indivíduos com diabetes *mellitus* e os fatores de risco associados. **Método:** Estudo transversal com 224 indivíduos com diabetes *mellitus* conduzido em ambulatório de endocrinologia de hospital público de Campina Grande, Paraíba. Testes de sensibilidade e percepção do tato foram empregados na avaliação; e foi realizada análise descritiva e multivariada com regressão de Poisson. **Resultados:** Encontrou-se prevalência da percepção do tato alterada de 53,1%. Os fatores de risco que tiveram impacto de forma significativa e conjunta na sua ocorrência foram: sexo feminino; úlcera prévia; diabetes *mellitus* tipo 2; queimação, rachaduras, fissuras, calosidades e pés de Charcot. **Conclusões:** Alta prevalência da percepção do tato alterada foi encontrada, e esta deve subsidiar o planejamento de ações voltadas para a prevenção do problema. O estudo evidenciou a relevância do fenômeno enquanto um diagnóstico de enfermagem passível de inclusão na NANDA-International.
Descritores: Percepção do Tato; Neuropatias Diabéticas; Diabetes *Mellitus*; Fatores de Risco; Cuidados de Enfermagem.

RESUMEN

Objetivo: Evaluar la prevalencia de la percepción alterada del tacto en los pies de individuos con diabetes *mellitus* y los factores de riesgo asociados. **Método:** Estudio transversal con 224 individuos con diabetes *mellitus* conducido en ambulatorio de endocrinología del hospital público de Campina Grande, Paraíba. Testes de sensibilidad y percepción del tacto han sido empleados en la evaluación; y ha sido realizado análisis descriptivo y multivariado con regresión de Poisson. **Resultados:** Ha sido encontrado prevalencia de la percepción alterada del tacto de 53,1%. Los factores de riesgo que tuvieron impacto de forma significativa y conjunta en su ocurrencia han sido: sexo femenino; úlcera previa; diabetes *mellitus* tipo 2; irritación, rajaduras, fisuras, callosidades y pies de Charcot. **Conclusiones:** Alta prevalencia de la percepción alterada del tacto ha sido encontrada, y esta debe subsidiar el planeamiento de acciones vueltas para la prevención del problema. El estudio evidenció la relevancia del fenómeno en cuanto un diagnóstico de enfermaría pasible de inclusión en la NANDA International.
Descriptores: Percepción del Tato; Neuropatías Diabéticas; Diabetes *Mellitus*; Factores de Riesgo; Cuidados de Enfermaría.

INTRODUCTION

Diabetes *Mellitus* (DM) is part of the group of metabolic diseases of multiple etiologies and, given the increase in its prevalence, has been treated in recent years as a global public health problem[1]. According to the International Diabetes Federation (IDF), 425 million adults worldwide live with diabetes, which corresponds to 8.5% of the world population[2]. Brazil occupies the fourth place in the world ranking of cases of the disease, affecting more than 14.3 million people, with an estimated prevalence of 9.4% of the national population[2].

The World Health Organization (WHO) divides the DM complications into two groups: microvascular and macrovascular[3]. Microvascular complications are those that cause damage to capillaries, such as those that affect the eyes, kidneys, and nerves. Macrovascular diseases include heart disease and insufficient blood flow to the extremities of the body, especially in the lower limbs[4].

Diabetic neuropathies are considered the most prevalent microvascular complications and involve changes related to the structure and function of sensory, motor, and autonomic nerve fibers[5]. It appears that the problem affects approximately 50% of individuals with DM[6], and it is frequently underreported and treated inappropriately, which can lead to an increased risk of both morbidity and mortality[7].

The diagnosis of diabetic polyneuropathy is based mainly on physical examination and the finding of dermatological manifestations such as the presence of dry skin, cracks, hypotrophic or ingrown nails, maceration of the interdigital spaces and mycoses, calluses, absence of hair and changes in skin color and temperature (indicating ischemia), which are pre-ulcer conditions[8]. Thus, the physical examination must include the evaluation of the feet concerning the characteristics of muscle tone, tendon reflexes, sensitivity, and vibration tests[7,9].

Also, as recommended by national and international guidelines of the Brazilian Diabetes Society[10-12], it is essential to assess changes in the perception of individuals with DM during their clinical follow-up in order to identify early signs and symptoms of diabetic neuropathy and thus avoid complications such as diabetic foot[13]. This assessment can be made using the 10 G monofilament associated with other tests, such as those of vibratory and painful sensitivity and the Achilles reflex[9,11].

Studies have o been investigating the change in the touch perception in patients undergoing chemotherapy[13], in individuals with diabetes *mellitus* and alcoholics[14]. However, studies focusing on this problem in individuals with diabetes *mellitus* are scarce in Brazil, requiring further clarification on the risk factors associated with altered touch perception. Besides, NANDA International (NANDA-I) currently does not include a nursing diagnosis that identifies this human response. In this sense, there is a need for clinical studies on the signs, symptoms and risk factors associated with altered touch perception, since it is a common affection in individuals with DM, subject to assessment and intervention by nurses.

OBJECTIVES

To evaluate the prevalence of altered touch perception in the feet of individuals with diabetes *mellitus* and the associated risk factors.

METHOD

Ethical aspects

The study followed the principles of Resolution 466/12, of the Brazilian National Health Council, having been approved by the Research Ethics Committee. Individuals who agreed to participate in the study signed the Free and Informed Consent Form.

Study Design, location, and period

A cross-sectional study, with a quantitative approach, carried out with individuals with DM attended at an endocrinology outpatient clinic of a public hospital in the city of Campina Grande, Paraíba, Brazil, between May and October 2017. The Strobe instrument was used to analyze cross-sectional studies.

Population or sample; inclusion and exclusion criteria

For the sample calculation, a proportion of changes in tactical sensitivity in the population of interest was considered to be 20.7%[15], with a 95% confidence interval and a margin of error of 0.05. A finite population composed of 6,333 individuals with DM registered in 2016, in the municipality of Campina Grande, was employed. Thus, the minimum sample size foreseen for the study was 224 individuals.

Participants were recruited on the day of the appointment, at the endocrinology service, using the following inclusion criteria: medical diagnosis of type 2 DM or type 1 DM, after five years of diagnosis, when complications begin to appear[10]; and preserved cognitive ability. Cognition assessment was performed using the Mini-Mental State Examination (MMSE) instrument. Nine individuals with injury and/or amputation in the lower limbs and 17 who did not participate in the clinical evaluation of the feet were excluded.

Study Protocol

Data collection was carried out by the leading researcher and two undergraduate students previously trained and capable of applying an instrument composed of sociodemographic and clinical questions[16], in order to conduct individual interviews, data searches in the medical records, clinical tests, and data recording. Adjustments were made to the instrument after the application of a pilot study with 30 individuals with DM treated at the study location in 2017. The final version of the instrument was made up of 55 questions organized as follows: sociodemographic aspects, general and foot clinical assessment. Each interview and evaluation lasted an average of 40 minutes.

The diagnosis of altered touch perception was based on the abnormal response to the protective sensation test or the monofilament test, concomitant to a second altered test, such as vibratory sensitivity, painful sensitivity, or Achilles reflex[7,9]. During all tests, the patients lied down and received instruction to remain with his eyes closed during these assessments. All tests were applied three times in the same place, alternating two true applications and one false confirmation. The presence of altered touch perception was considered as a dependent variable, which was categorized as absent (no) or present (yes).

The test of the plantar protective sensation was performed with the 10 G monofilament, made in Brazil (SORRI®-Bauru, SP).

This monofilament exerted a buckling force of 10 G when bending and was applied at an angle perpendicular to the skin surface when it was slightly bent. The researched regions were: hallux (plantar surface of the distal phalanx) and the 1st, third, and fifth metatarsal heads of each foot[7,9].

For the vibratory sensitivity test, the tuning fork was used. After percussion with the tuning fork, it was applied perpendicularly, with constant pressure on the back of the distal phalanx of the hallux, so that the patient could identify the beginning and end of the vibration[7,9].

For the evaluation of painful sensitivity, we used the instrument with a blunt, sharp tip test, which started with touching the sharp tip on the back of the hallux, carefully to do not pierce the skin[9]. The tests of plantar protective sensitivity, vibratory sensitivity, and painful sensitivity were considered normal when the patient guessed correctly two of the three applications[9,16].

The Achilles reflex test was performed to test the deep reflex while the patient seated and let the foot relaxed and suspended in a discrete dorsiflexion position. A soft blow was applied with the reflex hammer on the Achilles tendon. The test response was considered abnormal when the reflex plantar flexion of the foot was absent or decreased[9,10].

The independent variables included the sociodemographic aspects (sex, age, and schooling), the general and feet clinical evaluation. Regarding the clinical data of evaluation of the Abdominal Circumference (AC) and Body Mass Index (BMI), the method and cutoff point established by the Guidelines of the Brazilian Association for the Study of Obesity and Metabolic Syndrome[17] were adopted. An analog scale with an anthropometric ruler was used to check weight and height. For the evaluation of abdominal circumference, a 150 cm inelastic tape was used. For the measurement and interpretation of systolic blood pressure (SBP) and diastolic blood pressure (DBP) values, and equipment with the current regulation and calibration and aneroid sphygmomanometer were used, considering recommendations of the Guidelines of the Brazilian Society of Cardiology[17]. The SBP and DBP variables were treated as continuous variables. The variable "smoking" was considered in two groups: never smoker and smoker / ex-smoker.

The variables related to DM included the type of diabetes; time of diagnosis (in years); levels of glycated hemoglobin identified in the chart and considering the last 12 months (continuous variable); the presence of complications such as retinopathy, nephropathy and cardiovascular complications (information obtained from medical records).

The questions regarding the clinical evaluation of the feet were based on dichotomous responses (no/yes) and included neuropathic signs and symptoms such as numbness, burning sensation, fatigue, loss of motor strength, dry skin, cracks and fissures, interdigital mycosis, nail fungus, absent hair, cyanosis, calluses, subcutaneous hemorrhage, claw toes, Charcot foot, overlapping toes, hammertoes, and tibial pulse.

Results analysis and statistics

The data collected were entered twice in the Epi Info software, version 3.5.1, checked for consistency, and exported to the statistical software STATA, version 12. We performed descriptive analysis was performed using simple frequency, measures of central tendency (mean and median), and measures of variability (standard deviation and percentiles). The prevalence rate of altered touch perception was calculated, established by dividing the number of existing cases of the phenomenon by the population at risk, multiplied by 1,000.

Poisson regression with robust variance was used to assess factors associated with altered touch perception. Prevalence ratios (PR) were estimated, with a 95% confidence interval (95% CI). Bivariate analysis was performed, and the independent variables that obtained a value of *p* below 20% ($p < 0.20$) were selected for the multivariate analysis by the multiple regression model, which were inserted by the *Backward* method. Those variables that obtained a significance level with $p > 0.05$ were removed from the model. The procedure was repeated until all the remaining variables had statistical significance ($p < 0.05$). The quality of the model fit was assessed using the *Deviance*.

RESULTS

This study evaluated 224 individuals, most of whom were female (53.1%), with a mean age of 52.4 years old (SD = 18.5), with a minimum age of 8 years and a maximum of 91 years old. As for education, 55.8% had completed or incomplete primary education. The most prevalent type of diabetes was type 2 DM (79.9%), and the time of diagnosis of the disease was, on average, 11 years (SD = 8.5).

We found that 119 individuals (53.1%) had altered touch perception. When stratifying by type of diabetes, the prevalence was 20% (n = 9) in individuals with type 1 DM and 61.5% (n = 110) in those with type 2 DM. Regarding the neurological tests for tracking the altered touch perception, 12.5% had a response to the absent Achilles reflex, and 21.9% had no painful sensitivity. Vibratory sensitivity was absent in 68.8% of individuals, and the protective sensation was absent in 59.4%.

The prevalence of altered touch perception (Table 1) was higher among illiterates and those with primary education, those with systemic arterial hypertension (SAH) and smokers. In addition, it was possible to observe that individuals with altered sensitivity presented a higher age and altered BMI, SBP, and AC. Factors related to the altered touch perception are considered the type of diabetes, time of diagnosis, glycated hemoglobin (HbA1c), and diabetes complications ($p < 0.05$), as these were those that had a significant association with the problem.

Regarding the signs and symptoms of sensory and autonomic neuropathy (Table 2), there was a significant association between altered touch perception and the following variables: injured feet without noticing, previous ulcer, prayer sign, numbness, burning sensation, fatigue, claudication, loss of motor strength, dry skin, cracks and fissures, interdigital mycosis, nail fungus and absent hair ($p < 0,05$).

As for signs and symptoms of motor and vascular neuropathy (Table 3), there was a significant association of altered touch perception with the following variables: cyanosis, calluses, proprioception loss, subcutaneous hemorrhage, claw toes, Charcot foot, overlapping toes, hammertoes, right and left foot posterior tibial pulse ($p < 0.05$). There was also a lower prevalence of altered touch perception among those individuals who had a tibial pulse.

Table 4 presents the final model obtained by the Poisson regression. In this model, the following variables remained significantly associated with altered touch perception ($p < 0.05$): gender, type of diabetes, previous ulcer, burning sensation, cracks and fissures, calluses, and Charcot foot (Table 4).

Table 1 - Sociodemographic and general clinical factors associated with altered touch perception (N = 224), Campina Grande, Paraíba, Brasil, 2017

	Altered Touch Perception		*p* value*	PR (95% CI)
	No	Yes		
Gender				
Male	31 (40.8%)	45 (59.2%)	0.180	1.00
Female	74 (50.0%)	74 (50.0%)		0.84 [0.66; 1.08]
Schooling				
Illiterate	6 (27.3%)	16 (72.7%)	-	1.00
Primary	50 (40.0%)	75 (60.0%)	0.199	0.83 [0.61; 1.11]
Secondary	34 (59.6%)	23 (40.4%)	0.005	0.55 [0.37; 0.83]
Higher	15 (75.5%)	5 (25.0%)	0.009	0.34 [0.15; 0.77]
Age				
Mean ± Standard Deviation	43.9 ± 19.8	59.8 ± 13.4	**< 0.001**	1.03 [1.02; 1.03]
Median (minimum – maximum)	47.0 (8 – 91)	62.0 (22 – 88)		
Body mass index				
Mean ± Standard Deviation	27.3 ± 5.6	29.7 ± 5.5	**< 0.001**	1.03 [1.01; 1.05]
Median (minimum – maximum)	27.0 (15.1 – 46.3)	28.8 (18.1 – 50.3)		
Abdominal circumference				
Mean ± Standard Deviation	92.9 ± 15.4	101.0 ± 12.4	**< 0.001**	1.02 [1.01; 1.03]
Median (minimum – maximum)	95.0 (56 – 148)	99 (70 – 148)		
Systolic blood pressure				
Mean ± Standard Deviation	125.8 ± 21.5	135.9 ± 24.3	**< 0.001**	1.01 [1.00; 1.01]
Median (minimum – maximum)	120 (80 – 200)	130 (90 – 220)		
Systemic arterial hypertension				
No	53 (60.9%)	34 (39.1%)	0.002	1.00
Yes	52 (38.0%)	85 (62.0%)		1.59 [1.18; 2.13]
Smoking				
Never smoker	69 (53.1%)	61 (46.9%)	0.027	1.00
Smoker / ex-smoker	36 (38.3%)	58 (61.7%)		1.31 [1.03; 1.68]
Type of diabetes				
Type 1	36 (80.0%)	9 (20.0%)	**< 0.001**	1.00
Type 2	69 (38.5%)	110 (61.5%)		3.07 [1.69; 5.58]
Diagnostic time				
Mean ± Standard Deviation	9.0 ± 7.6	12.8 ± 9.0	**< 0.001**	1.02 [1.01; 1.04]
Median (minimum – maximum)	8.0 (0 – 46)	10.0 (0 – 45)		
Glycated hemoglobin				
Mean ± Standard Deviation	8.3 ± 1.3	8.8 ± 2.0	0.031	1.92 [1.85; 1.99]
Median (minimum – maximum)	8.4 (5.5 – 12.2)	8.4 (5.1 – 15.8)		
Diabetes complications				
No	85 (53.5%)	74 (46.5%)	**< 0.001**	1.00
Yes	20 (30.8%)	45 (69.2%)		1.49 [1.18; 1.88]

*Notes: * Bivariate Poisson model; PR = prevalence ratio; 95% CI = 95% confidence interval. **Reference.*

Table 2 - Signs and symptoms of sensory and autonomic neuropathy associated with altered touch perception (N = 224), Campina Grande, Paraíba, Brasil, 2017

	Altered Touch Perception		*p* value*	PR (95% CI)
	No	Yes		
injured feet without noticing				
No	99 (52.7%)	89 (47.3%)	**< 0.001**	1.00
Yes	6 (16.7%)	30 (83.3%)		1.76 [1.43; 2.17]
Previous ulcer				
No	97 (52.4%)	88 (47.6%)	**< 0.001**	1.00
Yes	8 (20.5%)	31 (79.5%)		1.67 [1.34; 2.08]
Prayer sign				
No	74 (54.8%)	61 (45.2%)	0.003	1.00
Yes	31 (34.8%)	58 (65.2%)		1.44 [1.13; 1.83]
Numbness				
No	63 (54.8%)	52 (45.2%)	0.016	1.00
Yes	42 (38.5%)	67 (61.5%)		1.36 [1.06; 1.75]
Burning sensation				
No	79 (56.0%)	62 (44.0%)	**< 0.001**	1.00
Yes	26 (31.3%)	57 (68.7%)		1.56 [1.23; 1.98]
Fatigue				
No	55 (57.3%)	41 (42.7%)	0.010	1.00
Yes	50 (39.1%)	78 (60.9%)		1.43 [1.09; 1.87]
Claudication				
No	77 (52.4%)	70 (47.6%)	0.018	1.00
Yes	28 (36.4%)	49 (63.6%)		1.34 [1.05; 1.70]
Loss of motor strength				
No	84 (51.2%)	80 (48.8%)	0.021	1.00
Yes	21 (35.0%)	39 (65.0%)		1.33 [1.04; 1.70]

To be continued

Table 2 (concluded)

	Altered Touch Perception		*p* value*	PR (95% CI)
	No	Yes		
Dry skin				
No	25 (83.3%)	5 (16.7%)	0.002	1.00
Yes	80 (41.2%)	114 (58.8%)		3.53 [1.57; 7.93]
Cracks and fissures				
No	53 (69.7%)	23 (30.3%)	**< 0.001**	1.00
Yes	52 (35.1%)	96 (64.9%)		2.14 [1.49; 3.08]
Interdigital mycosis				
No	93 (51.1%)	89 (48.9%)	0.002	1.00
Yes	12 (28.6%)	30 (71.4%)		1.46 [1.15; 1.86]
Nail fungus				
No	60 (66.7%)	30 (33.3%)	**< 0.001**	1.00
Yes	45 (33.6%)	89 (66.4%)		1.99 [1.45; 2.73]
Absent hair				
No	79 (52.7%)	71 (47.3%)	0.010	1.00
Yes	26 (35.1%)	48 (64.9%)		1.37 [1.08; 1.74]

*Note: * Bivariate Poisson model; PR = prevalence ratio; 95% CI = 95% confidence interval.*

Table 3 - Signs and symptoms of motor and vascular neuropathy associated with altered touch perception (N = 224), Campina Grande, Paraíba, Brasil, 2017

	Altered Touch Perception		*p* value*	PR (95% CI)
	No	Yes		
Cyanosis				
No	95 (51.4%)	90 (48.6%)	**< 0.001**	1.00
Yes	10 (25.6%)	29 (74.4%)		1.53 [1.21; 1.94]
Calluses				
No	65 (65.7%)	34 (34.3%)	**< 0.001**	1.00
Proprioception loss				
No	87 (52.7%)	78 (47.3%)	**< 0.001**	1.00
Yes	18 (30.5%)	41 (69.5%)		1.47 [1.16; 1.86]
Subcutaneous hemorrhage				
No	103 (49.0%)	107 (51.0%)	**< 0.001**	1.00
Yes	2 (14.3%)	12 (85.7%)		1.68 [1.31; 2.16]
Claw toes				
No	95 (50.0%)	95 (50.0%)	0.009	1.00
Yes	10 (29.4%)	24 (70.6%)		1.41 [1.09; 1.83]
Charcot foot				
No	105 (47.9%)	114 (52.1%)	**< 0.001**	1.00
Yes	0 (0.0%)	5 (100.0%)		1.92 [1.69; 2.18]
Overlapping toes				
No	83 (51.6%)	78 (48.4%)	0.017	1.00
Yes	22 (34.9%)	41 (65.1%)		1.34 [1.05; 1.71]
Hammer toes				
No	95 (52.2%)	87 (47.8%)	**< 0.001**	1.00
Yes	10 (23.8%)	32 (76.2%)		1.59 [1.27; 2.00]
Right foot posterior tibial pulse				
No	6 (22.2%)	21 (77.8%)	**< 0.001**	1.00
Yes	99 (50.3%)	98 (49.7%)		0.64 [0.50; 0.82]
Left foot posterior tibial pulse				
No	7 (28.0%)	18 (72.0%)	0.015	1.00
Yes	98 (49.2%)	101 (50.8%)		0.70 [0.53; 0.93]

*Note: * Bivariate Poisson model; PR = prevalence ratio; 95% CI = 95% confidence interval.*

Table 4 - Final model of factors associated with altered touch perception obtained by Poisson regression (N = 224), Campina Grande, Paraíba, Brasil, 2017

	p value*	PR (95% CI)
Gender		
Male	0.019	1.00
Female		0.77 [0.62; 0.96]
Type of diabetes		
Type 1	0.002	1.00
Type 2		2.36 [1.37; 4.06]
Previous ulcer		
No	**< 0.001**	1.00
Yes		1.43 [1.15; 1.77]
Burning sensation		
No	0.003	1.00
Yes		1.39 [1.12; 1.74]
Cracks and fissures		
No	0.017	1.00
Yes		1.56 [1.08; 2.25]
Calluses		
No	0.033	1.00
Yes		1.39 [1.03; 1.87]
Chacort Foot		
No	0.019	1.00
Yes		1.66 [1.09; 2.53]

*Note: * Multivariate Poisson model; PR = prevalence ratio; 95% CI = 95% confidence interval p value Statistics Deviance = 0.999.*

To be continued

DISCUSSION

The present study demonstrates that altered touch perception can be considered a nursing diagnosis that nurses can identify in the consultation of individuals with DM[18]. Other studies have

identified the problem has in other populations at risk of developing peripheral neuropathy[13-14]. The present study estimated a prevalence of 53.1% of altered touch perception was in individuals with DM and seven factors associated with the problem (gender, type of diabetes, previous ulcer, burning sensation, cracks and fissures, calluses, and Charcot foot). These findings point to the need for nurses to emphasize DM individuals since there is a high incidence of altered touch perception and different clinical findings. We hoped that these results could also support the planning and implementation of nursing actions aimed at preventing ulcerations and, consequently, higher quality of life for individuals with DM.

The prevalence of altered touch perception in individuals with DM, in international studies[18-19], varied between 19.9% in Saudi Arabia, 58.7% in Nepal, to 70% in the United States. In Brazil, the prevalence was 35.2% in Paraná, 36.9% in Minas Gerais, 44.5% in Pernambuco, and 75.5% in the Federal District[15,21-23]. Such variability can be explained by the specialization of the location of research with individuals with DM, due to concentrating people with different types of complications, or the participants' age, the time before diagnosis and types of tests used for diagnosis.

In this study, we observed that the altered touch perception was diagnosed in most individuals based on results obtained with the tests of protective sensation or monofilament and vibratory sensation, as recommended by national[10] and international[11-12] guidelines. Thus, it is important to highlight the relevance of using different tests for the diagnosis, that will be used in the practice of health services since they evaluate different senses in order to identify microvascular complications and changes in the structure and function of sensory, motor and autonomic nerve fibers.

In the multivariate analysis, the variables that showed statistical significance ($p < 0.05$) for the occurrence of altered touch perception were female (considered as a protective variable (PR <1), type 2 DM, presence of previous ulcer, burning sensation, cracks and fissures, calluses and Charcot foot (considered exposure variables) (PR> 1).

We observed that women had a lower prevalence in altered touch perception, but, in the analysis, the female gender manifested as a protective factor for this phenomenon. This data corroborates other studies[23-24], which demonstrated significant differences in lifestyle and the practice of self-care between women and men with diabetes, with the male population showing more significant deficits in self-care.

Individuals with type 2 DM are more likely to develop altered touch perception, compared to those with type 1 DM. A cohort study carried out in India confirms this finding, especially regarding microvascular complications[25]. This finding can be explained by the fact that participants with type 2 DM have lived with the disease for longer and, therefore, have greater difficulty in maintaining glycemic control over time. Individuals with type 1 DM, on the other hand.

Individuals with previous ulcers were more likely to change their tactical sensory perception. The history of ulcers was the predictor in the development of posterior ulceration, amputations, and risk factors for future foot problems[26].

A critical sensory neuropathy symptom is a burning sensation. The findings found in this research confirm the study that says burning sensation is a strong predictor of changes in tactical sensory perception[8]. This symptom, along with others - for example, altered temperature perception, such as the sensation of feet on fire or a frozen surface -, may have a gradual or insidious onset caused by peripheral nerve damage (due to lack of oxygen) and an inflammatory process (because of constant hyperglycemia)[27].

Among the investigated signs and symptoms of autonomic neuropathy, we observed cracks and fissures, as for symptoms of motor neuropathy, the callus. All of these variables were associated with altered touch perception. The damage to autonomic fibers implies a lack of sympathetic autonomy with sudomotor dysfunction and sweat glands damage. This damage causes anhidrosis and consequent skin dryness, favoring hyperkeratosis, calluses, cracks, and fissures. Also, it can lead to an increase in blood flow (in the absence of arterial disease) caused by sympathetic vasoconstriction, with the possibility of progressing to Charcot foot. In turn, these biochemical and orthopedic changes in the diabetic foot cause repetitive trauma due to continuous aggression in a particular area of the foot, leading to ulcers[9,28].

As for the osteoarticular changes, we found that all individuals with Charcot foot had changes in sensation. It is an inflammatory syndrome of the foot and ankle that commonly affects diabetic individuals with neuropathy, causing severe deformity, recalcitrant ulcerations, and subsequent amputations resulting from the failure to treat this complication[18].

It is known that the annual incidence of diabetic foot ulcers in individuals with DM ranges from 2% to 4%, its prevalence, from 4% to 10%. Both are higher in countries with unfavorable socioeconomic status[27]; they are considered alarming and, above all, an important indicator that interferes with the high costs spent in the health area, also representing a social burden for those affected. A study stated that there is a gap in the risk assessment of complications resulting from DM and found that 34% of patients have some degree of loss in plantar protective sensation. Besides, it confirmed that these patients need periodic evaluation and scheduling between consultations between 1 and 12 months[29].

A study conducted to evaluate changes in the feet of patients found high cumulative mortality attributed to sensorial peripheral polyneuropathy (44.7%), peripheral vascular disease (71.7%), an association of these two conditions (62.4%) and amputation (67, 6%). In the multivariate analysis, the duration of follow-up with nurses remained as a protective factor for mortality ($p < 0.001$). The study concluded that patients with type 2 DM's foot care performed by nurses continuously were able to decrease the risk of death for patients[30].

Research that investigated both the guidance on foot care provided by nurses to people with DM and the frequency of having their feet examined found that 50% of nurses evaluate their feet and nails monthly, and only 31.6% undergo health education. The authors state that nursing support and care for diabetics are essential in treatment, as they directly affect the affected person's lifestyle[31].

Then we consider the final model obtained in the present study valid to describe the relationship between the altered touch perception and its predictive factors (gender, type of diabetes, presence of ulcer, burning sensation, cracks, fissures, calluses, and

Charcot foot) and allows to anticipate which diabetic patients are at risk of developing the problem. The altered touch perception is a phenomenon that precedes neuropathy and diabetic foot and is capable of implementing nursing care for its prevention or treatment. Although the NANDA-I no longer includes the nursing diagnosis that would characterize the phenomenon, the results presented here may collaborate with the return of the altered touch perception to the NANDA-I taxonomy.

The identification of the altered touch perception in patients can support nurses' clinical performance in specific care for this population. It is possible to say that, this study perceived the need to implement a protocol for the continuous assessment of the feet of individuals with DM by nurses in the country's health services, in addition to valuing their training to conduct actions for early screening and prevention of complications in the feet of individuals with DM.

Study Limitations

We identified as limitations of this study the impossibility of establishing a cause and effect relationship of the problem due to the cross-sectional research design. It is important to carry out studies with a prospective and multicenter design to confirm the results and establish its external validity.

Contributions to the nursing, health, or public policy fields

The final model obtained is valid to describe the relationship between the altered touch perception and the predictive factors of the problem, allowing to anticipate which diabetic individuals are at risk of altered touch perception, a phenomenon that precedes neuropathy and the diabetic foot, subject to nursing care implementation for its prevention or treatment. In this sense, the identification of a nursing diagnosis that can address the problem is valuable, and the relevance of its return to NANDA-I must be considered.

CONCLUSIONS

The study identified a high prevalence of altered touch perception in the assessed population (53.1%). Among the tests used in the evaluation of individuals with DM, those that most identified the changes in the individuals and that directly influenced the high prevalence of altered touch perception were the vibratory and monofilament tests.

Regarding the demographic and clinical factors identified, those that remained as the main risk factors for altered touch perception in the multivariate analysis were: previous ulcer, diabetes *mellitus* type II, burning sensation, cracks and fissures, female gender, Charcot foot, and calluses.

Thus, with these results, we consider that the present study contributes to the knowledge about the altered touch perception in individuals with DM and the identification of associated risk factors. Early recognition of the risk factors of the problem through clinical evaluation, identifying the severity and distribution of sensory loss in individuals with DM, favors the planning and implementation of evidence-based interventions focusing on the prevention of sensory damage and treatment of the problem aiming at the quality of life of these individuals.

The data presented here contribute, along with other studies, for the altered touch perception to be appreciated by the NANDA-I Diagnostic Development Committee, for its possible return to taxonomy as a nursing diagnosis relevant to the professional clinical practice of the area.

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