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Original article

Exploring the influence of dietary habits on foot risk in type 2 diabetes patients: An observational study

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S U M M A R Y

Background & aim: To date, there are no studies demonstrating the impact of the Mediterranean diet on the risk of diabetic foot ulcer. The aim of this research was to examine the connection between adherence to the Mediterranean diet and the level of risk of diabetic foot ulcers in individuals with type 2 diabetes.
Methods: Observational pilot study collecting sociodemographic, anthropometric, lifestyle, and type 2 diabetes-related data. Loss of protective sensation was assessed using the Semmes Weinstein 5.07–10 g monofilament, considered altered when not perceived in four points. Vascular status was assessed by palpating pulses and ankle-brachial index, indicating peripheral arterial disease if ankle-brachial index was less than 0.9 or if both pulses were absent. Foot deformities were recorded. The risk of diabetic foot ulcers was stratified into two categories: no risk and risk of diabetic foot ulcers. Adherence to the Mediterranean diet was evaluated using the Mediterranean Diet Adherence Screener-14 questionnaire (good adherence with score >7).
Results: Of the 174 patients with type 2 diabetes mellitus who participated (61.5% men and 38.5% women) with a mean age of 69.56 ± 8.86 years and a mean duration of type 2 diabetes of 15.34 ± 9.83 years. Non-adherent patients to the Mediterranean diet exhibited a higher association of diabetic foot ulcers ($p = 0.030$) and a lower average score on the Mediterranean Diet Adherence Screener-14 ($p = 0.011$). Additionally, a lower incidence of diabetic foot ulcers was observed in those who consumed nuts three or more times a week ($p = 0.003$) and sautéed foods two or more times a week ($p = 0.003$). Multivariate analysis highlighted the importance of physical activity (OR = 0.25, 95% CI 0.11–0.54; $p < 0.001$), podiatric treatment (OR = 2.59, 95% CI 1.21–5.56; $p = 0.014$), and duration of type 2 diabetes (OR = 3.25, 95% CI 1.76–5.99; $p < 0.001$) as significantly associated factors related to the risk of diabetic foot ulcers.
Conclusions: Adhering to the Mediterranean diet correlates with a lower incidence of diabetic foot ulcers in individuals diagnosed with type 2 diabetes mellitus. Furthermore, factors such as regular physical activity, podiatric treatment, and the duration of type 2 diabetes mellitus emerge as pivotal in preventing diabetic foot ulcers.

1. Introduction

The global prevalence of diabetic foot ulcer (DFU) is 6.3%, being higher in North America at 13% and lower in Oceania at 3% [1]. Risk factors for DFUs include male sex, duration of diabetes, insulin use,

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peripheral arterial disease (PAD), and microvascular complications such as retinopathy, nephropathy, and diabetic peripheral neuropathy (DPN) [2], as well as educational level [3]. Additionally, among the most important modifiable risk factors are glycemic control and smoking [2]. DFUs are responsible for 85% of lower extremity amputations (LEA) in individuals with diabetes [4]. DFUs and LEA are independent risk factors associated with premature death [5]. Approximately 50% of patients with DFUs will die within 5 years following the episode [6].

Regarding the costs associated with the treatment of DFUs, it is observed that patients with this complication incur expenses eight times higher compared to the treatment of patients without DFUs [7]. In addition to the direct economic impact on the healthcare system, DFUs impose severe economic burdens on society due to productivity loss, being one of the leading causes of disability [8,9]. This adds to the decreased health-related quality of life [10] and the high prevalence of depression among patients suffering from DFUs [11].

In the last decade, type 2 diabetes mellitus (T2DM) and the Mediterranean diet (MD) have garnered interest in medical research due to their potential relationships and effects on health. The MD was recognized as Intangible Cultural Heritage of Humanity by UNESCO [12] in 2010 and is distinguished by a diet based on products from traditional agriculture, such as cereals, legumes, fruits, vegetables, nuts and olive oil. Additionally, it includes moderate consumption of poultry, fish, dairy products and wine, while limiting the intake of red meats and sweets.

Previous studies have shown that adherence to the Mediterranean dietary pattern plays a protective role against PAD [13]. Likewise, it has been associated with a reduction in the incidence of microvascular complications such as diabetic retinopathy, nephropathy, and neuropathy [14]. A recent study demonstrated a correlation between lower adherence to the MD and increased impairment in pressure sensitivity, as evaluated by the monofilament test [15]. Additionally, supplementation with various nutrients that can be obtained through this diet, such as vitamin E, B-complex, omega-3 fatty acids, Coenzyme Q10 or N-acetylcysteine, improves the symptoms of DPN [16]. However, to date, there are no studies demonstrating the impact of MD on the risk of DFU. The main objective of this study was to analyze the relationship between adherence to MD and the level of DFU risk in patients with T2DM. The results obtained could guide intervention strategies focused on nutrition, providing a solid foundation for improving clinical care and dietary guidelines in the population with T2DM. This, in turn, would contribute to more effective management of the disease and its complication.

2. Methods

2.1. Study design

Observational pilot study designed following The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [17]. The research was conducted at an endocrinology outpatient clinic in the hospital and at a Primary Care Center from December 2020 to July 2023.

The inclusion criteria for this study involved patients diagnosed with T2DM for more than 5 years, aged over 18 years, and whose native language was Spanish. Patients with a life expectancy of less than 6 months, bilateral foot amputation, neuropathy unrelated to diabetes, as well as those suffering from mental illnesses or cognitive impairments that could interfere with questionnaire comprehension, were excluded.

A sample size of 174 subjects (157 + 10% losses) was determined for the target population, considering an estimated prevalence of 82% of patients following the MD [18]. This calculation was performed with a confidence level of 95%, a precision of 6%, and considering a loss rate of 10%. Patients were consecutively selected.

2.2. Ethics

The study was performed according to the Declaration of Helsinki (2008) and approved by the Ethics Committee with reference number CEIm P12019-106. All patients included in the study signed the informed consent.

2.3. Measurements

Through clinical interviews, data on sociodemographic variables (sex, age, nationality, marital status, and education level) and those related to T2DM (years of evolution, age at diagnosis, and corresponding treatment) were collected. Smoking habits were classified into three categories: non-smoker, ex-smoker, or smoker, and information on the number of years of smoking and/or the time since quitting smoking was also gathered. Physical activity was documented by asking patients about the type of activity performed weekly (walking, running, gymnastics, swimming, cycling, tennis/paddle, and/or others), as well as the frequency in minutes. Patients were considered to engage in physical activity when meeting the WHO recommended guidelines (more than 150 min. per week). Patients' weight (kg) and height (cm) were recorded using a scale with a stadiometer from the Bamed® brand. Body mass index (BMI) was calculated using the formula weight (kg)/ height^2 (m), and subjects were classified according to WHO criteria as normal weight (BMI 18.50–24.99), overweight (BMI 25–29.9), and obese (BMI $\geq$ 30).

To assess patients' glycemic control, glycosylated hemoglobin (HbA1c) (%) was recorded through a blood analysis conducted in the six months prior to the subject's inclusion in the study. To determine patient comorbidity, inquiries were made regarding the presence of complications associated with T2DM.

Furthermore, the presence of any foot deformity was examined, and the regular attendance of patients to the podiatrist, as well as the frequency of visits, was evaluated.

The assessment of loss of protective sensation (LOPS) was conducted using the pressure sensitivity test with the Semmes-Weinstein monofilament 5.07–10 g SensifilTM (Novalab Ibérica®) [19,20] at 12 specific anatomical points (dorsal area of the first toe at the level of the nail matrix, first intermetatarsal space dorsally, plantar area of the pulps of the first, third, and fifth toes, plantar area of the head of the first, third, and fifth metatarsals, internal and external longitudinal arch, and the heel). The assessment of evaluation points was done randomly, avoiding application in areas with ulcers, hyperkeratosis, scars, or necrotic tissue. The presence of LOPS was determined when the patient could not detect the stimulus in at least 4 anatomical areas of one of the two feet.

Vascular status was assessed through pulse palpation and determination of the ankle-brachial index (ABI). Palpation of the dorsalis pedis pulse was performed on the dorsal aspect of the foot, on the lateral side of the long extensor tendon of the big toe, between the second and third cuneiform bones. Evaluation of the posterior tibial pulse was carried out behind and below the medial malleolus. Pulses were classified as present or absent. In patients whose pulses could not be evaluated due to significant lower limb edema or amputations that hindered palpation, they were considered absent.

The ABI determination was performed using a bidirectional Doppler probe BIDOP V3 (Hadeco®) and a manual sphygmomanometer (Riester®). The ABI was calculated with the patient in the supine position on a bed after a period of rest. Two systolic blood pressure (SBP) values were recorded in the dorsalis pedis and posterior tibial arteries of each lower limb, selecting the higher value in each limb, and dividing it by the brachial SBP of the control arm. Thus, two ABI values were obtained, one for each lower limb. A patient was considered to have PAD when the ABI was less than 0.9 or both pulses were absent in one foot.

Finally, patients were classified according to the DFU risk stratification of the International Working Group on the Diabetic Foot (IWGDF), which is based on four grades: grade 0, very low risk of ulceration (no LOPS or PAD); grade 1, low risk of ulceration (LOPS or PAD without deformities); grade 2, moderate risk of ulceration (LOPS and PAD or NPD with deformities or PAD with deformities); and grade 3, severe risk of ulceration (LOPS or PAD and any of the following: history of DFU, lower limb amputation, or end-stage renal disease) [21]. Subsequently, the risk of DFU was classified into two categories: those without risk of DFU (grade 0) and those with some degree of risk of developing DFU (grade 1, 2 and 3).

The assessment of adherence to the MD was performed using the Mediterranean Diet Adherence Screener-14 (MEDAS-14), employed in the PREDIMED study [22]. This questionnaire comprises 14 questions that allow analyzing the frequency of consumption of key components of the MD, such as olive oil, nuts, vegetables, fruits, fish, and legumes, as well as the recommended quantity. A point was assigned to each component when it met the MD pattern goal. The final score was determined by summing up the scores of the 14 questionnaire items. A patient was considered to show good adherence to the MD when the score was greater than 7 [23].

2.4. Statistical analysis

For the statistical analysis, Statistical Package for the Social Sciences v. 29.0 (SPSS Inc., Chicago, IL, USA) was used. For qualitative variables, a description was conducted using frequency distribution, expressing the results in counts and percentages. As for quantitative variables, mean and standard deviation were used for description.

For bivariate inferential analysis, Chi-square test was applied for qualitative variables, and Kruskal–Wallis test for non-parametric quantitative variables. To determine if a variable followed a normal distribution (parametric), the Shapiro–Wilk method was applied, considering the study had a sample size larger than 50 subjects. Statistical significance was established when the p-value was less than 0.05. Logistic regression was performed to identify factors associated with of DFU.

3. Results

We selected 196 potentially eligible participants. Of these, only 174 were included in the study. We lost 22 participants due to various reasons: 12 could not be contacted for scheduling, 3 had deceased, and 7 did not provide informed consent. Of the included patients 61.5% were male and 38.5% were female. The majority of the sample were Spanish (97.7%), followed by 1.1% Algerian, 0.6% French, and 0.6% Cuban. The mean age was 69.56 ± 8.86 years (95% CI: 68.23–70.88), with an average BMI of 29.57 ± 4.74, indicating overweight according to WHO classification. The mean duration of T2DM was 15.34 ± 9.83 years (95% CI: 13.87–16.81), and the mean age at diagnosis was 54.32 ± 11.32 years (95% CI: 52.63–56.02). Regarding educational level, 55.2% of participants had no education or had only completed primary education.

62.1% of the patients engaged in regular physical activity, while 61.5% of the patients attended the podiatrist periodically. 15.5% were smokers at the time of the study, with an average duration of tobacco use of 44.75 ± 13.20 years (95% CI: 39.63–49.87). 52.3% had smoked in the past, with an average time since quitting smoking of 19.01 ± 13.27 years (95% CI: 16.25–21.77).

Regarding glycemic control, it was observed that 42.5% of the patients did not achieve the therapeutic target for HbA1c (HbA1c $\leq$ 6.5), presenting a mean value of 7.06 ± 1.17 (95% CI: 6.88–7.23). Regarding comorbidities associated with T2DM, 18.4% of the patients had DFU in one of the two feet during the examination, while 20.7% had a history of DFU. Additionally, 8% had experienced lower limb amputation, and only 1.7% were undergoing dialysis.

60.3% of the patients showed some type of foot deformity, and 32.8% suffered from LOPS.

Regarding the examination of arterial pulses, the pedal pulse was absent in 25.9% of patients, and the posterior tibial pulse was not palpable in 33.9% of cases. 14.4% and 10.3% of patients showed an ABI <0.9 in the right and left lower extremities, respectively. 44.8% of patients had PAD.

Concerning the stratification of DFU risk, 52.9% of patients belonged to grade 0, 5.2% to grade 1, 16.1% to grade 2, and 25.9% to grade 3.

Regarding adherence to the MD, 40.2% of the patients followed the diet (>7 points), obtaining an average score of 7.05 ± 1.71 (95% CI 6.79–7.30) on the MEDAS-14.

In the bivariate analysis, a significant association was observed between various variables and the risk of DFU, such as age ($p = 0.016$), educational level ($p = 0.024$), physical activity ($p < 0.001$), duration of T2DM ($p < 0.001$), age at T2DM diagnosis ($p < 0.001$), HbA1c ($p = 0.010$), regular visits to the podiatrist ($p < 0.001$), and T2DM treatment with insulin ($p = 0.002$). See Table 1.

Furthermore, a significant relationship was found when comparing the risk of DFU between patients adherent or non-adherent to the MD, showing an association with a higher risk of DFU (grade 1, 2 and 3) in those patients who did not adhere to the MD ($p = 0.030$). Likewise, the mean score on the MEDAS-14 was significantly higher in patients without DFU risk (grade 0) ($p = 0.011$). See Table 2.

The scores of each of the components evaluated in the MEDAS-14 were examined, revealing an association in patients with a risk grade of 0 who consumed nuts $\geq$3 times a week ($p = 0.003$) and sautéed foods (tomato sauce, garlic, onion, or leek cooked slowly with olive oil) $\geq$ 2 times a week ($p = 0.003$). See Table 3.

The multivariate analysis indicated that physical activity (OR = 0.246, 95% CI 0.109–0.544; $p < 0.001$), podiatric treatment (OR = 2.592, 95% CI 1.209–5.559; $p = 0.014$), and duration of T2DM (OR = 3.246, 95% CI 1.760–5.986; $p < 0.001$) were significantly related to the risk of DFU. Nagelkerke R^2 model 0.41. See Table 4.

4. Discussion

The main objective of this study was to analyze the relationship between adherence to the MD and the level of DFU risk in patients with T2DM. We observed that patients who consumed nuts at least three times a week showed a lower risk of DFU. This finding is supported by the results of the study by Jiang et al. [24], which suggest that the consumption of nuts and seeds is inversely associated with levels of inflammatory markers such as C-reactive protein, interleukin-6, and fibrinogen, markers closely related to PAD and NDP, both conditions closely associated with the risk of DFU. A recent systematic review also supports these findings by concluding that consuming nuts is associated with a lower incidence of PAD [25]. Additionally, a study conducted by Kumar and Sharma [26] in diabetic rats demonstrated that resveratrol, a phenolic compound present in various nuts, exerts a potential neuroprotective effect against NDP. Therefore, the consumption of

Table 1
Sociodemographic characteristics according to the stratification of DFU risk.

Sociodemographic characteristics	Stratification of DFU risk				P value
	GRADE 0 n = 92	GRADE 1 n = 9	GRADE 2 n = 28	GRADE 3 n = 45	
	n (%) mean ± SD	n (%) mean ± SD	n (%) mean ± SD	n (%) mean ± SD	
Sex					0.072[b]
Male	55 (59.8)	6 (66.7)	13 (44.8)	33 (75)	
Female	37 (40.2)	3 (33.3)	16 (55.2)	11 (25)	
Age (years)	70.07 ± 8.73	74.33 ± 6.27	71.75 ± 6.88	66.20 ± 9.73	0.016[a]
Educational level					0.024[b]
No formal or primary studies	42 (45.7)	5 (55.6)	16 (57,1)	33 (73.3)	
Secondary or university studies	50 (54.3)	4 (44.4)	12 (42.9)	12 (26.7)	
Marital status					0.795[b]
Single	2 (2.2)	1 (11.1)	0 (0)	3 (6.7)	
Married	61 (66.3)	5 (55.6)	17 (60.7)	28 (60.7)	
Separated or divorced	11 (12)	1 (11.1)	3 (10.7)	5 (11.1)	
Widowed	18 (19.6)	2 (22.2)	8 (28.6)	9 (20)	
BMI (kg/m^2)	29.48 ± 4.64	29.51 ± 5.72	30.66 ± 4.65	29.10 ± 4.86	0.636[a]
Smoking habit					0.216[b]
Current smoker	33 (35.9)	2 (22.2)	9 (32.1)	12 (26.7)	
Ex-smoker	10 (10.9)	0 (0)	7 (25)	10 (22.2)	
Never smoked	49 (53.3)	7 (77.8)	12 (42.9)	23 (51.1)	
Physical activity					<0.001[b]
Sedentary lifestyle	19 (20.7)	5 (55.6)	14 (50)	28 (62.2)	
Physically active	73 (74.3)	4 (44.4)	14 (50)	17 (37.8)	
Duration of T2DM (years)	12.39 ± 9.50	21.33 ± 7.50	16.61 ± 6.59	19.38 ± 10.64	<0.001[a]
Age at T2DM diagnosis (years)	57.95 ± 9.60	52.67 ± 7.43	54.79 ± 9.26	46.96 ± 12.91	<0.001[a]
Hb1Ac (%)	6.82 ± 1.04	6.97 ± 0.66	7.09 ± 0.98	7.54 ± 1.46	0.010[a]
Podiatric treatment					<0.001[b]
Yes	48 (52.2)	2 (22.2)	22 (78.6)	35 (77.8)	
No	44 (47.8)	7 (77.8)	6 (21.4)	10 (22.2)	
Insulin treatment for T2DM					0.002[b]
Yes	17 (18.5)	4 (44.4)	11 (39.3)	22 (48.9)	
No	75 (81.5)	5 (55.6)	17 (60.7)	23 (51.1)	

$p < 0.05$ statistically significant.
BMI, body mass index; DFU, diabetic foot ulcer; Hb1Ac, glycated hemoglobin; T2DM, type 2 of diabetes mellitus.
[a] Kruskal–Wallis test.
[b] Chi-squared test.

Table 2
Relationship between adherence to the MD and the MEDAS-14 score with the stratification of DFU risk.

	Stratification of DFU risk		P value
	No risk DFU n = 92	DFU risk n = 82	
	n (%) mean ± SD	n (%) mean ± SD	
Adherence MD			0.030[a]
No (>7 score MEDAS-14) (n = 70)	48 (52.2)	56 (68.3)	
Yes (≤7 score MEDAS-14) (n = 104)	44 (47.8)	26 (31.7)	
MEDAS-14 score (n = 174)	7.35 ± 1.67	6.71 ± 1.70	0.011[b]

$p < 0.05$ statistically significant.
DFU, diabetic foot ulcer; MD, mediterranean diet; MEDAS, mediterranean diet adherence screener.
[a] Chi-squared test.
[b] Kruskal–Wallis test.

nuts could play a beneficial role in the prevention of both diseases. Furthermore, the presence of certain micronutrients in nuts, such as magnesium and selenium, may play an important role in DFU prevention. This association is reinforced by the research of Rodríguez-Morán and Guerrero-Romero [27], who identified hypomagnesemia as a significant risk factor for the onset of DFU. Furthermore, Bolajoko et al. [28] observed significant differences in selenium levels between the DFU group and the control group (0.48 vs. 0.81 μmol/L, $p < 0.001$).

Additionally, patients who consumed sautéed foods at least twice a week showed a lower risk of DFU. This association could be related to the nutrients present in the ingredients of sautéed foods, such as garlic and onion, which are rich in vitamin C, and olive oil, a source of vitamin E. The meta-analysis by Bechara et al. [29] revealed a significant deficiency of vitamin C and E in patients with DFU compared to controls, suggesting that the lack of these vitamins could contribute to the onset of these lesions. Adokwe et al. [30] found that consuming plant-based foods, especially fruits, nuts/seeds and grains, was associated with lower fasting blood glucose levels. These findings suggest that a diet rich in plant-based foods may improve metabolic health and reduce the risk of complications associated with T2DM, including DFU.

Physical activity was inversely associated with the risk of DFU, indicating that patients with a sedentary lifestyle had a higher risk of developing DFU compared to those who were more physically active. This finding is consistent with the results of a systematic review that demonstrated that exercise in the treatment of diabetic foot leads to improvements in nerve conduction velocity, cutaneous sensitivity, and nerve fiber density, delaying the progression of NDP and preventing skin damage [31]. On the other hand, a direct correlation was observed between the frequency of visits to the podiatrist and the risk of DFU, suggesting a greater need for specialized care in patients with NDP or PAD to detect and prevent complications related to diabetic foot. Additionally, the prolonged duration of T2DM was associated with a higher risk of DFU, supporting the findings of a systematic review that identified this factor as one of the main predictors of DFU [32].

The use of artificial intelligence (AI) and machine learning (ML) applications represents a significant advancement in healthcare

Table 3
Relationship between the items of the MEDAS-14 questionnaire and the stratification of DFU risk.

MEDAS-14	Category	Stratification of DFU risk		P value
		DFI risk n = 92 n (%)	No risk DFU n = 82 n (%)	
Question 1. Olive oil as the primary fat	Yes	86 (93.5)	73 (89)	0.296
	No	6 (6.5)	9 (11)	
Question 2. Olive oil (quantity)	≥4 tablespoons per day	40 (43.5)	36 (43.9)	0.955
	<4 tablespoons per day	52 (56.5)	46 (56.1)	
Question 3. Vegetables	≥2 time per day	15 (16.3)	9 (11)	0.309
	<2 time per day	77 (83.7)	73 (89)	
Question 4. Fruit	≥3 time per day	38 (41.3)	35 (42.7)	0.854
	<3 time per day	54 (58.7)	47 (57.3)	
Question 5. Red meat	<1 time per day	85 (92.4)	72 (87.8)	0.309
	>1 time per day	7 (7.6)	10 (12.2)	
Question 6. Butter, margarine or cream	<1 time per day	80 (87)	70 (85.4)	0.761
	>1 time per day	12 (13)	12 (14.6)	
Question 7. Sugary or carbonated drinks	<1 time per day	63 (68.5)	57 (69.5)	0.883
	>1 time per day	29 (31.5)	25 (30.5)	
Question 8. Wine	≥7 times per week	17 (18.5)	11 (13.4)	0.364
	<7 times per week	75 (81.5)	71 (86.6)	
Question 9. Legumes	≥3 times per week	22 (23.9)	23 (28)	0.534
	<3 times per week	70 (76.1)	59 (72)	
Question 10. Fish or seafood	≥3 times per week	26 (28.3)	15 (18.3)	0.153
	<3 times per week	66 (71.7)	67 (81.7)	
Question 11. Non-homemade baking	<2 times per week	60 (65.2)	15 (18.3)	0.164
	≥2 times per week	32 (34.8)	67 (81.7)	
Question 12. Nuts	≥3 times per week	42 (45.7)	20 (24.4)	0.003
	<3 times per week	50 (54.3)	62 (75.6)	
Question 13. White meat preferably	Yes	66 (71.7)	69 (84.1)	0.050
	No	26 (28.3)	12 (15.8)	
Question 14. Sautéed dishes	≥2 times per week	36 (39.1)	15 (18.3)	0.003
	<2 times per week	56 (60.9)	67 (81.7)	

DFU, diabetic foot ulcer; MD, mediterranean diet; MEDAS, mediterranean diet adherence screener.
$p < 0.05$ statistically significant.
Chi-squared test.

Table 4
Multivariate analysis to determine the variables associated with the risk of ulceration (no risk: grade 0; at risk: grades 1, 2, and 3).

	B	Standard error	Wald	gl	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Adherence to MD	−0.763	0.402	3.592	1	0.058	0.466	0.212	1.026
Educational level	−0.223	0.385	0.352	1	0.553	0.796	0.374	1.692
Physical activity	−1.413	0.410	11.854	1	<0.001	0.246	0.109	0.544
Insulin treatment	0.473	0.481	0.965	1	0.326	1.604	0.625	4.121
Podiatric treatment	0.953	0.389	5.991	1	0.014	2.592	1.209	5.559
Hb1Ac	0.194	0.183	1.122	1	0.289	1.214	0.848	1.738
Duration of T2DM	1.177	0.312	14.218	1	<0.001	3.246	1.760	5.986
Constant	−1.943	1.359	2.044	1	0.153	0.143		

Logistic regression.
a. Dependent variable: DFU risk.
$p < 0.05$ statistically significant.
DFU, diabetic foot ulcer; Hb1Ac, glycated hemoglobin; MD, mediterranean diet; T2DM, Type 2 diabetes mellitus.

[33]. These technologies enable the analysis and interpretation of large volumes of clinical and lifestyle data, facilitating the customization of dietary plans and monitoring for patients [34]. Additionally, AI can identify behavioral patterns and risk factors, aiding in the anticipation of complications and timely preventive measures. Prediction models can help achieve good blood glucose control and reduce diabetes-related foot complications [35]. However, challenges include the effective integration of these tools into clinical practice, the need for continuous validation, and ensuring patient data privacy and security.

4.1. Limitations

However, this study has several limitations. Firstly, the cross-sectional nature of the research precludes establishing causal relationships and determining whether the reported dietary habits reflect long-term consumption patterns or recent changes. Additionally, it is important to acknowledge the possibility of recall bias when retrospectively assessing food intake.

Another relevant limitation is that adherence to the MD was assessed using a self-assessment questionnaire, implying that each participant evaluated and reported their own food consumption without direct supervision from the researcher. Although the MEDAS-14 questionnaire has been previously validated, it is crucial to consider this limitation. For future research, it would be beneficial to record the duration of participants' consumption of a Mediterranean-type dietary pattern.

Furthermore, it would be appropriate to consider the influence of food seasonality, as this factor could affect consumption patterns and potentially impact the study results. Given the complexity of these limitations, additional prospective studies are required to further investigate our research hypothesis.

4.2. Conclusion

In conclusion, promoting regular consumption of nuts and sofrito in the diet of patients with T2DM could be key to reducing the risk of developing DFU. However, it is crucial to consider other lifestyle factors, such as physical activity, in the prevention of diabetic complications. Adopting a healthy and balanced diet that includes these nutrient-rich foods could be an effective strategy for preventing complications associated with T2DM.

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Author contributions

All authors have made substantial contributions to the conception and design of the study, SZG, JJBG and RSO were involved in data acquisition; SZG, MIJT and ECL were involved in analysis, and interpretation. ECL and SZG were responsible for drafting and critically revising the article for important intellectual content.

Conflict of interest

The authors declare that they have no competing interests.

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