

Factors associated with non-traumatic amputation in people with Diabetes Mellitus: a cross-sectional study

Fatores associados à amputação não traumática em pessoas com Diabetes Mellitus: um estudo transversal

Iraktania Vitorino Diniz¹, Patrícia Simplicio de Oliveira¹, Isabel Cristina Ramos Vieira Santos¹, Suellen Duarte de Oliveira Matos¹, Isabelle Katherinne Fernandes Costa¹, Marta Miriam Lopes Costa¹, Maria Julia Guimaraes Oliveira Soares¹

ABSTRACT

The objective of this study was to verify the factors associated with non-traumatic amputation in persons with Diabetes Mellitus. Cross-sectional study with 212 patients from a public hospital of the Paraíba state. Data collection occurred through an interview, from June 2013 to June 2014. The investigated variables were occurrence of amputations, age group, gender, origin, years of study, family income and clinical characteristics. The *odds ratio* and the logistic regression model were used to predict the probability of the amputation variable according to the explanatory variables. The factors associated with the occurrence of amputation were time of disease ($p=0.006$), search time for attendance ($p=0.001$), gangrene ($p=0.001$) and smoking ($p=0.016$). There was a high risk of amputation associated with: time of diabetes, search time for attendance, gangrene and smoking, calling attention to greater efforts addressed to identification of the complication and early referral to the care of greater complexity.

Descriptors: Diabetes Mellitus; Amputation; Diabetic Foot; Epidemiology; Nursing Care.

RESUMO

Objetivou-se verificar os fatores associados à amputação não traumática em pessoas com Diabetes Mellitus. Estudo transversal com 212 pacientes de um hospital público do estado da Paraíba. A coleta de dados ocorreu através de entrevista, de junho de 2013 a junho de 2014. As variáveis investigadas foram: ocorrência de amputações, faixa etária, sexo, procedência, anos de estudo, renda familiar e características clínicas. Foram utilizados o *odds ratio* e o modelo de regressão logística para prever a probabilidade da variável amputação em função das variáveis explanatórias. Os fatores associados à ocorrência de amputação foram: tempo da doença ($p=0,006$), tempo de procura por atendimento ($p=0,001$), gangrena ($p=0,001$) e tabagismo ($p=0,016$). Verificou-se um alto risco para amputação associada a: tempo de diabetes, tempo de procura por atendimento, gangrena e tabagismo, chamando atenção para maiores esforços direcionados à identificação da complicação e o precoce referenciamento à atenção de maior complexidade.

Descritores: Diabetes Mellitus; Amputação; Pé Diabético; Epidemiologia; Cuidados de Enfermagem.

¹Federal University of Paraíba — João Pessoa (PB), Brazil. E-mails: iraktania@hotmail.com, p_simplicio@hotmail.com, tutornad@yahoo.com.br, suellen_321@hotmail.com, isabellekfc@yahoo.com.br, marthamiryan@hotmail.com, mmjulieg@gmail.com

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INTRODUCTION

Persons with DM are at risk of dysfunction and chronic complications due to its hyperglycemic state and are more frequent in individuals with advanced age. Complications include nephropathy, retinopathy, autonomic neuropathy, causing gastrointestinal, genitourinary and cardiovascular symptoms, and peripheral neuropathy, with risk of lower limbs ulcers, Charcot neuroarthropathy and amputations⁽¹⁻³⁾.

Among the chronic complications of this disease, the diabetic foot syndrome is the main cause of non-traumatic amputation of the lower limbs and the occurrence of feet ulcers stands out as the most common risk factor for this condition. This syndrome results mainly from three main foot diseases, which can occur alone or in combination: peripheral neuropathy, peripheral vascular disease and infection. The first two are many times, asymptomatic, which contributes to underdiagnosis and undertreatment, culminating in late hospitalizations and increased risk of amputation. In turn, the infection complicates a substantial percentage of foot ulcers, increasing the likelihood of treatment failure, requiring lower limbs amputation⁽⁴⁻⁶⁾.

In Brazil, the DM presents high prevalence in the adult population, affecting approximately 10% of individuals with 60 years or older⁽⁴⁾. Considering the proportion of persons above 18 years in Brazil with self-reported diagnosis of the disease for 10 years or more, the ulcerations in the feet are present in 5.8% and limb amputations correspond to 2.4%⁽⁷⁾.

Despite being controversial, the rate of amputations has been considered an indicator of quality of care of diabetic foot complications⁽⁸⁾. This disorder is considered a condition sensitive to Primary Care, meaning that the appropriate management of the disease in this level of Care would avoid hospitalizations and deaths⁽⁹⁾.

In opposition to the factors associated with the development of an ulcer in the foot in diabetic persons who are already well-defined, the risk factors for amputation are less clear. Therefore, their clarification may help nurses and other health professionals to make special efforts to prevent this grievance. This information may also identify the baseline risk for lower limbs amputations among the hospitalized patients, allowing comparisons of the rates of amputation in different centers.

Despite the impact on individuals with DM, as well as for the society as a whole, few studies in the country, in the last five years, have addressed the amputations resulting from the disease and the associated risk factors^(10,11). In order to help fill this gap, the present study aimed to verify the factors associated with the non-traumatic amputation in persons with DM in the State of Paraíba.

METHODOLOGY

Cross-sectional study carried out in the outpatient clinic of a public hospital of reference in angiology care, located in the city of João Pessoa, Paraíba, Brazil. Persons with complications in the lower limbs due to Diabetes Mellitus are referred to this hospital, not only from the municipality of João Pessoa, but also from the entire state of Paraíba. An interview was conducted with patients who met the inclusion criteria, which were delimited by the existence of feet complications in people with DM and age over 18 years. Exclusion criteria were persons with foot ulcers of others etiologies.

The sample was probabilistic, of simple random type. The sample calculation was obtained from the number of persons with DM registered in the State, using the exposure frequency (occurrence of diabetic foot) of 15 %⁽¹²⁾, with a confidence level of 95% and a refusal percentage of 10%, through the Epi Info 7.2 software, totaling 212 patients.

The data collection occurred between June 2013 and June 2014, using and validated form⁽¹¹⁾, in a quiet place, preserving the participant's privacy, while persons waited for the consultation of the vascular surgeon. The variables investigated were: occurrence of amputations, age group, gender, origin, years of study, family income; data related to clinical characteristics — when and how he learned to be diabetic, record of arterial hypertension, heart disease, stroke, comorbidity, smoking, time of current problem (diabetic foot), record of gangrene, performance of conservative procedures and factors related to consultations conducted in health primary care: number of consultations, glycaemia, feet examination, orientation about foot care, nutrition and physical activity; use and availability of oral antidiabetics, referral of the Family Health Strategy.

For data analysis, both in bivariate and multivariate analysis, the *odds ratio* (OR) was used as a relative risk estimator, with confidence interval of 95% (IC95%). For the bivariate analysis, the Chi-square test was used. For the modeling process, the logistic regression model was adopted with the aim at predicting the probability of the response variable (amputation), as a function of the explanatory variables, according to the model.

All variables associated with amputations ($p \leq 0.20$) in the bivariate analysis were included in the initial logistic model, except those with very low frequency and with high *odds*, suggesting confusing factor. From then on, the variables were excluded one by one, by the *Backward Stepwise* method (*Likelihood Ratio*). All analysis were carried out with a significance of 5%, using the Statistical Package for the Social Sciences software – SPSS 22.0.

The Research Ethics Committee approved the study under protocol nº 0153/12 of the Health Sciences Center of the Federal University of Paraíba (CAAE nº 03459112.1.0000.51.88).

RESULTS

A total of 212 persons with DM and diabetic foot participated in the study, among whom, 44 (20.7%) had already been submitted to non-traumatic amputation of some segment of lower limbs; 109 (52.7%) were over 60 years; 116 (55.2%) were female; 104 (49.1%) were from the metropolitan region of João Pessoa, Paraíba; 167 (79.2%) had more than four years of study; 208 (99.1%) had less than three minimum wages as family income (Table 1).

Among the sociodemographic data, it was found that persons with family income below three minimum wages (MW) have, approximately, three times more likely ($p=0.033$; $odds=2.894$) to suffer non-traumatic amputation, in relation to persons with income above this. However. It should be pointed out that this statement should be viewed with caution, since the number of people with more than three wages was very low.

With regard to the clinical data (Table 2), the time of DM stands out, observing that, the longer the disease, the greater the chance of amputation ($p=0.050$); the smoking which has increased the chance by approximately five times of amputation ($p=0.010$), the delay in the search time for care after the diabetic foot ($p<0.001$) and the history of gangrene, increasing by 28 times the chance of amputation a chance ($p<0.001$).

Regarding the data of the Primary Health Care (Table 3), it should be stressed that the persons who performed a higher

number of consultations and follow-up, despite not verifying statistical significance ($p=0.110$), resulted in a lower number of amputations. It was also found that 199 (93.9%) performed the glucose blood level test in the last year. However, despite not having been verified statistical significance, of the 12 (5.7%) who did not perform the test, one third evolved to amputation ($p=0.096$). When questioned about the knowledge of the normal glucose blood level, it was found that, proportionally, those who evolved to amputation did not know its glucose blood level test, and this relationship was significant ($p=0.005$).

After applying the logistic regression model (Table 4) it was verified that the gangrene record increases about 11 times the chance of amputation, the longer time for seeking care after diabetic foot increases in 10.8 times the risk of amputation, the longer time of DM increases in 7.5 times the risk and be smoker increases in almost six times the chance of suffering amputation.

DISCUSSION

The study found that factors such as income, longer time of DM diagnosis, smoking, delay in searching for the health service, history of gangrene and not knowing the normal value of blood glucose level are related to the increased occurrence of amputation.

Table 1. Prevalence of non-traumatic amputation by Diabetes Mellitus and association of sociodemographic data. João Pessoa, PB, 2014.

| Sociodemographic characteristics | Amputation | | OR | CI95% | p-value |
|----------------------------------|------------|------------|------|-----------|---------|
| | Yes n (%) | No n (%) | | | |
| Age group | | | | | |
| <60 years | 20 (9.7) | 78 (37.7) | 1.09 | 0.55-2.17 | 0.78 |
| ≥60 years | 24 (11.6) | 85 (41.1) | | | |
| Gender | | | | | |
| Female | 25 (11.9) | 91 (43.3) | 1.09 | 0.55-2.14 | 0.79 |
| Male | 19 (9.0) | 75 (35.7) | | | |
| Origin | | | | | |
| Region Metropolitan | 19 (9.1) | 85 (40.7) | 1.47 | 0.75-2.88 | 0.26 |
| Countryside | 25 (12.0) | 80 (38.3) | | | |
| Schooling | | | | | |
| ≥4 years | 37 (17.7) | 130 (62.2) | 0.90 | 0.38-2.12 | 0.81 |
| <4 years | 7 (3.3) | 35 (16.7) | | | |
| Family Income | | | | | |
| ≤3 MW | 44 (21.0) | 164 (78.1) | 2.98 | 1.09-8.15 | 0.033 |
| >3 MW | 0 (0.0) | 2 (1.0) | | | |

OR: *odds ratio*; CI: confidence interval.

It has been demonstrated that the low purchasing power can increase to, approximately, three times the chances of amputation. This relationship may be a consequence of difficulties in access to health services and non-adherence to treatment due to lack of resources

to acquire medicines, healthy foods and supplies, such as appropriate shoes^(13,14). In a study conducted in Spain with persons with DM, the influence of socioeconomic precariousness was also detected as a factor related to the occurrence of amputation⁽¹⁵⁾.

Table 2. Prevalence of non-traumatic amputation by Diabetes Mellitus and association with clinical data. João Pessoa, PB, 2014.

| Clinical data | Amputation | | OR | CI95% | p-value |
|------------------------------------------------|------------|------------|------|------------|---------|
| | Yes n (%) | No n (%) | | | |
| When he learned to be diabetic | | | | | |
| Before the diabetic foot | 38 (18.4) | 152 (73.4) | 0.85 | 0.19-1.78 | 0.87 |
| After the diabetic foot | 5 (2.4) | 12 (5.8) | | | |
| How he learned to be diabetic | | | | | |
| Before the hospitalization | 41 (19.9) | 156 (75.7) | 1.59 | 1.18-4.54 | 0.70 |
| After the hospitalization | 2 (1.0) | 7 (3.4) | | | |
| How long have you been a diabetic | | | | | |
| <5 years | 12 (5.9) | 94 (46.1) | 0.38 | 0.15-0.62 | 0.05 |
| ≥5 years | 31 (15.2) | 67 (32.8) | | | |
| Hypertension registration | | | | | |
| Yes | 15 (7.1) | 42 (20.0) | 1.50 | 0.74-3.07 | 0.91 |
| No | 29 (13.8) | 124 (59.0) | | | |
| Cardiopathy registration | | | | | |
| Yes | 5 (2.4) | 11 (5.2) | 1.67 | 0.55-5.01 | 0.80 |
| No | 39 (18.6) | 155 (73.8) | | | |
| Stroke registration | | | | | |
| Yes | 2 (1.0) | 2 (1.0) | 3.95 | 0.54-28.88 | 0.12 |
| No | 42 (20.0) | 164 (78.1) | | | |
| Smoker | | | | | |
| Yes | 11 (5.3) | 20 (9.6) | 5.14 | 1.07-5.60 | 0.01 |
| No | 33 (15.8) | 145 (69.4) | | | |
| Time of emergence of diabetic foot | | | | | |
| Less than one year | 4 (1.9) | 44 (21.0) | 0.26 | 0.09-0.78 | 0.93 |
| More than one year | 40 (19.0) | 122 (58.1) | | | |
| Search time for attendance after diabetic foot | | | | | |
| Less than one year | 13 (6.2) | 104 (49.5) | 0.17 | 0.12-0.50 | <0.001 |
| More than one year | 31 (14.8) | 62 (29.5) | | | |
| Gangrene registration | | | | | |
| Yes | 10 (4.8) | 7 (3.4) | 28.6 | 2.16-28.90 | <0.001 |
| No | 33 (15.9) | 158 (76.0) | | | |
| Performance of conservative procedures | | | | | |
| Yes | 37 (17.7) | 142 (67.9) | 1.39 | 0.34-2.13 | 0.65 |
| No | 7 (3.3) | 23 (11.0) | | | |

OR: *odds ratio*; CI: confidence interval.

Table 3. Prevalence of non-traumatic amputation by diabetes mellitus with regard to data of the primary health care. João Pessoa, PB, 2014.

| Variables relating to primary care | Amputation | | OR | CI95% | p-value |
|-----------------------------------------------------------------------|------------|------------|------|------------|---------|
| | Yes n (%) | No n (%) | | | |
| After diagnosis of Diabetes Mellitus, perform consultation every year | | | | | |
| Yes | 40 (19.3) | 155 (74.9) | 1.37 | 0.05-35.75 | 0.85 |
| No | 3 (1.4) | 9 (4.3) | | | |
| Performed consultation in the last year | | | | | |
| Yes | 41 (19.5) | 159 (75.7) | 3.22 | 0.23-44.63 | 0.38 |
| No | 3 (1.4) | 7 (3.3) | | | |
| Number of consultations in the last year | | | | | |
| Less than three | 17 (8.2) | 73 (35.3) | 1.91 | 0.86-4.25 | 0.11 |
| More than three | 26 (12.6) | 91 (44.0) | | | |
| Performed glucose blood level test in the last year | | | | | |
| Yes | 40 (19.1) | 157 (75.1) | 6.84 | 0.71-66.11 | 0.09 |
| No | - | - | | | |
| Knows normal blood glucose levels | | | | | |
| Yes | 29 (13.9) | 123 (59.1) | 4.70 | 1.59-13.92 | 0.01 |
| No | - | - | | | |
| You are always informed about your blood glucose level | | | | | |
| Yes | 33 (15.9) | 121 (58.5) | 0.55 | 0.17-1.78 | 0.32 |
| No | 10 (4.8) | 43 (20.8) | | | |
| Feet examined in all consultations in the last year | | | | | |
| Yes | 40 (19.1) | 151 (72.2) | 1.26 | 0.26-6.21 | 0.77 |
| No | 4 (1.9) | 14 (6.7) | | | |
| Received guidance on foot care | | | | | |
| Yes | 39 (16.7) | 130 (62.2) | 0.41 | 0.10-1.65 | 0.21 |
| No | 5 (2.4) | 35 (16.7) | | | |
| Received nutritional guidance | | | | | |
| Yes | 23 (11.0) | 62 (29.5) | 0.47 | 0.20-1.13 | 0.09 |
| No | - | - | | | |
| Received guidance on physical activity | | | | | |
| Yes | 5 (2.4) | 19 (9.0) | 1.79 | 0.52-6.21 | 0.35 |
| No | 39 (18.6) | 147 (70.0) | | | |
| Makes use of oral antidiabetics | | | | | |
| Yes | 40 (19.0) | 151 (71.9) | 0.28 | 0.01-6.02 | 0.42 |
| No | 4 (1.9) | 15 (7.1) | | | |
| Availability of oral antidiabetics in the Family Health Strategy Unit | | | | | |
| Yes | 36 (17.5) | 139 (67.5) | 0.90 | 0.23-34.8 | 0.88 |
| No | 7 (3.4) | 24 (11.7) | | | |
| Forwarded by the Family Health Strategy | | | | | |
| Yes | 39 (18.7) | 123 (58.9) | 0.41 | 0.15-1.11 | 0.08 |
| No | 4 (1.9) | 43 (20.6) | | | |

OR: odds ratio; CI: confidence interval.

The longer time of the disease also showed an association with amputation, increasing by up 7.5 times the chances of its occurrence. According to the literature, over the years, the probability of developing diabetic foot increases by 10% in people diagnosed with DM, which associated with other factors, culminates in amputation⁽¹⁶⁾. In study conducted in Santa Catarina, Brazil, with persons with DM who underwent amputation, the patients presented an average of 16.12 years of time of diagnosis⁽¹⁶⁾.

Another risk factor identified was the smoking, responsible for increasing in almost six times the chances of suffering amputation similar to the results of a study conducted in Recife⁽¹⁰⁾ and in Alagoas, Brazil⁽¹⁷⁾. This relationship can be explained by the fact that the cigarette reduces the sensitivity of insulin action and, so, contributes to the increase in glycemic concentration, a contributing factor to the emergence of complications⁽¹⁸⁾.

Specifically, the smoking acts in a negative way in the healing of the diabetic foot by impairing the function of several types of cells, such as neutrophils and macrophages, important for inflammatory and bactericidal activity, beyond of compromising oxygenation to the tissues⁽¹⁹⁾.

The risk for amputation increased 10.8 times in significant association with the delay in the time of seeking care after the patient develop diabetic foot. A case-control study conducted with inpatients to perform amputation, also found this relationship, showing that 75% of the total participants had not been consulted in a specialized service of care for the person with DM⁽¹⁶⁾.

Delays in the search health service may be a consequence of difficulties in foot care, which are related to the patient, health professionals and the health system. Regarding the patient, the complications of DM are

factors that may influence the postponement of diabetic foot. Since neuropathy, because of it has as a characteristic the absence of pain, it leads to the “false” feeling that the lower limbs are healthy, in addition to retinopathy, that can impair the acuity in the daily inspection of the feet. As well as the lack of knowledge regarding the health-disease process of DM, this is considered another factor that prevents the affected person from seeking health services frequently⁽²⁰⁾.

Regarding professionals and the health system, the International Federation of Diabetes estimates that only one third of professionals recognize the symptoms of diabetic neuropathy, even when the patients are symptomatic⁽²¹⁾. This fact can be attributed to the lack of training for screening and diagnosis, in addition to the focus of care being more focused on treatment than on preventive actions, such as the education for self-care. The history of gangrene presented the risk of increasing the chances of amputation occurrence. Gangrene, together with infection, is one of the most common indications for non-traumatic amputation. A study carried out in a hospital in Indonesia, similarly found that gangrene increases by about 26 times the chances of amputation⁽²²⁾.

A lower number of amputations was identified in those patients who underwent more consultations and follow-up. This finding accords with the literature, which shows a variation of 8.6 times in the incidence of amputation in those patients who do not have access to health services⁽²³⁾.

The International Consensus on Diabetic Foot recommends that the consultation be conducted annually to identify risk factors for diabetic foot and amputation. However, persons with neuropathy, peripheral vascular disease and history of previous amputation/ulceration

Table 4. Multiple logistic regression model between non-traumatic amputation by Diabetes Mellitus and exposure variables. João Pessoa, PB, 2014.

| Variables | B | OR | IC95% | p-value |
|---------------------------|-------|-------|------------|---------|
| Gangrene | 2.13 | 11.05 | 2.40-29.65 | 0.001 |
| Time for seeking care | 1.65 | 10.84 | 1.95-13.96 | 0.001 |
| Time of DM | 1.39 | 7.53 | 1.49-10.91 | 0.006 |
| Number of consultations | -0.30 | 0.34 | 0.27-2.03 | 0.56 |
| Glucose blood level | 0.95 | 1.12 | 0.45-15.03 | 0.29 |
| Glucose blood level value | 0.77 | 2.34 | 0.81-5.77 | 0.13 |
| Nutritional guidance | -0.79 | 3.39 | 0.19-1.05 | 0.06 |
| Inter Reference | -1.07 | 2.91 | 0.09-1.17 | 0.08 |
| Smoker | 1.46 | 5.76 | 1.31-14.13 | 0.02 |
| Constant | -3.01 | 4.79 | - | 0.03 |

OR: *odds ratio*; CI: confidence interval.

should undergo a consultation between one and three months⁽²⁴⁾.

The greatest chance of amputation was found in patients who did not know the normal value of glucose and this may indirectly influence the control of glycemic levels and self-care increasing the risk for amputation. There is a close relationship between the inadequate glucose control and the peripheral arterial disease, providing the chances of amputation⁽²¹⁾. A study conducted in the United Kingdom⁽²⁵⁾ with persons with diabetic foot also showed this association with risk for amputation.

On the other hand, adequate glycemic control is associated with improved sensory nerve function, reduced incidence of diabetic foot and amputation⁽²⁶⁾. This demonstrates the importance of periodically performing blood glucose tests, as well as the knowledge of persons with DM about the recommended parameters, since one of the components for adherence to treatment and prevention of complications is the knowledge about the aspects related to the disease and treatment.

It was evidenced that people with DM who received guidance, mainly nutritional, had a lower risk of amputation. Adherence to a healthy feeding contributes to reduce the blood glucose, mainly when it is based on foods with predominance of fibers and low glycemic index⁽²⁷⁾.

Guidance on the disease and treatment are essential for the person with DM to develop knowledge about their health condition and, thus, have greater predisposition and autonomy to perform self-care activities, reducing the chances of occurrence of complications and providing better quality of life⁽¹⁴⁾.

CONCLUSION

Although this study used a hospitalized population, its potential lies in the representativeness, both in terms of sampling and in the fact that in this population is verified through the indicator “occurrence of amputations”, the impact of preventive care and thus it is believed to be the first of its nature in the State and one of the few in Brazil to describe the use of primary care from hospitalizations for diabetic foot.

The study showed that the variables associated with the occurrence of non-traumatic amputations in people with Diabetes Mellitus were: family income, knowledge of the blood glucose value, time of DM, smoking, time of seeking care and gangrene, and the last four remaining in the final logistic model, including high risk of gangrene and time of seeking care for the occurrence of amputations.

These results call attention for greater efforts aimed at identifying the complication and the early referral by Primary Care towards a more complex attention as a way to reduce the incidence of these amputations.

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