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ORIGINAL ARTICLE

Examining risk factors for diabetic foot: assessing diabetes self-management in type 2 diabetes patients

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Abstract

Objective Poor sugar regulation heightens the risk of complications linked to type 2 diabetes mellitus, while the adoption of effective diabetes self-management strategies has been shown to mitigate these risks. The objective of the study was to investigate the risk factors for diabetic foot by evaluating diabetes self-management using the Diabetes Self-Management Scale in patients with type 2 diabetes mellitus with and without diabetic foot.

Methods The study is a single-centre, prospective, cross-sectional study conducted between August 29, 2022 and November 29, 2022. A total of 133 patients who presented to the diabetes and diabetic foot outpatient clinic were selected using a simple random sampling method. In order to make the evaluation, the sociodemographic form and Diabetes Self-Management Scale has been used. Potential risk factors associated with the presence of diabetic foot were examined using multivariate logistic regression analysis. A significance level of $p < 0.05$ was considered statistically significant.

Results The mean age of the patients was 60.35 years and 45.1% (60) of them were female. According to the results of the multivariate logistic regression analysis, having more than 12 years of education, receiving diabetes education, and having higher Diabetes Self-Management Scale total scores negatively predicted the presence of diabetic foot. On the other hand, the duration of diabetes, systolic blood pressure, and HbA1c levels positively predicted the presence of diabetic foot.

Conclusion Effective diabetes self-management plays a crucial role in improving diabetes complications. Care should be taken regarding diabetic foot in patients who have difficulties in effective diabetes self-management, as well as those with high systolic blood pressure, high HbA1c levels, shorter total education duration, and longer duration of diabetes.

Keywords Diabetic foot · Diabetes mellitus type 2 · Self-management

Introduction

Diabetes mellitus (DM), despite being a preventable disease, can lead to significant damage to multiple end organs and impair their functions. Particularly, in parallel with the increasing prevalence of diabetes in recent times, diabetic foot (DF), whose incidence and significance are progressively rising, has become an increasingly crucial issue of concern [1]. DF is a significant public health problem that can lead to progressive organ loss, causing mental, physical, social, and financial challenges. It complicates daily life, prolongs hospital stays, and contributes to increased mortality and morbidity associated with diabetes [2]. In the management of type 2 diabetes mellitus (T2DM), in addition to achieving optimal blood glucose control, attention should also be given to the factors that contribute to the risk of complications associated with T2DM [3].

Diabetes Self-Management (DSM) encompasses adherence to prescribed medications, maintaining a healthy diet, engaging in regular physical activity, conducting routine foot examinations, and managing symptoms of low or high blood glucose levels among individuals with diabetes. DSM facilitates glycemic control and can reduce the risks of complications associated with the disease [4, 5].

It has been observed that poor sugar regulation increases the risk of complications associated with T2DM, and implementing effective DSM practices has been found to reduce these complications. Therefore, DSM plays a crucial role in the management of T2DM by significantly contributing to the reduction of associated complications [6].

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The aim of the study was to investigate the risk factors for DF by evaluating DSM using the Diabetes Self-Management Scale (DSMS) in patients with T2DM with and without DF.

Materials and methods

Study design

The study is a single-center, prospective, cross-sectional study conducted between August 29, 2022, and November 29, 2022, at Diabetes and DF Outpatient Clinic. Patients with T2DM who presented to the clinic were enrolled in the study. Ethical approval was obtained from the Medical Ethics Committee on August 28, 2022.

A total of 133 patients who presented to the Diabetes and DF outpatient clinic were selected using a simple random sampling method. In 3 months, approximately 200 patients visit the clinic in total. When calculating the sample size from the study population, with a confidence level of $\alpha = 0.05$, a 95% confidence interval, an occurrence frequency of 0.8 for the condition under study, and a desired ± deviation of 0.05 according to the occurrence frequency, when considering a population of 200 patients, the minimum number of patients to be included in the study is calculated to be 133. When divided into strata, the minimum number of patients diagnosed with DF was determined to be 41, while the number of diabetic patients without DF was 92. In the patients, the degree of diabetic foot was not assessed; therefore, no specific diabetic foot classification was used. An ulcer, infection, or tissue damage occurring in the lower extremities of a diabetic patient with accompanying neuropathy and/or peripheral artery disease has been defined as diabetic foot.

Information about the study was provided to the patients, and both verbal and written consent were obtained. A data collection questionnaire was administered to collect sociodemographic data as well as information on HbA1c, waist circumference, duration of diabetes, family history of diabetes, smoking status, and presence of additional chronic illnesses. Subsequently, the DSMS was administered.

DSMS was developed by Dr. Koc in 2020, and its validity and reliability have been studied. The aim of the DSMS is to assess the knowledge and behavioral patterns related to diabetes self-management [7]. The scale consists of a total of 19 questions. When comparing the scores between groups, a higher score indicates better self-management, while a lower score indicates poorer self-management.

The demographic information, such as gender, educational status, was presented using counts (n) and percentages (%) to show the distribution of individuals in the study. The normality of continuous variables was assessed using the Shapiro–Wilk test. It was found that continuous variables, except for the duration of diabetes, followed a normal distribution. Descriptive statistics were presented as mean ± standard deviation values. Independent samples *t*-test was used to compare the two-group variables between the DF and non-DF patient groups, while the Mann–Whitney *U* test was used for comparing the duration of diabetes. The chi-square test was used to compare categorical variables between the DF and non-DF groups.

Potential risk factors associated with the presence of DF were examined using multivariate logistic regression analysis. The results were reported as Odds Ratio (Exp(B)) with a 95% confidence interval. IBM SPSS Statistics 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) and MS-Excel 2007 were used for statistical analysis and calculations. A significance level of $p < 0.05$ was considered statistically significant.

Results

A total of 133 T2DM patients were included in the study, with 30.8% (41) diabetic foot patients. The mean age of the patients was 60.35 years and 45.1% (60) of them were female. The demographic data, physical examination and laboratory findings of continuous variables in the patient groups are presented in Table 1 and Table 2.

The multivariate logistic regression analysis results are shown in Table 3.

Table 1 Demographic data, physical examination, and laboratory findings of continuous variables in total patients and diabetic foot groups

	Total (n: 133)	DF Patients (n:41)	Non-DF Patients (n:92)	*p*
Age (years)	60.35 ± 10.71	64.44 ± 9.87	58.53 ± 10.62	**0.003**
BMI (kg/m^2)	29.83 ± 4.17	30.06 ± 3.65	29.73 ± 4.39	0.681
Waist Circumference(cm)	98.42 ± 12.20	99.10 ± 13.42	98.12 ± 11.68	0.671
Duration of Diabetes (years)	10.39 ± 7.76	14.10 ± 7.33	8.74 ± 7.39	**< 0.001***
$HbA1_c$ (%)	7.72 ± 1.52	8.95 ± 1.99	7.17 ± 0.78	**< 0.001**
Systolic Blood Pressure (mm Hg)	135.75 ± 14.92	141.34 ± 12.35	133.26 ± 15.34	**0.04**
Diastolic Blood Pressure (mm Hg)	75.53 ± 0.04	77.32 ± 7.51	74.73 ± 10.93	0.171
DSMS Score	58.17 ± 10.60	53.29 ± 9.61	60.35 ± 10.34	**< 0.001**

Independent t test, Mann–Whitney U*

Table 2 Demographic data of categorical variables in total patients and diabetic foot groups

		Total % (n: 133)	DF Patients % (n:41)	Non-DF Patients % (n:92)	*p*
Gender	Female	45,1 (60)	9,8 (13)	35,3 (47)	**0.038**
	Male	54.9 (73)	21.1 (28)	33,8 (45)	
Education	≥ 12 years	24.1 (32)	9.8 (13)	14.3 (19)	0.168
	< 12 years	75.9 (101)	21.1 (28)	54.9 (73)	
Family History of Diabetes	Yes	54.9 (73)	17.3 (23)	37.6 (50)	0.851
	No	45.1 (60)	13.5 (18)	31.6 (42)	
Marital Status	Married	78.9 (105)	24.1 (32)	54.9 (73)	0.358
	Single	6.0 (8)	0.8 (1)	5.3 (7)	
	Widowed/Divorced	15.0 (20)	6.0 (8)	9.0 (12)	
Smoking Status	Smoker	23.3 (31)	8.3 (11)	15.0 (20)	**0.042**
	Ex-user	22.6 (30)	10.5 (14)	12.0 (16)	
	Nonsmoker	54.1 (72)	12.0 (16)	42.1 (56)	
Hypertension	Yes	60.2 (80)	21.8 (29)	38.3 (51)	0.096
	No	39.8 (53)	9.0 (12)	30.8 (41)	
Hyperlipidemia	Yes	21.1 (28)	5.3 (7)	15.8(21)	0.452
	No	78.9 (105)	25.6 (34)	53.4 (71)	
Cardiovascular Disease	Yes	23.3 (31)	12.0 (16)	11.3 (15)	**0.004**
	No	76.7 (102)	18.8 (25)	57.9 (77)	
Additional Diseases	Yes	12.8 (17)	3.8 (5)	9.0 (12)	0.89
	No	87.2 (116)	27.1 (36)	60.2 (80)	

Chi-square test

Table 3 Factors predicting diabetic foot in the multi-logistic regression model

Variables	β	Standard Error	Wald	*p*	Exp(B)	% 95 Confidence Interval for Exp(B)	
						Lower	Upper
Constant	-15.962	7.944	4.037	**0.045**	< 0.001		
Age (years)	0.042	0.049	0.755	0.385	1.043	0.948	1.148
Gender (female)	1.072	0.722	2.208	0.137	2.921	0.710	12.016
Education (≥ 12 years)	-2.828	1.099	6.624	**0.010**	0.059	0.007	0.509
Family History of Diabetes	-1.067	0.825	1.670	0.196	0.344	0.068	1.735
Duration of Diabetes (years)	0.127	0.054	5.575	**0.018**	1.135	1.022	1.262
Diabetes Education	-2.778	0.889	9.756	**0.002**	0.062	0.011	0.355
DSMS Total Score	-0.123	0.044	7.757	**0.005**	0.884	0.811	0.964
BMI (kg/m^2)	0.013	0.028	0.205	0.651	1.013	0.959	1.069
Waist Circumference (cm)	0.002	0.030	0.005	0.944	1.002	0.946	1.162
Systolic Blood Pressure (mmHg)	0.079	0.032	5.983	**0.014**	1.083	1.016	1.154
Diastolic Blood Pressure (mmHg)	-0.002	0.042	0.003	0.960	0.998	0.919	1.083
Hba1c (%)	1.303	0.337	14.946	**< 0.001**	3.681	1.901	7.127
Additional Chronic Diseases	2.169	1.197	3.285	0.070	8.750	0.838	91.366
Cardiovascular Diseases	-1.657	0.867	3.653	0.056	0.191	0.035	1.043

Discussion

Various factors can influence the development of DF. In a study conducted in Thailand in 2012, it was observed that individuals with DF had poorer self-management compared to those without DF. The study also found a significant relationship between DF and self-management [8]. It can be considered that patients with DF may face more difficulties in seeking healthcare, become more susceptible to infections, and providing effective and sufficient DSM may become more challenging due to DF complications.

The study by Ramirez-Perdomo et al. showed a significant relationship between foot care knowledge and educational level. The study indicated that effective diabetes education conducted by healthcare professionals, particularly nurses, can prevent the development of diabetic foot and improve self-care and quality of life for individuals with diabetes [9]. In our study, the regression model showed that diabetes education and educational level negatively predicted the development of DF, which is consistent with the findings of the Ramirez-Perdomo et al. study. It can be assumed that individuals with higher educational levels can better comprehend the diabetes education provided, pay more attention to treatment adherence and self-care, and act more consciously regarding complications.

In the study conducted by Yesil et al., it was stated that advancing age is a risk factor for lower extremity amputations due to DF [10]. In the study by Ugwu et al., no significant relationship was found between lower extremity amputations due to DF and age [11]. In our study, the group with DF was found to have a higher average age. The decline in motivation with advancing age can make it more challenging for individuals to adhere to healthy lifestyle behaviors, which can lead to treatment disruptions and the development of DF.

There are studies similar to our study that demonstrate a higher risk of DF in T2DM patients who smoke [12]. Smoking, particularly in individuals with T2DM, significantly contributes to macro and microvascular complications. Regular tobacco use in individuals with diabetes is associated with a twofold increase in mortality rates [13]. In addition to the development of DF, smoking cessation is an important goal in terms of diabetes self-management. Quitting smoking has significant benefits for overall health and can positively impact the management of diabetes.

Caetano Lira et al., and Qureyşi et al. found in their studies that the risk of developing DF increases with a longer duration of diabetes [12, 14]. Our study is in line with both studies and supports the finding that the duration of diabetes positively predicts the development of DF.

According to a study conducted by Dietrich et al., the majority of patients with DF also have insulin resistance, obesity, dyslipidemia, and hypertension, which characterize metabolic syndrome and are associated with an increased risk of DF [15]. In our study, it was observed that the presence of cardiovascular disease is higher in the group of patients with diabetic foot; however, in the regression analysis, the presence of cardiovascular disease did not predict the occurrence of diabetic foot.

Longo-Mbenza et al. conducted a study and found that hypertensive individuals with diabetes had a higher prevalence of DF and stroke. They also identified a relationship between hypertension and DF [16]. In another study, it was mentioned that arterial hypertension increases the risk of developing DF [12]. In our study, individuals with high systolic blood pressure were found to have a higher risk of developing DF. This finding suggests a potential link between elevated systolic blood pressure and the risk of DF.

In a study conducted by Dekker et al. in 2016, a significant association was found between HbA1c increase and the development of DF [17]. A similar study by Dhatariya et al. indicated a potential role of HbA1c in the development of micro and macrovascular diseases in diabetic patients. It was found that patients with higher HbA1c values had slower healing of DF ulcers, while those with lower HbA1c values had faster healing. Furthermore, a significant relationship was observed between HbA1c variability and healing time [18]. In our study, in line with the literature, the multivariate regression analysis revealed that HbA1c increased the risk of DF by 3.6 times.

Conclusion

It is essential for individuals with diabetes to have knowledge, skills, decision-making abilities, stress management techniques, and advanced approaches to address diabetes-related issues, in order to strengthen diabetes self-management. In the management of diabetic patients, providing appropriate diabetes education to increase their self-management is a suitable approach, especially in complications such as DF and cardiovasular diseases, which are among the most important complications of diabetes. Effective diabetes self-management plays a crucial role in improving diabetes complications. Care should be taken regarding DF in patients who have difficulties in effective diabetes self-management, as well as those with high systolic blood pressure, high HbA1c levels, shorter total education duration, and longer duration of diabetes.

Limitations of the study

The failure to discriminate risk factors for ischemic and neuropathic diabetic foot is a limitation of the study. Additionally, the lack of a detailed examination of risk factors such as diabetic peripheral neuropathy, foot deformities, peripheral artery disease, and chronic kidney disease can be considered as limitations of the study. Another limitation to acknowledge is the lack of assessment regarding the classification of diabetic foot ulcers in our study.

Author contribution **VU:** Conceptualization, Data curation, Methodology, Resources, Supervision, Visualization, Writing—original draft, Writing—review & editing. **ET**: Conceptualization, Data curation, Methodology, Resources, Supervision, Visualization, Writing—original draft, Writing—review & editing. **AD**: Conceptualization, Methodology, Supervision, Writing—review & editing.

Declarations

Ethics approval The study was approved by the Medical Research Ethics Committee of the hospital. All procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

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