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Use of the 'cuidando do pé' app for risk classification and orientation regarding diabetic foot

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Abstract

Introduction and Objective. Diabetic foot is a complication of diabetes mellitus (DM) and is the leading cause of lower limb amputation. Use of the application 'Cuidando do Pé' (Caring for the Foot), with the aim of achieving better preventive alternatives and seeking better patient monitoring.

Materials and method. Cross-sectional study, carried out with 20 patients with Type II Diabetes Mellitus, in routine consultations between June – November 2022. The collection was performed from a questionnaire made available through the application 'Cuidando do Pé' and the behaviours given accordingly.

Results. 40% did not know about foot care; among those who did, 80% had never had their feet evaluated by health professionals, 55% did not perform proper care, and 30% claimed to have chronic pain at the site. None of the patients presented deformities or changes in skin integrity or colour; however, absent pilification (20%), xeroderma (25%), cracks (5%), hypertrophic (5%) or hypotrophic (5%) nails, humid (5%) or macerated (5%) interdigital spaces, decreased superficial (35%) and deep (5%) sensibility, altered reflexes (20%), lower limb oedema (15%), cold temperature (5%), and decreased peripheral pulses (up to 25%) were presented.

Conclusion. Most of the patients with type II DM analysed did not perform proper foot care, and many did not know what this care was and were classified, on average, as having moderate risk of developing complications. Several alterations were presented, most of which could be avoided with routine consultations and more information on comorbidities associated with type II DM. The application 'Cuidando do Pé' is a viable alternative for better standardisation of care, also having simplicity and accessibility for health workers.

Key words

Diabetic foot, Diabetes mellitus, Rehabilitation

INTRODUCTION

Diabetes mellitus (DM) is a chronic disease of metabolism due to relative or absolute lack of insulin [1]. Type I diabetes includes forms caused by primary autoimmune destruction of pancreatic B cells or a primary defect in B-cell function secondary to another (non-autoimmune) cause. Type II, on the other hand, includes the most common form of diabetes, resulting from insulin resistance combined with inadequate insulin secretion [2]. In addition to these, there is also gestational DM, generated from changes in the body during pregnancy [3].

About 422 million people worldwide have diabetes, and about 1.6 million deaths are attributed to it every year. Most of those affected reside in low- and middle-income countries, which ultimately worsens the outcome of the disease and reduces treatment options [4], and there is an intrinsic relationship between risk of comorbidities and death with diabetes [5].

Type II DM generates symptoms that reverberate throughout the patient's body, these can be divided into six categories: hyperglycaemic, hypoglycaemic, psychological, cardiovascular, neuropathic, and ophthalmologic [2]. The risk of developing these chronic complications is directly associated with increasing body mass, which generates attention, as the high prevalence of DM is linked to sedentary lifestyles, increasing levels of obesity, an aging population, and diets high in calories and fat [1, 6].

Among chronic complications, the high frequency of 'Diabetic Foot', a condition characterized by ulceration or destruction of the deep tissues of the foot, infection, associated with neuropathy and/or peripheral obstructive arterial disease [7]. The diabetic foot syndrome encompasses several pathological conditions, including Charcot foot, a neuro-osteoarthropathy that generates inflammation in its active phase, followed by varying degrees of non-infectious bone and joint destruction, which can lead to tissue ulceration and secondary infections, putting the limb at risk [8].

Among those diagnosed with diabetes mellitus, the risk of developing foot ulceration is estimated at 15% and the lifetime incidence can be as high as 25%. Peripheral arterial disease, peripheral neuropathy, foot ulceration, or lower limb amputation are twice as common in diabetics and affect 30% of diabetics over the age of 40 [9]. Treatment of diabetic foot ulcers, if not performed preventively, ultimately leads to

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emotional and physical damage, as well as being extremely costly. A 1999 study estimated that treatment of a diabetic foot ulcer had an average cost of $28,000 for the 2 years after diagnosis [10].

Among the causal pathways leading to foot ulcers and other diabetic foot-related pathologies, the most relevant is peripheral neuropathy, which is present in more than 50% of diabetic people over the age of 60 years. Besides this, excessive plantar pressure, traumas (especially when repetitive), and previous foot ulcers can be listed. Contributing factors to damage are peripheral vascular disease (twice as common in people with DM), intrinsic wound healing disorders and immunological disturbances, and patients with DM also have a higher rate of onychomycosis and infections that can lead to skin lesions [9].

In a study conducted at the Federal University of Alfenas, Brazil, the application 'Cuidando do pé' ('Care of the Foot'), which by means of agile methodologies implemented the indicators of the evaluation of diabetic foot recommended by the Ministry of Health, transforming them into an attractive and practical technological product, which is a useful tool for guiding health professionals in the process of evaluating the feet of people with DM and measuring the risk of diabetic foot [11].

This work proposes the use of the 'Cuidando do Pé' for risk classification and the guidance on diabetic foot care in a standardized manner and the generation of appropriate behaviours regarding treatment and prevention. In addition, to teach and inform patients diagnosed with diabetes about the existence of the diabetic foot and the importance of care to minimise future complications.

MATERIALS AND METHOD

A cross-sectional study was undertaken at the outpatient clinic of the National Plan for Reorganization of Attention to Hypertension and Diabetes Mellitus (HIPERDIA). The research project was conducted after approval by the Research Ethics Committee of the Lusíadas University Centre (5.637.271). Patients of any age, diagnosed with type 2 Diabetes Mellitus and enrolled in the Hiperdia outpatient clinic were included in the study. The exclusion criteria were patients with cognitive and/or speech alterations linked to sequelae of other diseases that would compromise the ability to answer the evaluation questions, and previous episodes or diseases of foot lesions not related to diabetes (e.g., fractures, surgeries, traumatic amputations or congenital diseases).

The application 'Cuidando do pé' was the tool for data recording, classification and guidance to the evaluated patients. This application was developed at the Federal University of Alfenas which published its formulation steps [11]. To formulate a systematic anamnesis with correct orientations, the application takes into consideration age, gender, time of diagnosis, weight, height, blood glucose measurement at the time of the questionnaire, medications in use, personal history, classification regarding knowledge about foot care, and level of foot pain. For the physical exam, the evaluation of skin integrity and annexes, colour, pilification, hydration, nails, interdigital spaces, evaluation of sensitivity and vibration perception, Achilles tendon reflex, vascular evaluation, temperature, deformities, and evaluation of posterior tibial and pedial pulses was standardised. New options are opened for each described alteration, together with photos, for the evaluator to have an easier identification of atypical forms of presentation of the feet during the physical examination, and it can be considered a method to guarantee standardisation of care, and ensure that the treatments will be the most necessary individually for each person. The use of individual topics, which, when identified, opens new more specific options, generates a better stratification of the physical examination, ensuring that the examiner does not forget when investigating diseases.

After evaluation and insertion in the application database, an individualized management is generated based on the answers described above. The risk of the patient having diabetes is reported, as well as appropriate recommendations, and the frequency with which to seek evaluation with a professiona (Tab. 1). It is also shown which changes were evidenced and the best management for each change described (Tab. 2).

The data on each patient is recorded on the application, and analyzed in order to try to establish relationships between the time of diabetes, foot changes, and degree of risk classification.

Data analysis performed with mean, standard deviation and percentages, with Principal Component Analysis (PCA), with correlation matrix, removing from the analysis variables with similar or high correlation. Spearman's correlation was used, since most of the data were categorical, with $p<0.05$ as the significance level, the classification of r was given as <0.3 weak, between 0.3 – 0.6 moderate, 0.6 – 0.9 strong 0.9 – <1 very strong, and r=1 -perfect. The Past 4.03 programme was used to perform the analyses.

RESULTS

Between June 2022 – November 2022, 20 patients were enroled in the study. The mean age of the participants was 61.1 years (±7.5), with 14 women and 6 men. Blood glucose at the time of the study averaged 181.55 mg/dL (±81.1) and the mean diagnostic time was 14.34 years (±14.4). The anthropometric data of the study patients were analyzed, mean mass – 90.74 kg (±18.3) and mean height – 1.65 meters (±0.1).

Table 1. Classification of diabetic foot risk

Grade	Risk	Recommendation	Turnaround time
0	Low	Guidance on appropriate footwear; encouragement of self-care	Once a year
1	Moderate	Consider the use of adapted shoes; consider surgical correction if there is no adaptation	Every 3–6 months
2	High	Consider the use of adapted shoes; consider the need to refer to a vascular surgeon	Every 2–3 months Evaluate referral to vascular surgeon
3	Very High	Consider the use of adapted shoes; consider surgical correction if there is no adaptation; if there is Peripheral Arterial Disease, consider the need for referral to a vascular surgeon.	Every 1–2 months

Table 2. Changes and conducts evidenced in the exam

Changes	Conduct 1	Conduct 2
Mycosis in interdigital spaces (moist and/or maceration)	Guiding the patient to dry the interdigital spaces after bathing, and not to pass moisturizing lotion between the toes	Refer for medical evaluation for appropriate treatment.
Hypertrophic/thickened nails	Suggests onychomycosis, refer for medical evaluation for proper treatment	-
Hypotrophic/ ingrown nails	The patient should be referred to a doctor for evaluation of the need for canthinoplasty	-
Blisters and calluses	Shoe fit, the need for orthoses, pressure point changes, and reduced activity level for the feet should be evaluated	In the case of failure of treatment with conservative measures, assess the need for debridement.
Signs of venous insufficiency	Evaluate the need to refer the person to a vascular surgeon	-
Xeroderma/dryness and cracking	To guide the use of common moisturizer after bathing, always taking care to spare the interdigital spaces, in order to avoid the appearance of mycoses	-
Deformities	To guide the patient in choosing the correct footwear that should adapt to the foot, avoiding pressure on the support areas or bony extremities, as well as resources to reduce overload, protectors, insoles, and orthoses	Evaluate the need for referral to occupational therapy (NASF professional or specialised service), to make orthoses or for orthopedic evaluation
Ulcerations	Assess the wound taking care to identify the structures: viable tissues (granulation and epithelialization), nonviable tissues (dry and wet necrosis).	Change dressing daily with moistened gauze and saline solution; Choose the type of dressing according to predominance of the tissue type, and the priority that the treatment requires

Of the medications used 90% of the respondents tated that they used oral hypoglycaemic agents and 50% said they used insulin. In the personal history survey, 75% claimed to have Systemic Arterial Hypertension (SAH) coexisting with diabetes, 35% had decreased visual acuity, and 10% were smokers.

Regarding foot care, only 60% of the patients know about it; of these, 80% have never had their feet evaluated by a health employee, and 55% have not performed proper care. After being asked about chronic pain in their feet, 30% of the study patients had pain in their feet.

After the initial anamnesis, physical examination of the feet was performed; the first step was the inspection in which 100% had preserved the integrity of the skin of the feet; 100% had normal colour of the feet during the study; 20% had no pilification. None of the patients examined had deformities on their feet. Regarding foot hydration, 25% had xeroderma/ dryness and 5% had cracks. In the analysis of the nails, an incorrect cut was evidenced in 10% of the participants 5% had hypotrophic/clenched nails and 5% had hypertrophic/ clenched nails. When the digital spaces were examined, 5% were moist and 5% had maceration.

The first step was based on the Semmes-Weinstein 10g monofilament test, in which 35% of the patients presented altered sensitivity in at least 1 of the 4 points evaluated. The second step, vibratory sensitivity, was performed with a 128Hz tuning fork, in which 95% of the participants presented vibratory perception at least twice during the evaluation. The Achilles tendon reflex, the third stage of the evaluation, was altered in 20% of the participants.

Evaluation of vascular circulation was also stratified into 2 steps, the first being the general observation of peripheral circulation, in which 15% of the patients had oedema in the lower limbs and 5% of the evaluated patients had cold temperature in their feet. The second step was the search for the decrease of peripheral pulses, being analyzed the posterior tibial pulse and the pedial pulse, the left posterior tibial pulse was decreased in 20% of patients, the right posterior tibial pulse, left pedial pulse and the right pedial pulse were decreased in 25% of the examined patients.

In the PCA analysis, it was a observed that there was great dispersion in the participation of the variables in explaining the model, but the first component (PC1) explained 25.6% and the second (PC2) 18.5%. For PC1 the pilification was 0.86, the tibial pulse – 0.79, level of pain -0.63; for PC2 the diagnosis time 0.77, use of medication – 0.74 and blood glucos – 0.62, it was possible to observe that men concentrated on the right, indicating that these variables were more important to them, while women were distributed in all hemispheres (Fig. 1).

Correlation was significant for both weight and height ($p=0.020$, $r=0.515$), time of diagnosis and blood glucose ($p=0.009$, $r=0.565$), time of diagnosis and medications ($p=0.031$, $r=0.484$), blood glucose and medications ($p=0.028$, $r=0.490$), foot care and age ($p=0$, 020, $r=0.517$), level of foot pain and pilification ($p=0.012$, $r=-0.548$), pulse and pilification ($p=0.008$, $r=0.577$), in addition to pulse and sensibility ($p=0.013$, $r=-0.545$), i.e. in all cases the correlation was only moderate.

DISCUSSION

The present study was conducted with the participation of diabetic patients who answered a questionnaire presented through an application, with the aim of providing foot care to this population sample. The patients were classified according to the risk of presenting diabetic foot manifestations, with an average of moderate risk, obtained from data of 20 patients with a mean diagnosis time of 14.34 years. Most were female (70%), which shows a higher frequency in health centres by the group described, as it is already known that lifestyle is one of the factors that influence even the lower mortality among them [12].

The participants were interested in understanding the comorbidity, but showed a high level of ignorance, only 60% knew about foot care, a result similar to that found by Lima et al. [13]. When asked about routine visits to health carers for evaluation, only 20% claimed to have already been to a consultation. In this way, the study, as part of the

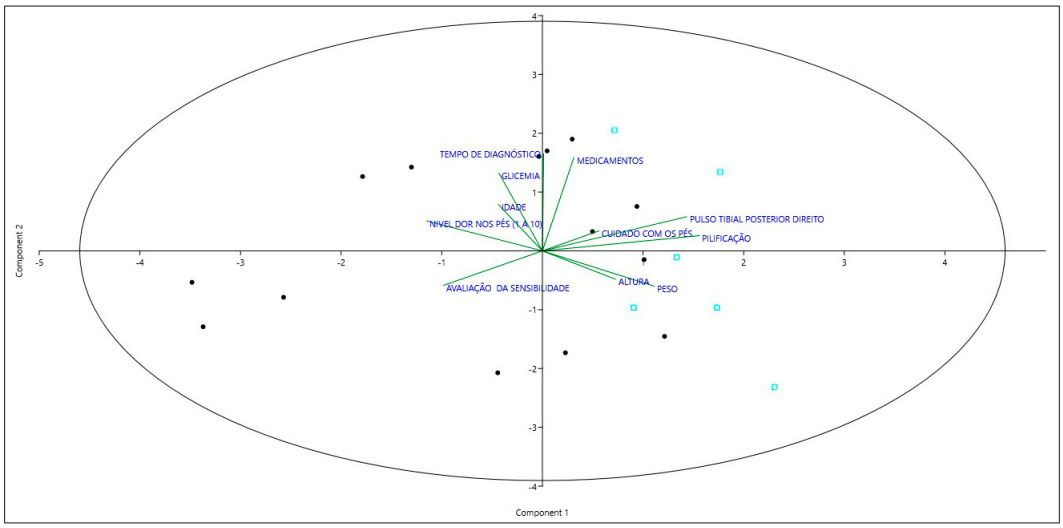

Figure 1. Graphical presentation of the PCA, with the lines in green showing the analyzed variables, and distribution of the participants (black dot – women; green square – men)

evaluation routine, worked as a means of disseminating information, since it was explained what diabetic foot is and provided general recommendations in the last step of the app. It must be taken into consideration that the use of educational programmes are an important part of DM control [14].

Analysis of the application data was also useful for demonstrating the prevalence of the involvement of patients in general, considering the population under analysis (patients already diagnosed with type 2 diabetes mellitus and under medication control), showing the relationship between personal antecedents with diabetes – 75% of diabetic patients also had associated hypertension. The mean calculated BMI of the patients was 34.37 (± 8.94), classified as grade I obesity (30.0–34.9), and the visualization of the PCA figure indicated a higher relationship with men, which is different from that found in the literature on the general population and in diabetics [15–17].

It can be evidenced that clinical signs and symptoms were more frequent, such as alteration of sensitivity in 35% of those analysed, while others appeared only with increasing severity of the disease, it was observed that the lower the pulse, the greater the sensory loss, as well as the presence of hair [18–21].

It was evidenced that 90% of the participants performed the proper nail cut, of which a large part perform the nail cut in professionals in the area. The correct cut should be straight, with the corners of the nails sanded and rounded to prevent the development of injuries and ingrown nails [13].

The mean blood glucose value of the examined group was 181.55 mg/dL, which is above the usual reference values (70 – 99 mg/dL), but was considered adequate for a therapeutic goal of HbA1c of close to 7%, which is equivalent to a mean daily blood glucose of 122 – 184 mg. These values, according to the guidelines of the Brazilian Diabetes Society (SBD) [22], can considerably decrease the risk of microvascular complications (such as diabetic neuropathy), taking into account the type of individualised treatment of each patient and their due related comorbidities. Unsurprisingly, there was a correlation between blood glucose with time of diagnosis and medication use.

All patients in the study received guidance according to the findings obtained, learnt about the need to refer to different professionals in the area, and that a better outcome could be expected. The use of the app also enables better instruction and increased knowledge about foot care, the need for evaluation by a health professional, and the need for referral to different professionals for the correction of problems. The initial interface, with ease of access to the data of each consultation, helps the analyzer to have a greater control of his patients, and enables a better understanding of how the diabetic foot presents itself. In addition, it is a mobile application with great accessibility and simplicity of use that can be accessed from anywhere, and has the option to download the data through a computer connection.

The importance of diabetes care and associated comorbidities in the population is obvious [5, 13, 17, 20]. With the analysis of the results it is possible to observe the need for access to information among patients with this disease, because 40% of those analyzed did not know the importance of foot care was in diabetes sufferers, although the average time of diagnosis among the study population was 14.34 years, and only 20% claimed to have already had their feet examined by a health worker. The standardisation of care and the proper behaviour should be advocated among all healthcare workers to ensure the therapeutic success among the population.

CONCLUSIONS

It is possible to infer that the application 'Cuidando do Pé' helps patients and healthcare workers perform a better screening for signs of diabetic foot, in addition to allowing a better systematisation of anamnesis and physical examination. Risk stratification and management suggestions also help in a better shared decision, contributing to better therapeutic success.

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