

**PODAL CUTANEOUS FUNGAL INFECTIONS AS PREDICTORS OF
COMPLICATIONS IN PERSONS WITH DIABETES: AN INTEGRATIVE REVIEW****INFECÇÕES FÚNGICAS CUTÂNEAS PODAIS COMO PREDITORAS DE
COMPLICAÇÕES EM PESSOAS COM DIABETES: UMA REVISÃO
INTEGRATIVA****INFECCIONES FÚNGICAS CUTÁNEAS EN LOS PIES COMO PREDICTORAS DE
COMPLICACIONES EN PERSONAS CON DIABETES: REVISIÓN INTEGRATIVA**

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ABSTRACT

Objective: to analyze, according to national and international scientific productions, the presence of peripheral cutaneous fungal infections and the main fungi identified in people with type 2 diabetes mellitus. **Method:** this is an integrative literature review, with studies published in the databases MEDLINE, LILACS, Web of science, BDENF, SCIELO and PUBMED. **Results:** the main dermatophytes found in cultures isolated from individuals with diabetes were trichophyton rubrum and trichophyton metagraphyte, as well as the yeast-like fungi identified were candida albicans and candida tropicalis, with the prevalence of onychomycosis 2.5 times more elevated in people with diabetes. **Conclusion:** superficial and cutaneous peripheral fungal infections do not refer only to aesthetic or cosmetic complications, mainly for people with diabetes, but also to a serious public health problem, due to complications and their potential for morbidity and mortality

Descriptors: Dermatomycoses; Mycoses; Onychomycosis; Diabetic Foot; Nursing

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RESUMO

Objetivo: Analisar, segundo as produções científicas nacionais e internacionais, a presença de infecções fúngicas cutâneas periféricas e os principais fungos identificados em pessoas com diabetes mellitus tipo 2. **Método:** Trata-se de revisão integrativa de literatura, com estudos publicados nas bases de dados MEDLINE, LILACS, Web of Science e bibliotecas eletrônicas BDENF, SciELO e PubMed. **Resultados:** Os principais dermatófitos encontrados nas culturas isoladas de indivíduos com diabetes foram o *Trichophyton rubrum* e o *Trichophyton mentagrophyte*, assim como, os fungos do tipo leveduras identificados foram a *Candida albicans* e a *Candida tropicalis*, sendo a prevalência de onicomicose 2,5 vezes mais elevada em pessoas com diabetes. **Conclusão:** As infecções fúngicas superficiais e cutâneas periféricas não se referem apenas de complicações estéticas ou cosméticas, principalmente para as pessoas com diabetes, mas sim, de um sério problema de saúde pública, devido às complicações e o seu potencial de morbi-mortalidade.

Descritores: Dermatomicoses; Micoses; Onicomicose; Pé Diabético; Enfermagem

RESUMEN

Objetivo: Analizar, según producciones científicas nacionales e internacionales, la presencia de infecciones fúngicas cutáneas periféricas y los principales hongos identificados en personas con diabetes mellitus tipo 2. **Método:** Revisión integrativa de la literatura, con estudios publicados en las bases de datos MEDLINE, LILACS, Web of Science y en las bibliotecas electrónicas BDENF, SCIELO y PUBMED. **Resultados:** Los principales dermatofitos encontrados en cultivos aislados de individuos con diabetes fueron *trichophyton rubrum* y *trichophyton mentagrophytes*, además, los hongos levaduriformes identificados fueron *candida albicans* y *candida tropicalis*, la prevalencia de onicomicosis es 2,5 veces mayor en personas con diabetes. **Conclusión:** Las infecciones fúngicas periféricas superficiales y cutáneas no son solo complicaciones estéticas o cosméticas, principalmente en personas con diabetes, sino también un grave problema de salud pública, debido a las complicaciones y su potencial de morbilidad y mortalidad.

Descriptor: Dermatomicosis; Micosis; Onicomicosis; Pie Diabético; Enfermería.

INTRODUCTION

Currently considered a globally progressing pandemic¹⁻², diabetes mellitus occurs when the pancreas does not produce enough insulin or the body cannot effectively use the insulin it synthesizes. Diabetes and its etiology have become one of the most significant causes of morbidity and mortality. By 2040, it is predicted that there will be more than 642 million people with this disease worldwide.³ In 2014,

diabetes affected 422 million adults compared to 108 million in 1980. Since 1980, the worldwide prevalence of this disease has increased by almost the double, that is, from 4.7% to 8.5% in the adult population, with 1.5 million deaths attributed to it in 2012.¹ Approximately 74 thousand deaths were attributed to hyperglycemia in Brazil in 2016.⁴

Type 2 diabetes is the most frequent form of this disease, representing around 90% of cases, affecting mainly

adults and the elderly; however, there has been an increasing incidence in children and young people. It should be clarified that in type 2 diabetes, hyperglycemia is the result of inadequate production and the body's inability to respond to the hormone produced by the pancreas, insulin.²

Long-term complications develop gradually, including the longer the disease has progressed and the lower the serum glucose control, the greater the risk of complications. However, with proper and recommended treatment, as well as lifestyle changes, many people with diabetes are able to prevent or delay the onset of problems, avoiding serious health consequences.³

With time of disease progression and lack of control, damage to target organs such as the heart, kidneys, eyes, as well as nerves and blood vessels can occur, increasing the risk of cardiovascular and cerebrovascular diseases.¹ It is noteworthy that the decrease in blood flow that , associated with damage to peripheral nerves, specifically in the feet, increases the vulnerability to injuries and infections, with the outcome of amputation.¹

The incidence of foot ulcers in people with diabetes is 25% and commonly precedes most lower limb extirpations. More than 50% of all foot ulcers will be infected, requiring

hospitalization, and 20% of lower limb infections will result in amputation.

Diabetic foot disease, described as such worldwide, leads to ulceration, complications and possible subsequent amputation of the lower limbs, mainly due to neuropathy, peripheral arterial disease and/or infection. It is one of the most costly complications of diabetes and can result in significant economic, social and public health losses, especially in low-income communities. Therefore, it is noteworthy that a paradigm shift is urgent and necessary to treat peripheral complications and foot ulcers in people with diabetes, especially with a focus on prevention.³

Different situations are considered significant predictors for the development of foot ulcerations, including: impaired vision, anterior foot ulcer, amputation, loss of sensation, tinea pedis (interdigital mycosis), and onychomycosis (nail mycosis).⁵ Some studies show that the prevalence of onychomycosis is 25% to 30% higher in people with diabetes.⁶⁻⁹

The clinical management of peripheral cutaneous fungal infections, especially with regard to onychomycosis and tinea pedis, is progressively recognized as a potential strategy to prevent complications related to the feet of people with diabetes.^{3,10-12} Thus, this study

aimed to analyze, according to national and international scientific production, the presence of peripheral skin fungal infections and the main fungi identified in people with type 2 diabetes mellitus.

METHOD

This is an integrative literature review study with a view to enabling the synthesis of multiple published studies and the construction of general inferences on the subject. The development of this evidence-based review method aims to offer important contributions to nursing research and practice.¹³

The method in screen recommends the application of six steps to achieve the proposed objectives. In this sense, the first step refers to the choice of the theme and the formulation of the guiding question. The proposed theme was: skin complications on the feet of people with diabetes. The following guiding question was selected: what do scientific publications describe about the presence of peripheral cutaneous fungal infections and the main fungi identified in people with type 2 diabetes?

In the second stage, the databases and inclusion and exclusion criteria for the scientific production that will form the scope of analysis are defined, enabling the

achievement of the objectives. The databases selected for this study were: PubMed, Database in Nursing (BDENF) and Web of Science. The Health Sciences Descriptors (DeCS) used, in Portuguese, English and French, with application of the Boolean operators AND/OR were characterized as: Dermatomycosis OR Mycoses OR Onychomycosis AND Diabetic Foot. For the English terms in the PubMed database, the Medical Subject Heading (MeSH) was used: Onychomycoses OR Nail Fungus OR Fungus, Nail OR Tinea Unguium AND Diabetic Foot OR Foot, Diabetic OR Diabetic Feet OR Feet, Diabetic OR Foot Ulcer, Diabetic.

Data collection took place between July and December 2019, and the corpus analysis was completed in August 2020. The selection of articles was based on pre-established inclusion and exclusion criteria. It should be noted that scientific productions were included in the format of articles, available in full in the free format of the public domain, in Portuguese, English, Spanish and French, whose time frame was from 2005 to 2019, as they are presented in the databases of researched data. Duplicate articles, monographs, theses and dissertations, as well as reviews and editorials were excluded from this study. In addition, articles developed with

animals and in duplicate in the different databases were excluded.

In the third stage, the information to be extracted from the selected studies was defined. For this purpose, the data were sorted in a spreadsheet using the Microsoft Excel program. The articles were numbered in descending order according to the year of publication - A1 to A17 - and the following information was extracted from the selected material: year of publication, journal, language, article classification, indexing, authors, title, objective, design and location.

Subsequently, in the fourth and fifth stages, in which the evaluation of the studies included in the integrative review and the interpretation of the results occur, respectively, exhaustive readings of the material, the analysis and interpretation of the findings were carried out, observing the similarities and differences between studies, thus seeking to achieve the stated objective.

The presentation of the review, according to the method, is performed in the sixth stage, for this, a synthesis of the main results was built through thematic analysis, evidenced throughout the textual construction and the discussion of the categories. For a better understanding of the stages of the research, an information diagram was built with the different phases

covered to compose the corpus of analysis (Figure 1).

RESULTS

The corpus of analysis consisted of 17 articles tabulated in a spreadsheet, arranged in Chart 1 for better visualization of the findings and summarization of information. The analysis revealed that 94% (16) of the publications were from international sources. Publications from different continents such as: Asian continent (09 - 56%) including India (05), Turkey (02), Japan (01) and Taiwan (01); European continent (25% - 04) covering Italy (01), Holland (01), Denmark (01) and Belgium (01); African continent (02 - 13%) comprising Cameroon (01) and Morocco (01) and South America (01 - 6%), identifying Peru (01) and only one (01) national publication from the southern region from Brazil.

Table 1. Characterization of the scientific productions analyzed on the presence of peripheral skin fungal infections in people with type 2 diabetes. Rio de Janeiro, RJ, Brazil, 2020.

n	Year of publication, Language, Article classification, Indexing	Title	Goal	Local design
A1	2019 English Original article MEDLINE	Emergence of Fluconazole-resistant Candida Infections in Diabetic Foot Ulcers: Implications for Public Health ¹⁵	To study the prevalence of fluconazole resistance in patients with DFU and culture-proven fungal infections	Retrospective study Kerala (India)
A2	2019 English Original article MEDLINE	Chemical Peeling as an Innovative Treatment Alternative to Oral Antifungals for Onychomycosis in Special Circumstances ¹⁶	Report successful use of black to medium peel normally used for anti-acne and cosmetic indications	Case report New Delhi (India)
A3	2018 English Original article MEDLINE	Epidemiology of diabetic foot infections in a reference tertiary hospital in India ¹⁷	To examine the microbial profile and antibiotic susceptibility of diabetic foot infections in the intensive care unit of a tertiary referral center for diabetic foot	Prospective Study Maharashtra (India)
A4	2017 Portuguese Original article LILACS	Fatores associados à ulceração nos pés de pessoas com diabetes mellitus residentes em área rural ¹⁸	To analyze the factors associated with the risk of ulceration in the feet of people with diabetes mellitus living in rural areas	Cross-sectional study Southern region (Brazil)

A5	2017 English MEDLINE Case Report	Toenail onychomycosis by <i>Trichophyton rubrum</i> and concurrent infestation with <i>Tyrophagus putrescentiae</i> ¹⁹	Case report on the presence of <i>Trichophyton (T.) rubrum</i> onychomycosis combined with <i>Tyrophagus (T.) putrescentiae</i> nail infestation in an elderly diabetic farmer	Case report Perugia (Italy)
A6	2016 BMC Research Notes English Original article MEDLINE	Onychomycosis in diabetic patients in Fako Division of Cameroon: prevalence, causative agents, associated factors and antifungal sensitivity patterns ²⁰	To provide information on the characteristics of onychomycosis in diabetics in Fako, we evaluated the prevalence, associated factors, causative agents and the patterns of antifungal sensitivity of the isolates.	Buea cross-sectional study (Cameroon)
A7	2016 Pakistan Journal of Medical Sciences English Original article MEDLINE	Tinea pedis and onychomycosis frequency in diabetes mellitus patients and diabetic foot ulcers: A cross sectional – observational study ²¹	Evaluate onychomycosis and/or frequency of tinea pedis in diabetic patients and effects on the development of chronic complications, particularly foot ulcers	Adana cross-sectional study (Turkey)
A8	2015 Trials English Original article MEDLINE	Laser therapy for onychomycosis in patients with diabetes at risk for foot complications: study protocol for a randomized, double-blind, controlled trial (LASER-1) ²²	To evaluate the effectiveness of four sessions of 1064 Nm Nd:YAG laser application on the one-year clinical and microbiological cure rate in a randomized, double-blind, simulation-controlled trial with blinded outcome assessment	Simulation-controlled double-blind study Zwolle (Netherlands)
A9	2014 Plos one English Original article MEDLINE	Diabetic peripheral neuropathy in ambulatory patients with type 2 diabetes in a general hospital in a middle income country: a cross-sectional study ²³	Estimate the morbidity rate and associated factors for diabetic peripheral neuropathy (PDN) in a low-income country setting	Cross-sectional study Lima (Peru)

A10	2014 Pan African Medical Journal French Original article MEDLINE	Quels agents incriminés dans les mycoses du pied? Enquête auprès des diabétiques consultant au CHU Mohammed VI de Marrakech ²⁴	Identify the local flora mycological responsible for foot injuries in diabetics and determine the factors that favor the occurrence of mycoses	Cross-sectional study Marrakech (Morocco)
A11	2011 Journal of Advanced Nursing English Original article MEDLINE	Beneficial effects of foot care nursing for people with diabetes mellitus: An uncontrolled before and after intervention study ²⁵	Evaluate the effectiveness of a preventive foot care program for diabetic patients	Study design based on the conceptualization of disease management Osaka (Japan)
A12	2011 English Review Article MEDLINE	Onychomycosis: Diagnosis and management ²⁶	–	Review article Delhi(India)
A13	2009 English case report MEDLINE	Onychomycosis caused by <i>Fusarium solani</i> in a woman with diabetes ²⁷	Case report of untreated fusional onychomycosis leading to serious consequences in a 92-year-old woman with chronic renal failure and diabetes mellitus	Case Report Kaohsiung(Taiwan)
A14	2008 English Original article MEDLINE	Spectrum of microbial flora in diabetic foot ulcers ²⁸	Determine the clinical characteristics, the spectrum of the aerobic microbial flora and evaluate its in vitro susceptibility compared to commonly used antibiotics.	Prospective study Chandigarh (India)
A15	2007 English Original article MEDLINE	The prevalence, epidemiology and risk factors for onychomycosis in hemodialysis patients ²⁹	To investigate the prevalence of onychomycosis in hemodialysis patients with and without diabetes mellitus and discover the factors that are likely to be associated with the development of onychomycosis in hemodialysis patients	Hatay cross-sectional study (Turkey)

A16	2006 English Original article MEDLINE	Prevalence of toe nail onychomycosis in diabetic patients ³⁰	To investigate the prevalence of onychomycosis among diabetic patients in a Danish university hospital	Cross-sectional study Copenhagen (Denmark)
A17	2005 English Original article MEDLINE	The nail under fungal siege in patients with type II diabetes mellitus ³¹	To review the relative prevalence of dermatophyte, yeast and non-dermatophytic fungal onychomycosis in diabetic adults	Prospective study Liege (Belgium)

Regarding the methodological nature of the studies, most are cross-sectional study design (07 - 41%). However, prospective studies were also captured (03 - 17%), a retrospective study (01 - 6%), a double-blind study controlled by simulation (01 - 6%), case reports (03 - 18%), review (01 - 6%) and one (01) qualitative study (6%).

It is worth highlighting that the topic seems to have been discussed for at least 15 years, which may highlight the need for attention not only to research aimed at the most common microorganisms in chronic lesions, such as gram positive and/or gram negative bacteria, but yes, the construction of more national researches that also involve the mycological profile of infections.

DISCUSSION

The notion of theme is linked to a statement about a certain subject¹⁴, so the thematic analysis was performed and the categorization emerged from the various themes analyzed arising from the articles.¹⁵⁻³¹ In this perspective, the three categories that express the responses to the research questioning. The categories emerged from the corpus of analysis by grouping and similarity, which were named as follows: I) Etiology, description of the pathogenesis, and main clinical presentations; II) Mycological profile and

frequency in isolated cultures and III) Analysis of the risk of ulceration associated with the presence of foot fungal infections in people with diabetes.

Etiology, description of the pathogen, and main clinical presentations

International studies have shown that the prevalence of superficial and cutaneous fungal infections in adults and elderly people with diabetes is mainly related to onychomycosis and tinea pedis.^{7,32}

Mycology studies the fungi that are found in almost every location in the world and occupy the Fungi kingdom, divided into five phyla. Some fungi are considered harmful and others beneficial to humans. The fungi called saprophytes live in organic matter, soil and water; and other fungi called parasites live on the surfaces or inside of plants and animals. Fungi are single-celled eukaryotes such as yeast, others grow with filaments called hyphae, which intertwine and form a mass called mycelium.³³

Fungal infections in humans are known as mycoses, classified as superficial, cutaneous, subcutaneous or systemic, which can progress in all stages. Superficial mycoses are fungal infections located in the most external areas of the human body, such as: fingernails and

toenails and the most external and devitalized layers in the epidermis. Cutaneous mycoses refer to fungal infections of the living layers of the skin, such as the dermis and other classifications in inner layers. A group of fungi collectively classified as dermatophytes cause ringworm or tinea infections. Tinea infections are described according to the site of infection in the human body, such as tinea pedis (athlete's foot), tinea unguium (nails of the hands and toes), tinea capitis (hair scalp), tinea barbae (face and neck),

Tinea pedis is a common dermatophytosis that clinically presents in three forms. The Interdigital form is characterized by a pruritic erythematous lesion in the interdigital regions of the feet, with or without the presence of fissures, which can cause pain. Another type of tinea pedis refers to the hyperkeratotic form, which is characterized by the appearance of a diffuse hyperkeratotic plaque involving the sole and the medial and lateral region of the feet. Yet, the vesiculobullous form, which presents pruritic vesiculobullous eruptions, with erythema generally affecting the medial region of the foot. Treatment time varies depending on the resolution of the infection. To prevent recurrence, people who have other concomitant fungal

infections such as tinea manuum and tinea unguium should be evaluated and treated.³⁴

As for onychomycosis, different factors determine its prevalence, including age, occupation, climate and frequency of travel.²⁶ It is one of the most frequent dermatoses caused by nail infection, caused by dermatophytes, yeasts and/or filamentous fungi not dermatophytes.³⁵ Dermatophytes are the most frequent causative agents and their infection is called tinea unguium and yeasts, formerly known as contaminants, are increasingly recognized as pathogens of nail infections.^{22,26,36}

The clinical presentation of onychomycosis caused by dermatophytes is divided into five variations: distal and lateral subungual onychomycosis; proximal subungual onychomycosis; superficial white onychomycosis; endonyx and total dystrophic onychomycosis.^{26,35}

Onychomycosis caused by yeasts affect the nails, finding that almost half of the cases are related to *Candida* species and commonly present in the forms of paronychia, granuloma or cause resulting onycholysis.^{26,35}

The clinical appearance may provide clues about the infecting pathogen, and may present total or partial dystrophies of the nail plates with thickening, discoloration, detachment of edges and

pain.³⁵ However, onychodystrophy can manifest for several causes and the appearance caused by different causes is indistinguishable pathogens. Therefore, it is necessary to identify the fungal microorganism for the correct etiological diagnosis.^{26,35}

Mycological profile and frequency in isolated cultures

For analysis of this category, eight articles were grouped by similarity, in view of the quantitative approach and the research designs of transversal, longitudinal, retrospective and prospective types, which were synthesized and distributed to the different characteristics presented in Table 2. Subsequently, based on in the studies, the microbial distribution was tabulated with the fungal species found (Table 3).

It is noteworthy that in the studies analyzed, the distribution of microorganisms isolated from samples of nail plates, skin and/or skin lesions collected from people with diabetes mellitus revealed the frequent presence of dermatophyte pathogens. The main dermatophytes found were: *Trichophyton rubrum*^{16,19,20,24,29-31}, mentioned in 7 studies (63.6%), followed by *Trichophyton metagraphyte* (3 - 27.2%)^{20,29,30} and *Trichophyton tonsurans* (2 - 18.1%).^{20,30}

Yeast-like fungi also appeared as prevalent: *Candida albicans* (5 - 45.4%)^{15-17,28,30} and *Candida tropicalis* (2 - 18,1%),^{17,28} followed by *Aspergillus niger* (2 - 18.1%).²⁸⁻²⁹

In Brazil, the study on the frequency of onychomycosis in the state of Paraná also showed that the genus *Trichophyton* was also the most isolated in tinea unguem podal, as it is the microorganism of the group of dermatophytes with universal distribution, predominant in tropical and subtropical regions.³⁷ The keratinophilic filamentous fungi called dermatophytes use keratin as nutrients in infections and are classified into three genera: *Trichophyton*, *Microsporum* and *Epidermophyton* according to the morphology and formation of their conidia. They are further divided as zoophilic, geophilic and anthropophilic species according to their primary habitat.³⁶

Anthropophilic species represent 70% of infections in humans with adaptation to the host, causing chronic infections with slow progression. Although not associated with significant mortality, they are associated with considerable morbidity, affecting children, adults in general and individuals in lower socioeconomic environments, both in the United States and worldwide.³⁶

Trichophyton rubrum is a cosmopolitan microorganism, most frequently isolated from lesions caused by dermatophytes and its transmission is exclusively inter-human or through contaminated fomites. It is an

anthropophilic fungus, responsible for infections of keratinized tissues: skin and nails and rarely, hair. Onychomycosis caused by *Trichophyton rubrum* may be refractory to treatment.³⁷⁻³⁹

Table 3. Fungal microbial distribution in people with diabetes, according to studies. Rio de Janeiro, RJ, Brazil, 2020.

Microbial Distribution	A1	A2	A3	A5	A6	A10	A13	A14	A15	A16	A17
<i>Acremonium spp</i>											X
<i>Alternaria tennis</i>											X
<i>Aspergillus flavus</i>								X			
<i>Aspergillus fumigatus</i>			X								
<i>Aspergillus niger</i>								X	X		
<i>Aspergillus spp</i>											X
<i>Candida albicans</i>	X	X	X					X		X	
<i>Candida auris</i>	X										
<i>Candida glabrata</i>										X	
<i>Candida krusei</i>										X	
<i>Candida guiliermondii</i>								X			
<i>Candida parapsilosis</i>	X									X	
<i>Candida spp.</i>			X								
<i>Candida tropicalis</i>			X					X			
<i>Epidermophyton floccosum</i>									X		
<i>Fusarium oxysporum</i>											X
<i>Fusarium solani</i>							X				
<i>Fusarium sp.</i>		X						X			
<i>Malassezia sp</i>										X	
<i>Pichia etchellsii/carsonii</i>									X		
<i>Rhodotorula sp.</i>			X								
<i>Scopulariopsis brevicaulis</i>											X
<i>Trichophyton metagrophyte</i>					X				X	X	
<i>Trichophyton rubrum</i>		X		X	X	X			X	X	X
<i>Trichophyton tonsurans</i>					X					X	

Other studies have confirmed that the most common fungal agents associated with prevalence in dermatophytosis are: *Trichophyton rubrum* and *Trichophyton metagraphyte*, as well as yeast mycoses are increasingly recognized as pathogens in nail plate infections.^{36,37,40-42}

Risk analysis of ulceration associated with the presence of foot fungal infections in people with diabetes

Increasingly, onychomycosis is being seen as more than just a cosmetic problem, as even with improved standards of personal hygiene and the environment, nail and interdigital fungal infections continue to persist and spread. It is a debilitating disease with immense negative physical and psychological impact.²⁶

The prevalence rate is determined by age, predisposing factor, social class, occupation, climate, living environment and frequency of travel. Nail and interdigital fungal infections in immunocompromised patients can represent a more serious health problem, especially for people with diabetes.¹⁸ This type of infection is commonly found in the population with diabetes mellitus and is easily identified through clinical evaluation of the feet, and may be treated in the context of primary health care. This action could significantly reduce the risk of

infected lesions on the feet of people with diabetes, which is the main factor that precedes amputations.¹⁸

The clinical management of onychomycosis is progressively being recognized as a potential strategy to prevent diabetes-related foot complications.^{7,22,24-26} Individuals with diabetes are 2.5 times more likely to have onychomycosis than the control population, having as predisposing factors: increasing age, male gender, duration of diabetes, impaired peripheral circulation, peripheral neuropathy and retinopathy.⁴³ In this sense, it is worth clarifying that impaired cellular immunity and reduced phagocytic function of polymorphonuclear leukocytes facilitate the development of fungal infections and bacterial on the skin due to uncontrolled hyperglycemia in people with diabetes.²¹

It should therefore be considered that the presence of onychomycosis is currently considered risk category 2 (high risk) by the guidelines of the International Diabetes Federation, although there have been discussions on the subject for at least 15 years, according to the publications surveyed.³¹ Current guidelines aim to protect the diabetic foot from collapse by preventing foot ulceration and lower limb amputations. Through early preventive measures in the disease process and

complications, the treatment of feet in the first risk categories of 1 (moderate risk) and 2 (high risk) is a priority, so that there is no progression to the very high risk category (3 - very high risk).

People with diabetes who suffer from onychomycosis and neuropathy or peripheral arterial disease are at increased risk for developing complications related to diabetes, but also for complications related to treatment.²² The therapy should transcend the drug aspect, also encompassing the assessment of the characteristics of the feet appearance, observing deformities, dry skin, calluses, loss of muscle mass, nail dystrophies, infection and cracks.²³ It should be emphasized that a preventive nursing care program improves the general status of the feet and prevents the possibility of ulceration in the feet of diabetics, especially in those at high risk for amputations.²⁵

CONCLUSION

According to the publications analyzed and the discussions presented, it could be inferred that superficial fungal infections and peripheral skin infections are not just aesthetic or cosmetic complications, especially for people with diabetes, but a serious public health

problem due to complications, with its potential for morbidity and mortality.

The dermatophytosis studied showed an increasing global behavior, with a higher frequency of involvement in adults and elderly people with diabetes. About 25% to 30% of adults with diabetes have superficial or skin fungal infections such as tinea pedis or tinea unguium. In this sense, it could be concluded that people with type 2 diabetes, who have onychomycosis, tinea pedis, neuropathies and/or peripheral arterial disease have an increased risk of developing serious complications related to comorbidity, especially with regard to complications related to the feet and the risk of lower limb amputations.

It was also evidenced the need for a closer look by health professionals in an integrated way, especially nurses who remain attentive to foot care and superficial and cutaneous fungal infections for the prevention of ulceration in people with diabetes, especially in high-risk groups.

Despite the scarcity of national studies, the results found of a higher prevalence of dermatophyte microorganisms and yeasts in onychomycosis and tinea pedis are in line with researches of a worldwide trend. This inference seems to reveal a global behavior

of the pathogen, requiring further studies to discuss the findings and better understanding of the relevance of this type of infection for people with type 2

diabetes. Therefore, it is suggested that more studies be carried out on the subject.

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