

RISK FACTORS FOR PLANTAR ULCERS FROM LEPROSY ACCORDING TO THE DECISION TREE<sup>1</sup>

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## ABSTRACT

**Objective:** To identify the risk factors for plantar ulcers in patients with leprosy. **Methods:** This is an epidemiological, observational, cross-sectional and analytical study. The population was composed of leprosy cases reported from 2005 to 2016. Pearson's Chi-square test or Fisher's exact test and Mann-Whitney test were used for the univariate analysis, with a statistical significance of 5% ( $p < 0.05$ ). In the multivariate analysis, a decision tree was elaborated using the CHAID algorithm. **Results:** Clinical form, degree of physical incapacity at discharge, affected nerve and the lack of insoles or adapted footwear before appearing to ulcer are risk factors for plantar ulcer. **Conclusion:** the need for an early diagnosis of leprosy was highlighted, as well as the efficient association of non-drug interventions with disability prevention techniques and the use of accommodating insoles and/or special shoes.

**Keywords:** Leprosy. Foot Ulcer. Risk factor. Disabled Persons. Decision tree.

## INTRODUCTION

Leprosy is a slowly evolving infectious-contagious disease caused by *Mycobacterium leprae* (*M. leprae*), an obligate intracellular parasite that infects the peripheral nerves and, more specifically, Schwann cells<sup>(1)</sup>.

The diagnosis of leprosy is essentially clinical and epidemiological, and it is performed through a physical examination, analysis of the patient's history and life conditions.

The purpose of the clinical examination is to dermatoneurologically evaluate the patient, seeking to identify the signs and symptoms of the disease. Dermatological assessment identifies skin lesions and investigates their sensitivity, and neurological evaluation detects peripheral nerve involvement, physical disabilities and deformities<sup>(2)</sup>.

In Brazil, the Ministry of Health (MS) adopted the operational classification based on number of skin lesions. Cases with up to five skin lesions should be classified as paucibacillary (PB). Cases with more than five

lesions are classified as multibacillary (MB). Bacilloscopy, when available, should be used as a complementary exam, so that a positive test classified the case as MB regardless of the number of lesions<sup>(2)</sup>.

For scientific purposes, a classification for leprosy was proposed based on clinical, histopathological, immunological and bacteriological criteria. For this, the tuberculoid (TT) and virchowian (VV) forms were established and the dimorphic group (D), divided into: dimorphic-tuberculoid (DT), dimorphic-dimorphic (DD) and dimorphic-virchowian (DV)<sup>(3)</sup>.

The affinity of the leprosy bacillus for cells of the peripheral nervous system mainly affects the sensory, motor and autonomic fibers, causing autonomic, sensory and motor neuropathy that causes the decrease or absence of the sensibility and muscular weakness in the eyes, hands and feet<sup>(4)</sup>. If not treated, they can cause physical deformities.

Among the most common physical deformities seen in clinical practice are ulcers in

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the plantar region, which occur due to impaired tibial nerve, causing autonomic, sensory and motor deficits to the person<sup>(5)</sup>. These ulcers, when not treated, can become infected and progress to osteomyelitis, bone resorption and, progressively, amputations<sup>(5,6)</sup>.

In Brazil, ulcers are a serious public health problem, although epidemiological studies on plantar ulcers in patients with leprosy are scarce. The high number of people with these ulcers contributes to the burden of public costs<sup>(6)</sup>.

Evidences associate plantar ulcer with the compromise of the tibial nerve. However, little is known about the other risk factors for plantar ulcers due to leprosy.

In view of the above, the present study aimed to identify the risk factors for the plantar ulcers in patients diagnosed with leprosy.

## METHODS

This is an observational, transversal and analytical study. The population under study consisted of 1070 leprosy patients, who presented or not plantar ulcers at the time of diagnosis, during the treatment and after the end of treatment, from 2005 to 2016, in a State Reference Hospital for the treatment of leprosy, located in the city of Belo Horizonte (MG).

Data were collection was from the records and in the reports / investigation records of the Notification of Injury Information System (Sinan), from December 2016 to August 2017. The socio-demographic information studied was: gender, age, occupation. Clinical and epidemiological information were: provenance, schooling, clinical form, neuropathy, reactions, bacilloscopic index (BI) at admission, number of nerves at the beginning of treatment, medical prescription and initial dose of prednisone, treatment time with multidrug therapy, degree of disability at the beginning and end of treatment, and use of adapted insoles or shoes.

The association of factors for plantar ulcer was made through univariate analysis, for comparison of patients with and without ulcer, Pearson's Chi-square test or Fisher's exact test were used in the analysis of categorical variables, and test of Mann-Whitney, in the analysis of numerical variables. Then, a multivariate analysis was performed using the

Chi-square Automatic Interaction Detector (CHAID) algorithm, due to the excessive multicollinearity between the explanatory variables analyzed. This method of analysis is based on classification rules.

The tree starts with a root knot that contains all the observations of the sample. The following knots represent data subsets and subdivisions. It allows the identification of homogeneous subgroups by systematic comparison of their characteristics, aiming at establishing a relationship between the explanatory variables and a single response variable. The division process was repeated until none of the selected variables showed significant influence on the division or when the size of the subset was very small<sup>(7)</sup>.

In this analysis, a p value greater than 0.05 was used as the stopping criterion. The adjusted final model was assessed by estimating the risk of incorrect classification. The risk estimate indicates to what extent the tree correctly predicts the results by comparing the difference between the adjusted value estimated by the model and the actual value observed in the sample.

For statistical analysis, SPSS software version 21.0 was used. The study was approved by the Ethics Committee of the Federal University of Minas Gerais under Opinion No. 042/2017.

## RESULTS

Of the 1,070 patients seen in the study period, 166 had plantar ulcer due to leprosy, 71.6% were males, the age median was 54 years, 42.1% were white, and 54.2% had not accomplished Elementary School. Concerning occupation, a greater proportion of ulcers were found in the "rural workers" groups, with 28 individuals 17%, and "construction workers", with 16.3%.

The clinical and epidemiological characteristics of the patients are presented in Table 1. It was observed that among patients with ulcer, compared with those without ulcer, there was a higher proportion of new cases; provenance of the central macro-region; multibacillary cases; positive IB; clinical form DD and DV; multibacillary therapeutic scheme; with reaction episode 1; neuritis, use of

corticosteroids and longer duration of use; fibular and tibial nerves affected and with 2 involved nerves; level 2 at diagnosis and

discharge; without use of insole but with more guidelines on use; and higher mean of post-discharge follow-up.

**Table 1.** Distribution of clinical and epidemiological factors associated with plantar ulcer due to leprosy (n=1070).

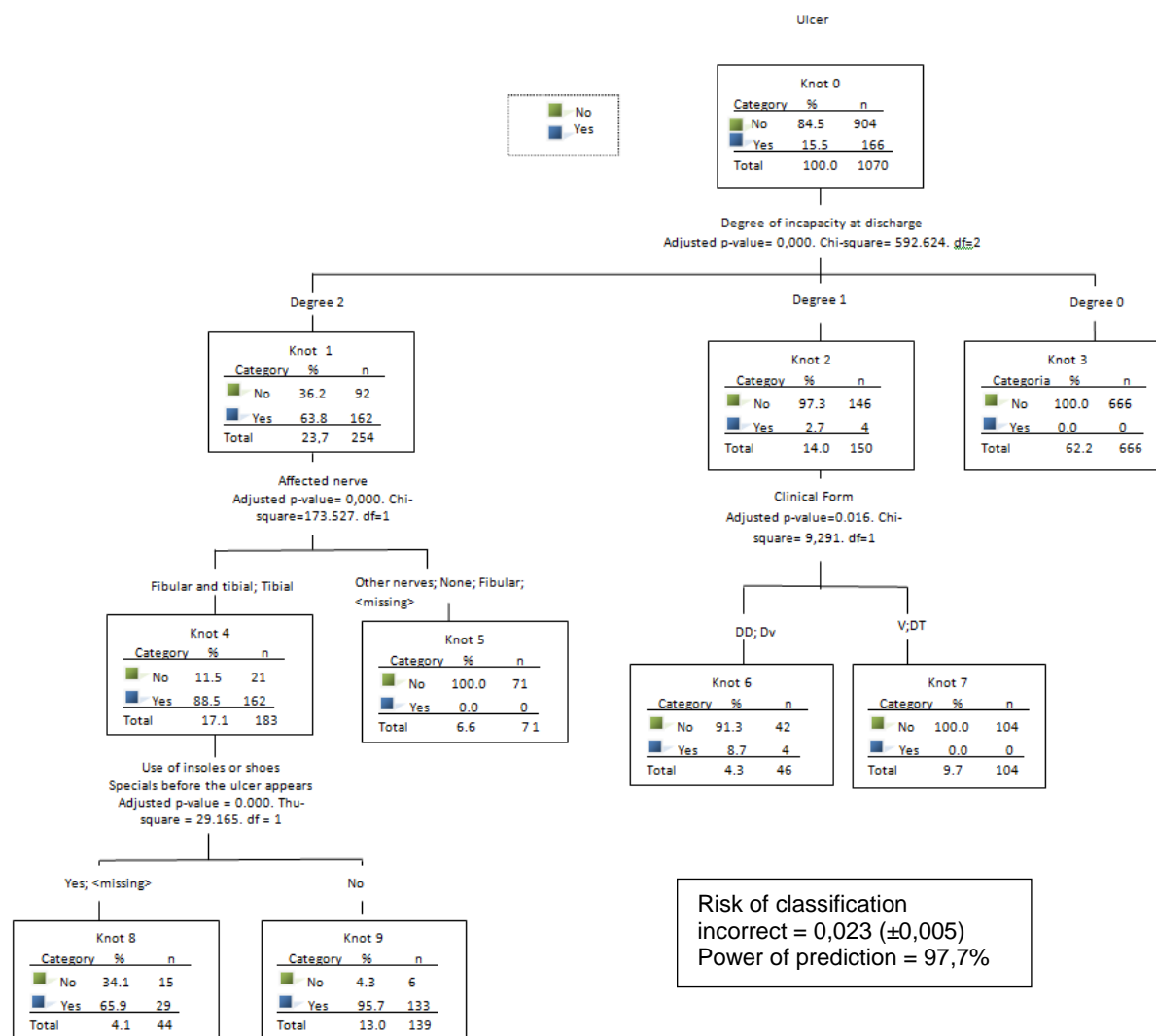
Variable	Ulcer		p-value
	Yes	No	
<b>Entering</b>			
New case	111 (66.9%)	667 (73.8%)	<0.001*
Transferred	38 (22.9%)	91 (10.1%)	
Other	17 (10.2%)	146 (16.1%)	
<b>Region of provenance</b>			
Central Macroregion	103 (62.0%)	684 (75.7%)	0.001*
Other	63 (37.9%)	220 (24.3%)	
<b>Operational classification defined by WHO</b>			
Multibacillary	166 (100%)	789 (87.3%)	<0.001*
Paucibacillary	0 (0%)	115 (12.7%)	
<b>Bacilloscopic Index</b>			
Negative	95 (57.2%)	610 (67.5%)	0.006*
Positive	71 (47.8%)	294 (32.5%)	
<b>Clinical form</b>			
T	0 (0.0%)	125 (13.8%)	<0.001*
DT	83 (50.0%)	470 (52.0%)	
DD	25 (15.1%)	100 (11.1%)	
DV	26 (15.7%)	49 (5.4%)	
V	32 (19.3%)	160 (17.7%)	
<b>Therapeutic scheme</b>			
PB	0 (0.0%)	145 (16.0%)	<0.001*
MB	128 (77.1%)	670 (74.1%)	
Alternative scheme	38 (22.9%)	89 (9.8%)	
<b>Reaction episodes</b>			
None	84 (50.6%)	660 (73.0%)	<0.001*
Reaction episodes type 1	39 (23.5%)	74 (8.2%)	
Reaction episodes type 2	12 (7.2%)	100 (11.0%)	
Episodes 1 and 2	31 (18.7%)	70 (7.8%)	
<b>Neuritis</b>			
Yes	114 (68.7%)	367 (40.6%)	<0.001*
No	52 (31.3%)	537 (59.4%)	
<b>Corticosteroids</b>			
Yes	113 (68%)	382 (42.2%)	<0.001*
No	53 (32.0%)	522 (57.8%)	
<b>Time using corticosteroids</b>			
Mean $\pm$ standard deviation	28.8 $\pm$ 52.2	11.5 $\pm$ 7.9	<0.001***
Median (minimum - maximum)	12 (1 - 384)	10 (1 - 80)	
<b>Thalidomide</b>			
Yes	41 (24.7%)	169 (18.7%)	0.137*
No	125 (75.3%)	735 (81.3%)	
<b>Affected nerve</b>			
None	0 (0.0%)	534 (59.0%)	<0.001*
Tibial	55 (33.1%)	86 (9.5%)	
Fibular	0 (0.0%)	17 (1.9%)	
Fibular and tibial	111 (66.9%)	117 (13.0%)	
Other nerves	0 (0.0%)	150 (16.6%)	
<b>Number of affected nerves</b>			
0	0 (0.0%)	538 (60.3%)	<0.001*
1	55 (32.5%)	245 (27.7%)	
2	57 (34.9%)	82 (9.1%)	
4	54 (32.5%)	39 (4.0%)	
<b>Degree of disability in diagnosis</b>			
Degree 0	4 (2.4%)	697 (77.1%)	<0.001*
Degree 1	22 (13.3%)	128 (14.2%)	
Degree 2	140 (84.3%)	79 (8.7%)	
<b>Degree of incapacity at discharge</b>			
Degree 0	0 (0.0%)	666 (73.7%)	<0.001*
Degree 1	4 (2.4%)	146 (16.2%)	
Degree 2	162 (97.6%)	92 (10.2%)	
<b>Use of insoles or special shoes before ulcer</b>			
Yes	32 (19.3%)	430 (47.5%)	<0.001*
No	134 (81.0%)	474 (52.5%)	
<b>Guidelines for prevention and care of ulcers</b>			
Yes	154 (92.8%)	677 (75.0%)	<0.001*
No	12 (7.2%)	227 (25.1%)	
<b>Post-discharge follow-up time</b>			
Mean $\pm$ standard deviation	54.4 $\pm$ 44.4	19.0 $\pm$ 24.1	<0.001***
Median (minimum - maximum)	45 (1 - 20)	11 (1 - 16)	
<b>Total</b>	<b>166</b>	<b>904</b>	

\*Chi-square test \*\* Fisher's exact test \*\*\* Mann-Whitney test

**Source:** Elaborated by the author from the research data, Belo Horizonte (MG), 2017.

The analysis of the decision tree by the CHAID algorithm is shown in Figure 1. It was observed that, among the patients with “zero” degree of incapacity at discharge, there are no cases of ulcer. Among those with degree 1, the

clinical form is another relevant factor. If the patient has degree 1 and clinical form V or DT, the probability of ulcer is also zero. On the other hand, if the clinical form is DD or DV the probability of ulcer increases to 8.7%.



**Figure 1.** Decision tree through the CHAID algorithm evaluating the factors associated with plantar ulcer.

Patients with degree 2 disability on discharge and fibular affected nerve, others or no affected nerve also have no chance of having ulcer. Patients with degree 2, tibial nerve or fibular and tibial nerves affected, but used insole or special footwear before the ulcer, have a probability of 65.9% to have an ulcer. If the patient did not wear insoles or special shoes before the ulcer appeared, the probability of ulcer increased to 95.7%.

It is important to highlight that the risk of incorrect classification for this model was 0.023,

generating, therefore, a predictive power of 97.7%.

## DISCUSSION

In this study, the risk factors associated with ulcer were: clinical form, degree of physical incapacity at discharge, nerve involved and, mainly, the non-use of insoles or adapted footwear before the ulcer appeared.

Patients with physical disability 1 at discharge, classified as DD or DV clinical forms,

have the probability of ulcer increased to 8.7% in relation to the group of patients with “zero” disability. This fact can be explained by the potential neurological instability of the patients who are classified in degree 1 of disability, who are a group with frequent reaction episodes that evolve with neurites. Leprosy reactions show up in greater numbers during the leprosy treatment period<sup>(8)</sup>. The neural damage resulting from the participation of cellular immunity as a result of polychemotherapy treatment is often irreversible<sup>(9)</sup>. This situation is more intense in neurites, when the patient has inflammation of the peripheral nerves, which can cause sensory, motor and autonomic alterations and, consequently, causes incapacities<sup>(10)</sup>.

Among patients with plantar ulcer, the degree 2 of physical disability was predominant in both diagnosis (84.3%) and discharge (97.6%). This degree is attributed when people present neural damage with generally established and definitive sequelae, that is, this percentage is high considering that leprosy elimination targets predict not only the decrease in prevalence but also the reduction of physical disabilities in diagnosis<sup>(11)</sup>. It is also highlighted the high proportion of new cases diagnosed with visible deficiencies (degree 2 of disability), this data was also found in the study<sup>(12)</sup>. The proportion of leprosy cases with degree 2 disability at diagnosis was high, greater than 10%, which reaffirms the importance of early diagnosis of the disease and physical disability in a study.

Among all the statistically significant variables, it was possible to verify the importance of the use of accommodating insoles or special shoes. The probability of ulcer occurrence in individuals who did not use insoles or special shoes previously was 95.7% in relation to who used it. Studies<sup>(13-15)</sup> confirm that these types of orthoses reduce the pressure on

the plantar surfaces preventing the installation of ulcers and, when already installed, help in the treatment favoring the healing.

Regarding self-care guidelines, these should be offered throughout the treatment and in the post-discharge. The literature cites simple prevention measures, carried out by through guidelines to the patient for the regular practice of self-care, that can be performed individually or in groups of mutual help, daily self-inspection, procedures, techniques and exercises that the person can perform regularly at home<sup>(16-18)</sup>.

Finally, it should be mentioned that the consequences or impact of a disease such as leprosy should be evaluated in all dimensions of the person's life, that is, it is insufficient to seek the elimination of leprosy by analyzing only the epidemiological and clinical aspects of the disease. It is necessary to study the particular and social consequences of its sequelae and the quality of life of patients with plantar ulcers.

## FINAL CONSIDERATIONS

The identification of the possible risk factors that are associated with plantar ulcers is relevant, since they aid in the planning of routine actions that prioritize the prevention of its installation and complications, such as physical deformities, besides assisting in the treatment and follow-up of the patients who already have the ulcer.

It is recommended that in the care offered to patients with dimorphic-dimorphic and dimorphic-virchowian form, with degree 1 of physical disability, the importance of insoles or adapted footwear should be emphasized at the beginning of the treatment. Such guidance should be included along with the other guidelines for care and measures for the prevention of physical disabilities.

## FATORES DE RISCO PARA A OCORRÊNCIA DAS ÚLCERAS PLANTARES DECORRENTE DA HANSENÍASE DE ACORDO COM A ÁRVORE DE DECISÃO

### RESUMO

**Objetivo:** Identificar os fatores de risco para a ocorrência das úlceras plantares em pacientes com hanseníase.

**Métodos:** Trata-se de um estudo epidemiológico, do tipo observacional, transversal e analítico. A população foi composta pelos casos de hanseníase notificados no período de 2005 a 2016. Para a análise univariada foram utilizados os testes Qui-quadrado de Pearson ou teste exato de Fisher e teste de Mann-Whitney, com significância estatística de 5% ( $p < 0,05$ ). Na análise multivariada, foi elaborada árvore de decisão utilizando o algoritmo CHAID. **Resultados:** A forma clínica, grau de incapacidade física na alta, nervo acometido e o não uso de palmilhas ou calçado adaptado antes de surgir a úlcera são fatores de risco para a ocorrência de úlcera plantar. **Conclusão:** evidenciou a necessidade do

diagnóstico precoce da hanseníase, como também da eficiente associação das intervenções medicamentosas e não medicamentosas por meio das técnicas de prevenção de incapacidade e uso de palmilhas acomodativas e/ou calçados especiais.

**Palavras-chave:** Hanseníase. Úlcera plantar. Fatores de risco. Incapacidade. Árvore de decisão.

## FACTORES DE RIESGO PARA LA INCIDENCIA DE LAS ÚLCERAS PLANTARES RESULTANTE DE LA ENFERMEDAD DE HANSEN DE ACUERDO CON EL ÁRBOL DE DECISIÓN

### RESUMEN

**Objetivo:** identificar los factores de riesgo para la aparición de úlceras plantares en pacientes con hansen. **Métodos:** estudio epidemiológico, observacional, transversal y analítico. La población estaba compuesta por casos de lepra notificados entre 2005 y 2016. La prueba de Chi cuadrado de Pearson o la prueba exacta de Fisher y la prueba de Mann-Whitney se utilizaron para el análisis univariado, con una significación estadística del 5% ( $p < 0.05$ ). En el análisis multivariado, se elaboró un árbol de decisión utilizando el algoritmo CHAID. **Resultados:** la forma clínica, el grado de incapacidad física en el alta, la afectación nerviosa y el no uso de plantillas o calzado adaptado antes de la aparición de la úlcera son factores de riesgo para la aparición de úlcera plantar. **Conclusión:** se destacó la necesidad de un diagnóstico precoz de la lepra, así como la asociación eficaz de las intervenciones no farmacológicas con técnicas de prevención de la discapacidad y el uso de plantillas y/o calzado especial.

**Palabras clave:** Enfermedad de Hansen. Úlcera plantar. Factores de riesgo. Incapacidad. Árbol de decisión.

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