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Prevalence, risk level and risk factors of diabetic foot ulcer among adult individuals with diabetes in the Southeastern Anatolia Region of Turkiye

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ABSTRACT

Objective: The aim of the study was to determine the prevalence, risk, and predisposing factors of diabetic foot ulcers in adults with diabetes.

Methods: This study is multi-centered descriptive cross-sectional research. Data were collected between June 2022 and November 2022 in seven cities, including five teaching and research hospitals and two public hospitals. The study included 357 people with diabetes. The sample was selected using stratified and systematic sampling. General demographic characteristics, medical history, laboratory and foot examination results, history of foot ulcer and/or amputation, skin and nail problems, peripheral sensory loss (10 g-Semmes-Weinstein monofilament) and vascular assessment were obtained. Logistic regression analysis was used to screen for factors affecting the diabetic foot.

Results: The prevalence of diabetic foot ulcers was 17.1 % (%13.2-%21.5; %95 CI). Among 296 individuals with diabetes without foot ulcers, 86.5 % (256) had risk level 0, 7.3 % (26) had risk level 1, 3.4 % (10) had risk level 2, and 1.4 % (4) had risk level 3. In regression analysis, the variables of peripheral arterial disease (Exp β: 3.781 - P = .027), history of ulcer (Exp β = 26,180 - P < .001), edema (Exp β: 9.784 - P < .001), fungus between the toes (Exp β = 5.284 - p = .009) were associated with a significantly increased risk of developing diabetic foot.

Conclusion: The prevalence of diabetic foot ulcers was found to be approximately two out of every 10 patients with diabetes, and peripheral arterial disease, history of ulcers, edema, and presence of fungus between the toes were found to be among the risks predicting diabetic foot. All diabetic individuals should be diagnosed in terms of diabetic foot risk factors, and follow-up and treatment should be planned considering the basic building blocks of diabetic foot prevention according to the determined risk group.

1. Introduction

The burden of diabetes on healthcare systems is immense. According to the International Diabetes Federation, there are 9 million adults with diabetes in Turkey in 2021, the highest number in Europe, and this number will reach 13.4 million by 2045. The increasing prevalence of diabetes leads to developing diabetes-related complications [1]. One of the major complications is diabetic foot ulcers (DFUs), which are a

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serious concern globally [2].

It is reported that one third of the half a billion people with diabetes worldwide are likely to develop a diabetic foot ulcer in their lifetime; more than half of all DFUs will develop an infection and 17 % will lead to amputation [2]. It has been reported that more than one million diabetic foot ulcers and about half a million diabetic foot infections occur in Turkey [3]. By 2021, 25 % of global healthcare expenditure (USD 241 billion) will be related to diabetes [1]. In Turkey, 16 % of the 7350.16 billion spent on diabetes complications in 2012 was spent on diabetic foot complications [4].

DFU increases lower extremity amputations and length of hospital stay worldwide, leading to increased treatment and care costs and mortality [5]. Foot ulceration or amputation has become a major health problem, causing psychological problems and loss of quality of life due to the inability of individuals to perform activities of daily living [6].

The foot is at risk if there is reduced protective sensation in the feet and toes, slowed circulation to the feet, dryness and cracking due to loss of sweat, occlusive vascular disease, and visual impairment [7]. The prevention of DFUs starts with the identification of the foot at risk. It is important to perform a risk assessment as part of the foot examination to determine the risk factors for DFUs. The use of comprehensive risk assessment guidelines is recommended by the American Diabetes Association and the International Diabetic Foot Study Group. These guidelines emphasize that individuals who have been identified as being at risk for DFU should first be educated through an assessment of their current knowledge and should be followed up at a frequency appropriate to the risk level [7,8].

In a comprehensive meta-analysis study, the global prevalence of DFU was found to be 6.3 %. Although the prevalence of DFU, lower extremity amputation and ulcer recurrence may differ depending on whether the study is clinical or community-based, it can be said that the prevalence of DFU is higher in developing countries than in developed countries [9,10]. The IDF's 2022 report on diabetes-related foot complications also indicates that studies on the prevalence, risk level, and risk factors for DFUs are needed [1].

The region in which the study will be conducted is a region with a high prevalence of diabetes [11]. No multi-centered study has been identified in Turkey that deals with this issue. Therefore, the aim of this study was to determine the prevalence, the level of risk and the risk factors of diabetic foot ulcers in a multi-centered study. We believe that the study will contribute to scientific knowledge, will be useful in the determination of the severity of diabetic foot ulcers and in the planning of interventions for prevention, and will be an important contribution to the literature.

2. Methods

2.1. Study design and setting

The study was conducted as a multi-centered descriptive cross-sectional study. Data were collected between June 2022 and November 2022. The study was conducted in diabetes outpatient clinics of five training and research hospitals and two state hospitals in six provinces, and in internal medicine outpatient clinics of hospitals without diabetes outpatient clinics.

2.2. Sample

The study population consisted of adult patients with diabetes mellitus who presented to the diabetes and internal medicine outpatient clinics of the hospitals where the study was conducted during the study period. Individuals with gestational diabetes mellitus, stroke, bilateral below-knee amputation were excluded from the study.

A power analysis was performed on the study sample. In the power analysis, the minimum number of 336 planned to be reached was determined when the sample size was calculated with a margin of error of 7 %, alpha 0.05, power 0.80, considering the current wound status rate of 29.9 % in Koçakgöl's thesis study entitled "Investigation of Diabetic Foot Risk Levels and Risk Factors of Individuals with Diabetes". The stratified sampling method was used for the determination of the sample size for each center. The total number of samples to be taken from the outpatient clinic was determined by stratification based on the number of patients who had attended the diabetes outpatient clinic in the previous six months. The systematic sampling method was then used to select one in three people with diabetes. The study was completed with a total of 357 people with diabetes.

2.3. Data collection

The data were collected by co-researchers (five diabetes nurses with at least five years' experience working in five hospitals and certified by the Ministry of Health, and two PhD-educated lecturers who had studied diabetes in two hospitals). Prior to the study, an online training was conducted with the co-researchers who would participate in the data collection phase. This training included information about the duration of the study, sample selection, introduction to the forms, and foot examination. Data were collected by face-to-face interview in a quiet room. Consent for study participation was obtained from people with diabetes who were within the study criteria. A data collection form developed by the researchers based on the literature was used for data collection. Data collection took approximately 30 min, including foot examination.

2.4. Measuring instrument

The form consists of two parts. In the first section, there are eight questions about the identifying characteristics of individuals with diabetes (age, gender, educational status, place of residence, income and employment status, alcohol, and smoking). The second section includes questions about the disease and health status of the patients. These are.

- Status of regular physical activity, type of diabetes, duration of disease, chronic complications of diabetes (information recorded on the health information system was recorded), medication, history of ulcer and amputation, foot care training and previous foot examination were questioned.
- Since elevated blood glucose is an important risk factor for complications of diabetes [12], glycosylated hemoglobin A1c - HbA1C value was used for blood glucose regulation. For the HbA1c value, the HbA1c value requested from the patient within the last three months on the health information system or routinely requested by the health center during the visit was taken into consideration.
- Among the anthropometric measurements, BMI was evaluated according to the WHO criteria [13]. Blood pressure was measured according to the Turkish Society of Cardiology guidelines [14]. The devices used in the measurements were calibrated before measurement.
- Foot examination was performed for diabetic foot risk level assessment. Loss of protective sensation (LOPS) with 10-g (5.07 Semmes-Weinstein) monofilament and vibration perception with 128 Hz diapason were evaluated in peripheral neuropathy. The evaluation of the two tests was based on the evaluation criteria of the International Working Group on Diabetic Foot (IWGDF). Foot pulses were manually assessed (pulse present - pulse absent) in both lower extremities for posterior tibial and dorsalis pedis pulses [6]. Failure to obtain a pulse at any pulse assessment site was recorded as "no pulse".
- In the foot examination, deformities that may pose a risk for diabetic foot ulcers (hallux valgus, hammer toe or claw toe low foot, amputation), foot skin (presence of calluses, dryness, cracks, edema), nail pathology (nail thickening, fungus, ingrowth), nail cut (flat, round), toe spaces (normal, macerated, fungus), foot hygiene parameters and

inappropriate footwear (narrow, pointed toe, heels, slippers) were evaluated [6].

- Ulcer evaluation was performed according to Wagner ulcer classification. Grade 1 signifies a superficial ulcer on the outer layers of skin. Grade 2 is a deep ulcer. Grade 3 is an ulcer with bone involvement. Grade 4 means that there is gangrene or dead tissue in the front of the foot, while Grade 5 means that the gangrene has spread to the entire foot [15].
- After the foot examination, diabetic foot risk-levels were determined according to the data obtained. The classification created by the International Diabetic Foot Working Group (IWGDF) was used for risk level classification [16].

0: Very low risk (No LOPS and No Peripheral Artery Disease- PAD)
1: Low risk (LOPS or PAD)
2: Moderate risk (LOPS + PAD or LOPS + foot deformity or PAD + foot deformity)
3: High risk (LOPS or PAD and one or more of the following,

- a history of foot ulcers
- lower extremity amputation (minor or major)
- end-stage kidney disease

2.5. Statistical analysis

As descriptive statistics; arithmetic mean and standard deviations were given for quantitative data, frequencies and percentages were given for qualitative data. Normality tests were used to assess the distribution of quantitative data. For group comparisons, independent sample *t*-test for quantitative data, chi-square test and Fisher's exact test for qualitative data was used. Potential risk factors for DFU were assessed by using binary logistic regression. Adjusted odds ratios and 95 % confidence intervals were obtained. $p < .05$ was considered statistically significant. Analyses was performed using IBM SPSS Statistics for Windows, Version 25.0.

2.6. Ethical considerations

For the study, approval was obtained from University Clinical Trials Ethics Committee on January 05, 2022 (Session No:2022/01-01). Before the research, individuals with diabetes were informed about the purpose and process of the study and their consents were obtained with the Informed Volunteer Form. Participation in the study was based on volunteerism. This study was conducted in accordance with the Principles of Helsinki Declaration.

3. Results

The study included 357 diabetic individuals. DFU was detected in 17.1 % (61) of diabetic individuals. The duration of diabetes in individuals with DFU was 14.21 (SD = 7.42), 59 % (36) had a history of ulcers, 9.8 % (6) had a history of amputation, 36.1 % (22) had PAH, 23 % (14) had loss of vibration perception, 26.2 % (16) had LOPS, 82 % (50) had nail pathology, 36.1 % (22) had fungus between the toes, and 21.3 % (13) had foot deformities. Non-DFU individuals had diabetes duration of 9.96 (SD = 6.91), 8.4 %(25) had PAD, 5.7 %(17) had ulcer and 0.7 %(2) had a history of amputation, 2.7 %(8) had loss of vibration perception and 7.4 %(22) had LOPS, 6.4 %(19) had no pedal pulse, 49 % (145) had nail pathology, 8.1 %(24) had nail fungus and 8.4 %(25) had foot deformity.

Table 1 shows the comparison of individuals with and without DFU in terms of demographic variables. Statistically significant differences were found in the two groups according to age, educational level, and smoking status. The mean age of individuals with DFU was higher ($p = .006$), educational level was lower ($p = .043$), and smoking history was higher ($p = .043$).

Table 2 shows the comparison of DFU and non-DFU individuals in terms of clinical and biochemical parameters. There was a statistically significant difference between DFU and non- DFU individuals in terms of duration of diabetes, history of peripheral arterial disease, ulcer and amputation, having foot examination and receiving foot care education ($p < 001$; $p = .25$). The year of diabetes was statistically higher in individuals with DFU compared to individuals with non-DFU ($p < .001$).

Table 1
Comparison of sociodemographic parameters of DFU and Non-DFU individuals.

Variables		DFU(n = 61)	Non-DFU (n = 296)	p
Age (mean +SD)		60,22 ± 13,15	54.87 ± 13,77	.006[a]
Sex	Male	29 (47,5)	121 (40,9)	,393[b]
	Female	32 (52,5)	175 (59,1)	
Working	Working	9 (14,8)	80 (27,0)	,051[b]
	Not working	52 (85,2)	216 (73,0)	
Literacy	Illiterate	27 (49,1)	91 (30,1)	,043[b,c]
	Literate	7 (12,7)	44 (14,6)	
	Primary	17 (30,9)	109 (36,1)	
	High school and above	4 (7,3)	58 (19,2)	
Residence	Rural	30 (49,2)	113 (38,2)	,110[b]
	Urban	31 (50,8)	183 (61,8)	
Socio-economic status	Income less than expense	43 (70,5)	175 (59,1)	,097[b,c]
	Income equals expense	18 (29,5)	121 (40,9)	
Smoker	Uses	13 (21,3)	71 (24,0)	,043[b]
	Not using	36 (59,0)	199 (67,2)	
	Disposes	12 (19,7)	26 (8,8)	
Alcohol	Uses	2 (3,3)	14 (4,7)	,365[b,c]
	Not using	54 (88,5)	270 (91,2)	
	Disposes	5 (8,2)	12 (4,1)	

(Fisher's Exact test) $p < 0,05$, $p < 0,001$.
[a] *t*-test.
[b] Chi square.
[c] If the expected value < 5.

Table 3 shows the comparison of DFU and non-DFU individuals in terms of foot examination findings. There were statistically significant differences between DFU and non-DFU individuals in terms of vibration perception status, LOPS, foot pulse, foot hygiene status, foot edema, nail pathology, nail cutting type, foot deformity, maceration between toes and presence of fungus ($p < .001$; $p = .006$; $p = .014$; $p = .003$).

Table 4 shows the DFU risk levels and Wagner ulcer classification according to the International Diabetic Foot Study Group risk classification. It was determined that 86.5 % (256) of the individuals with diabetes had no risk, 7.3 % (26) had low risk, 3.4 % (10) had moderate risk, and 1.4 % (4) had high risk. Of the individuals with diabetes, 9 % (32) had superficial, 3.6 % (13) had deep tissue disruption or osteomyelitis, and 1.4 % (5) had partial gangrene. Ulcers were also detected at a rate of 17.1 % (13.2%–21.5 %; 95 % CI) in individuals with diabetes.

Table 5 shows the results of regression analysis for risk factors predicting diabetic foot ulcer. In the regression analysis, the model was found to be consistent (Chi-square.707; $p = .989$). Independent variables explained 63.4 % of the dependent variable. The regression model correctly predicted the DFU by 92.1 %. According to the results of regression analysis, the relationship between PAH, edema, history of ulcer, fungus between the fingers and DFU was statistically significant ($p = .027$, $p = .009$, $p < .001$).

PAH increases the risk of DFU 3.78 (95 % C.I.: 1.165–12.269) times, presence of edema 9.78 (95 % C.I.: 3.713–25.780) times, history of ulcer 26.18 (95 % C.I.: 0.256–94.458) times and presence of fungus between the fingers 5.28 (95 % C.I.: 1.505–18.553) times.

4. Discussion

In this study, diabetic foot ulcers were detected in 17.1 %(61) of 357 diabetic individuals. In the consensus report by Saltoğlu et al. [10] (2015), it was stated that more than one million diabetic foot ulcers and

Table 2
Comparison of clinical and biochemical parameters of DFU and Non-DFU individuals.

		DFU (n = 61)	Non-DFU (n = 296)	Test statistic
Diabetes duration (year) (mean ± SD)		14,21 ± 7,42	9,96 ± 6,91	p<,001[a]
Systolic blood pressure (mmHg) (mean ± SD)		125,57 ± 18,93	123,73 ± 15,29	p = ,413[a]
Diastolic blood pressure (mmHg) (mean ± SD)		76,06 ± 9,54	75,45 ± 9,53	p = ,650[a]
HbA1c (%) (mean ± SD)		9,94 ± 2,38	9,64 ± 2.37	p = ,374[a]
Type of diabetes	Type 1 DM Type 2 DM	5(8,2) 56(91,8)	28(9,5) 268 (90,5)	p = ,491[b, c]
Body mass index (kg/m^2)	Underweight (18.50) Normal (18.50–24.99) Pre-obese (25.00–29.99) Obese (≥30)	6 (10,9) 12 (21,8) 21 (38,2) 16 (29,0)	20 (6,5) 95 (31,5) 92 (30,5) 95 (31,5)	p = ,128[b]
DM Therapy	Oral Oral and insulin Insulin	11(18,0) 23(37,7) 27(44,3)	95(32,1) 101 (34,1) 101 (33,8)	p = ,080[b]
Diabetic retinopathy	Present Absent	20 (32,8) 41 (67,2)	67 (22,6) 229 (77,4)	p = ,102[b]
Diabetic nephropathy	Present Absent	12 (19,7) 49 (80,3)	36 (12,2) 260 (87,8)	p = ,147[b]
Cardiovascular disease	Present Absent	24 (39,3) 37 (60,7)	82 (27,7) 214 (72,3)	p = ,090[b]
Peripheral arterial disease	Present Absent	22 (36,1) 39 (63,9)	25 (8,4) 271 (91,6)	p<,001[b]
Ulcer history	Yes No	36 (59,0) 25 (41,0)	17 (5,7) 279 (94,3)	p<,001[b,]
Amputation history	Yes No	6 (9,8) 55 (90,2)	2 (0,7) 294 (99,3)	p<,001[b,]
Foot assessment with health professional	Yes No	30 (49,2) 31 (50,8)	54 (18,2) 242 (81,8)	p<,001[b]
Training on foot care in diabetes	Yes No	27 (44,3) 34 (55,7)	87 (29,4) 209 (70,6)	p = ,025[b]
Regular exercise	Yes No	12 (19,7) 49 (80,3)	95 (32,1) 201 (67,9)	p = ,065[b]

(Fisher's Exact test) p < 0,05, p < 0,001 Abrevation: HbA1c: glycosylated hemoglobin A1c.
[a] *t*-test.
[b] X^2 chi square.
[c] If the expected value < 5.

Table 3
Comparison of foot examination findings of DFU and Non-DFU individuals.

		DFU (n = 61)	Non-DFU (n = 296)	Test statistic[a]
Vibration perception	Present Absent	47 (77,0) 14 (23,0)	288 (97,3) 8 (2,7)	p<,001
LOPS	Present Absent	16 (26,2) 45 (73,8)	22 (7,4) 274 (92,6)	p<,001
Pedal pulse	Present Absent	50 (82,0) 11 (18,0)	277 (93,6) 19 (6,4)	p = ,006
Foot Hygiene	Sufficient Partly Insufficient	12 (19,7) 31 (50,8) 18 (29,5)	104 (35,1) 166 (56,1) 26 (8,8)	p<,001
Foot edema	Present Absent	33 (54,1) 28 (45,9)	34 (11,5) 262 (88,5)	p<,001
Nail pathologies	Present Absent	50 (82,0) 11 (18,0)	145 (49,0) 151 (51,0)	p<,001
Nail cutting	Straight Round	28 (45,9) 32 (54,1)	189 (63,9) 107(36,1)	P = ,014
Between the toes	Normal Macerated Fungus	24(39,3) 15 (24,6) 22(36,1)	238 (80,4) 34 (11,5) 24 (8,1)	p<,001
Craks	Present Absent	25(41,0) 36(59,0)	127(42,9) 169(57,1)	p = ,887
Callus	Present Absent	9(14,8) 52(85,2)	51(17,2) 245(82,8)	p = ,771
Dryness	Present Absent	23(37,7) 36(62,3)	151(51,0) 145(49,0)	p = ,068
Foot deformity	Present Absent	13(21,3) 48(78,7)	25 (8,4) 271 (91,6)	p = ,003
Shoe suitability	Appropriate Not suitable	54 (88,5) 7 (11,5)	279 (94,3) 17 (5,7)	p = ,154

(Fisher's Exact test) p < 0,05, p < 0,001 Abrevation: LOPS: Loss of protective sensation.
[b]If the expected value < 5.
[a] X^2 *chi square.*

Table 4
Diabetic foot risk category and Wagner ulcer classification.

Risk category	Characteristics	n	%
Risk 0	No LOPS and no PAD	256	86,5
Risk 1	LOPS or PAD	26	7,3
Risk 2	LOPS + PAD or LOPS + foot deformity or PAD + foot	10	3,4
Risk 3	deformity	4	1,4
	LOPS + PAD and (one or more of the following) History of ulcer, lower extremity amputation (major, minor), end-stage kidney disease		
Wagner ulcer classification			
Grade 1	Superficial ulcer	32	9,0
Grade 2	Deeper, full thickness extension	10	2,8
Grade 3	Deep abscess formation or osteomyelitis	13	3,6
Grade 4	Partial Gangrene of forefoot	5	1,4
Grade 5	Extensive Gangrene	1	0,3

Abrevation: LOPS:Loss of protective sensation PAD:Periferal Arterial Disease.

approximately half a million diabetic foot infections developed in Turkey. In the IDF report summarizing diabetes-related foot problems in 2022, the prevalence of DFU was 3.0 % in 2014. We can say that this result belongs to previous years. There has been a high rate of increase in the number of people with diabetes in Turkey over the last 10 years [1,11]. In view of the increase in the number of people with diabetes, it is considered inevitable that there will also be an increase in the rate of DFUs. In a study conducted in a single center in the southeastern region of Turkey to determine the risk level and risk factors for DFU, the DFU rate was found to be 29.8 %. In this study conducted by Koçakgöl [17], the reason for the high rate is thought to be related to the healthcare institution where the study was conducted. The hospital where the study was conducted is a hospital with a diabetes outpatient clinic, which is preferred in the province where it is located, in terms of DFU follow-up and treatment.

In a comprehensive meta-analysis, Zhang et al. [8] provided a broad overview of the study results on the prevalence of DFU across continents and found that the global prevalence was 6.3 %. This equates to approximately 33 million people affected by DFU. The prevalence of diabetic foot ulcers is 7.2 % in Africa, 5.5 % in Asia and 5.1 % in Europe. Studies conducted in low-income countries such as Sudan, Ethiopia, Kenya, Sudan, Ethiopia, and Kenya show that the prevalence of DFU ranges from 9.1 % to 21.1 % [18,20], while studies conducted in developing countries such as Indonesia, Egypt, United Arab Emirates,

Table 5
Binary logistic regression analysis.

	S.E.	Wald	Sig.	Adjusted OR 95 % C.I.
Age	,021	,444	,505	1014(0,973–1056)
Diabetes duration	,034	1945	,163	1049 (0,981–1121)
PAD (present)	,601	4905	,027*	3781 (1165–12,269)
LOPS (present)	1364	1826	,177	6320 (0,436–91,647)
Vibration perception (absent)	1409	3160	,075	12,241 (0,773–193,731
Amputation history (yes)	1412	,710	,400	3286 (0,206–52,330)
Ulcer history (yes)	,655	24,872	<0,001*	26,180 (7256–94,458)
Foot assessment with health professional (no)	,658	,155	,694	0,771 (0,212–2804)
Foot care training (no)	,595	,297	,586	0,723 (0,225–2320)
Foot hygiene (insufficient)	,558	,570	,450	0,656 (0,220–1958)
Foot deformity (present)	,761	1076	,300	0,454 (0,102–2018)
Edema (present)	,494	21,286	<0,001*	9784 (3713–25,780)
Nail pathology (present)	,541	1918	,166	2116(0,732–6113)
Nail cutting (round)	,481	1314	,252	1736(0,676–4456)
Between the toes (fungus)	,641	6750	,009*	5284 (1505–18,553)
Non suitable shoes	,821	,068	,794	1238(0,248–6190)
Education				
Illiterate		2020	,568	
Literate (1)	,819	,693	,405	0,506 (0,102–2518)
Primary (2)	,525	,013	,910	1061(0,380–2968)
High school and above (3)	,939	1062	,303	0,380 (0,060–2393)

Dependent variable: DFU; Wald:125,565; Exp(B):0,207; p<,001 Abrevation: LOPS:Loss of protective sensation; PAD:Periferal Arterial Disease.

and India show that this rate ranges from 6.1 % to 39 % [21–23]. It can be said that the results of this study are above the world prevalence and similar to those of developing countries.

When evaluated within the framework of these studies, these differences in the prevalence of DFU may be related to the level of development of the countries, as well as differences in DFU definitions, surveillance approach and completeness of follow-up. Therefore, more community-based large-scale epidemiological studies are needed to better characterize the prevalence, clinical course and risk factors of DFU.

In this study, approximately 5 % of individuals with diabetes without DFU (n = 256) were identified as being in the high- and intermediate-risk groups according to the IWGDF classification system (Table 4). Using IQVIA Medical Research Data, Wang et al. [24] showed that 8 % of 225,787 people with type 2 diabetes in the UK were at moderate and high risk, Vibha et al. [25] showed that one fifth of 620 people with diabetes in India were at moderate and high risk, Doaa O et al. [26] showed that 68 % of people with diabetes in their study in Egypt were at high risk, and Kishore et al. [27] showed that about 50 % of people with diabetes in a 3rd Level District Care Hospital (n = 100) in New Delhi, India were at mild to moderate risk. India and Egypt are among the top 10 countries in the world with the highest diabetes populations [1]. It can be said that a high-risk level for DFUs is an expected result due to the high prevalence of diabetes in these countries. We believe that this difference between this study and other studies is related to the criteria used to determine the risk level. In the studies in the literature, "existing ulcer" is considered to be a high-risk level in the classification of DFU risk levels. In this study, the rate of medium and high risk increases to approximately 20 % when the pre-existing ulcer is included in the risk level classification. In this study, if the participants' existing foot ulcer had healed, they would already be considered at high risk for DFU. Therefore, these people can be assessed as being at high risk. People with diabetes in the medium and high-risk groups are more important, especially in terms of the risk level of diabetic foot, and the frequency of follow-up of this group of people with diabetes should be increased [6].

Diabetic foot is the result of complex interactions between different components, such as the presence of peripheral sensory neuropathy (PDN) and peripheral arterial disease (PAD) coexisting with metabolic and immune dysfunction [6–28]. PAD is thought to be responsible for approximately 50 % of diabetic foot ulcers [29]. In many western countries, ischemia is also considered an important factor in increasing DFU rates [30]. As in many similar studies [31–33], PAH was found to be a risk factor for DFUs in this study, and the rate of PAH was 36.1 % in individuals with DFUs (Table 5).

In the study, 54 % of people with DFU had edema, and edema was found to be a risk factor for DFU (Tables 3–5). Edema of the lower limbs is a condition that is often caused by cardiac overload and heart failure, renal failure, and some oral antidiabetic drugs. In particular, the prevalence of peripheral edema is higher in people with type 2 diabetes mellitus than in healthy people [34]. Foot edema is a common finding in people with diabetes mellitus before the development of significant skin lesions. Skin health depends on adequate blood flow. Edema can disrupt the microcirculatory system and thereby affect the nutrition of the skin, leading to a disruption of its deep integrity [35]. The assessment of edema in the foot examination of the diabetic patient is a condition that should not be overlooked.

It is known that diabetic foot ulcers can recur 40 % in the first 1 year, 65 % in 5 years, and more than 90 % in 10 years [4]. In the current study, 59 % of individuals with DFU had a history of ulcer, and ulcer history was found to be an important risk factor for DFU (Tables 2–5). In many studies, ulcer history is shown to be a risk factor for DFU [36–39]. According to the IWGDF diabetic foot risk level classification system; individuals with a history of ulcer are at high-risk level and it is recommended to increase the frequency of follow-up of this group of individuals [6].

Another risk factor for DFU in the present study was fungal infection between the toes (Table 5). Similarly, Lauterbach et al. [33] found that diabetic neuropathy, diabetic angiopathy and fungal growth on the feet were risk factors for DFU based on data collected from 36,774 people with diabetes in the UK. A recent systematic review analyzed ten studies evaluating the association between DFU and onychomycosis. A significant association was found between the occurrence of onychomycosis and the presence of diabetic neuropathy (p = .012) and high glycosylated hemoglobin levels (p = .039). However, no significant association was found between onychomycosis and ulceration (p = .185). In the study conducted by Yusuf et al. [40] in the eastern part of Indonesia, no relationship was found between onychomycosis and ulceration. It is stated that the information described in the literature on the relationship between onychomycosis and DFU is insufficient and heterogeneous, onychomycosis diagnostic test should be applied instead of clinical diagnosis alone, and additional prospective, randomized, comparative studies are needed to improve the quality of studies in the literature [41]. In this study, fungus between the fingers and on the nails was assessed by trained nurses using the inspection method. Antifungal testing was not performed.

4.1. Strengths/Limitations

A limitation of this study is that PAH and skin temperature assessment was done only by palpation. However, the results obtained are guiding and important in the clinical decision-making processes of one-on-one patient examination. It is potentially simpler than other examination methods in developing countries where the prevalence of diabetes is high and healthcare personnel are limited. The generalizability of the results of the study to a specific group may be a limitation of the study. However, the fact that this study was conducted in provinces with

a high population of diabetics in Turkey and that the study data were collected by nurses who are experts in this field makes the study and its results valuable.

4.2. Implications for future research

In future studies, it is recommended to use highly reliable diagnostic methods in diagnosing complications accompanying diabetes, and to conduct epidemiological studies on diabetic foot on individuals with diabetes receiving primary care services. New studies can be planned regarding the risk factors identified as a result of this study and less mentioned in the literature.

5. Conclusion

In this multi-centered study conducted in the south-eastern region of Turkey, the prevalence of diabetic foot ulcers was 17.1 %, which was higher than both Turkish and global figures. PAH, history of ulcer, edema and presence of interdigital fungus were found to be among the factors predictive of DFU.

In Türkiye, most of the products for DFU treatment are very expensive because they are imported from abroad, and the reimbursement systems are very inadequate. There are almost no specific patient and outpatient clinics for patients with diabetic foot wounds. Therefore, we think that it is more important to develop DFU prevention policies for our country. In this respect, we believe that primary health care services are important and should be strengthened in early diagnosis of DFU and treatment by determining risk factors. There is a great need for trained health personnel in the management and prevention of DFU both in primary care and acute care settings. In this direction, health personnel should be supported with courses and certification programs. In addition, it is recommended that new technological approaches be used for patients to access qualified health services.

Contribution of the authors

M.K., N.O. in the concept, design and execution of the study, S.Ç.A, F. Z.K., S.O., S.Ş., E.K.B., Y.Ü., P.Ş., Z.T. in data collection, M.K., N.O., M.D. in the analysis and interpretation of data, M.K., M.D. in writing the results. M.K. in writing the manuscript, N.O took part in the final reading of the manuscript. All authors have seen and approved the final version of the article.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] International Diabetes Federation-IDF. Availabel from. https://diabetesatlas.org/idfawp/resource-files/2021/07/IDF_Atlas_10th_Edition_2021.pdf; 2021.
[2] Armstrong DG, Boulton AJM, Bus SA. Diabetic foot ulcers and their recurrence. N Engl J Med 2017;376(24):2367–75.
[3] Saltoglu N, Kilicoglu Ö, Baktiroglu S, et al. Diagnosis, treatment and prevention of diabetic foot wounds and infections: Turkish consensus report. J Klimik 2015 June; 28(1):2–34.
[4] Turkey Diabetes Program - TDP 2015-2020. (Cited: 12.04.2021) (Availabel from: https://extranet.who.int/ncdccs/Data/TUR_D1_T%C3%BCrkiye%20Diyabet%20Program%C4%B1%202015-2020.pdf].
[5] Armstrong DG, Swerdlow MA, Armstrong AA, Conte MS, Padula WV, Bus SA. Five year mortality and direct costs of care for people with diabetic foot complications are comparable to cancer. J Foot Ankle Res 2020;13(1):16.
[6] Navarro-Flores E, Cauli O. Quality of life in individuals with diabetic foot syndrome. Endocr, Metab Immune Disord: Drug Targets 2020;20(9):1365–72.
[7] Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA, Editorial Board IWGDF. Practical Guidelines on the prevention and management of diabetic foot disease (IWGDF 2019 update). Diabetes Metab Res Rev 2020 Mar;36(Suppl 1): e3266.
[8] ElSayed Nuha A, Aleppo Grazia, Aroda Vanita R, Bannuru Raveendhara R, Brown Florence M, Bruemmer Dennis, Collins Billy S, Gibbons Christopher H, Giurini John M, Hilliard Marisa E, Isaacs Diana, Johnson Eric L, Kahan Scott, Khunti Kamlesh, Leon Jose, Lyons Sarah K, Perry Mary Lou, Prahalad Priya, Pratley Richard E, Jeffrie Seley Jane, Stanton Robert C, Sun Jennifer K, Gabbay Robert A, on behalf of the American Diabetes Association. 12. Retinopathy, neuropathy, and foot care: standards of care in diabetes—2023. Diabetes Care 2023;46(Supplement_1):S203–15.
[9] Zhang P, Lu J, Jing Y, Tang S, Zhu D, Bi Y. Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Ann Med 2017 Mar;49(2): 106–16.
[10] IDF Diabetes Atlas report on diabetes foot-related complications. https://diabetesatlas.org/idfawp/resource-files/2022/12/IDF-Diabetic-Foot-Report.pdf; 2022.
[11] Satman I, Omer B, Tutuncu Y, Kalaca S, Gedik S, Dinccag N, Karsidag K, Genc S, Telci A, Canbaz B, Turker F, Yilmaz T, Cakir B, Tuomilehto J, TURDEP-II Study Group. Twelve-year trends in the prevalence and risk factors of diabetes and prediabetes in Turkish adults. Eur J Epidemiol 2013;28(2):169–80.
[12] Papachristoforou E, Lambadiari V, Maratou E, Makrilakis K. Association of glycemic indices (hyperglycemia, glucose variability, and hypoglycemia) with oxidative stress and diabetic complications. J Diabetes Res 2020;2020:7489795.
[13] A healthy lifestyle - WHO recommendations. https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle—who-recommendations. [Accessed 5 May 2023].
[14] Turkish Society of Cardiology (TKD). National hypertension treatment and follow-up guide. https://tkd.org.tr/kilavuz/k03/3_18530.htm?wbnum=1103. [Accessed 5 January 2021].
[15] Smith RG. Validation of Wagner's classification: a literature review. Ostomy/Wound Manag 2003;49(1):54–62.
[16] Bus SA, Lavery LA, Monteiro-Soares M, Rasmussen A, Raspovic A, Sacco ICN, van Netten JJ, International Working Group on the Diabetic Foot. Guidelines on the prevention of foot ulcers in persons with diabetes (IWGDF 2019 update). Diabetes Metab Res Rev 2020;36(Suppl 1):e3269.
[17] Koçakgöl N. Examination of diabetic foot risk levels and risk factors in individuals with diabetes [dissertation]. SANKO University; 2021.
[18] Almobarak AO, Awadalla H, Osman M, Ahmed MH. Prevalence of diabetic foot ulceration and associated risk factors: an old and still major public health problem in Khartoum, Sudan? Ann Transl Med 2017;5(17):340.
[19] Tola A, Regassa LD, Ayele Y. Prevalence and associated factors of diabetic foot ulcers among type 2 diabetic patients attending chronic follow-up clinics at governmental hospitals of Harari Region, Eastern Ethiopia: a 5-year (2013-2017) retrospective study. SAGE Open Med 2021;9:2050312120987385. https://doi.org/10.1177/2050312120987385.
[20] Maingi W, Kikuvi G, Matheri J. Prevalence and factors associated with diabetic foot ulcer among adult patients attending diabetic clinic at nyeri level 5. Afr J Health Sci 2020;33(6):44–52.
[21] Al-Maskari F, El-Sadig M. Prevalence of risk factors for diabetic foot complications. BMC Fam Pract 2007;8:59.
[22] Saldy Y, Mayumi O, Muhammad I, Saipullah R, Baharia L, Abdul T, Sukmawati K, Hiromi S, Toshio N, Junko S. Prevalence and risk factor of diabetic foot ulcers in a regional hospital, eastern Indonesia. Open J Nurs 2016;6(1):1–10.
[23] Chavan MS. Prevalence and risk factors of diabetic foot ulcer at a tertiary care hospital among diabetic patients International Journal of Advances in Medicine 2018;5(5):1274.
[24] Wang Z, Hazlehurst J, Subramanian A, Tahrani AA, Hanif W, Thomas N, Singh P, Wang J, Sainsbury C, Nirantharakumar K, Crowe FL. Diabetic foot risk classification at the time of type 2 diabetes diagnosis and subsequent risk of mortality: a population-based cohort study. Front Endocrinol 2022;13:888924.
[25] Vibha SP, Kulkarni MM, Kirthinath Ballala AB, Kamath A, Maiya GA. Community based study to assess the prevalence of diabetic foot syndrome and associated risk factors among people with diabetes mellitus. BMC Endocr Disord 2018;18(1):43.
[26] Doaa O, Bahaa El Din R, Aboelezz G. Assesment of diabetic foot risk factor among patients with diabetes attending to Zagazig University Hospital. Zagazig University Medical Journal 2021;27(1):155–65. 1.
[27] Kishore S, Upadhyay AD, Jyotsna VP. Categories of foot at risk in patients of diabetes at a tertiary care center: insights into need for foot care. Indian J Endocrinol Metab 2015 May;19(3):405–10.
[28] Lim JZ, Ng NS, Thomas C. Prevention and treatment of diabetic foot ulcers. J R Soc Med 2017;110(3):104–9.
[29] Brownrigg JR, Schaper NC, Hinchliffe RJ. Diagnosis and assessment of peripheral arterial disease in the diabetic foot. Diabet Med 2015;32(6):738–47.
[30] Prompers L, Huijberts M, Apelqvist J, Jude E, Piaggesi A, Bakker K, Edmonds M, Holstein P, Jirkovska A, Mauricio D, Ragnarson Tennvall G, Reike H, Spraul M, Uccioli L, Urbancic V, Van Acker K, van Baal J, van Merode F, Schaper N. High prevalence of ischaemia, infection and serious comorbidity in patients with

diabetic foot disease in Europe. Baseline results from the Eurodiale study. Diabetologia 2007;50(1):18–25.
[31] Al-Rubeaan K, Al Derwish M, Ouizi S, Youssef AM, Subhani SN, Ibrahim HM, Alamri BN. Diabetic foot complications and their risk factors from a large retrospective cohort study. PLoS One 2015 6;10(5):e0124446.
[32] Shukla V, Fatima J, Ali M, Garg A. A study of prevalence of peripheral arterial disease in type 2 diabetes mellitus patients in a teaching hospital. J Assoc Phys India 2018;66(5):57–60.
[33] Lauterbach S, Kostev K, Kohlmann T. Prevalence of diabetic foot syndrome and its risk factors in the UK. J Wound Care 2010;19(8):333–7.
[34] Ho TK, Leigh DR, Tsui J. Diabetic foot disease and oedema. Br J Diabetes Vasc Dis 2013;13(1):45–50.
[35] Chao CY, Zheng YP, Cheing GL. The association between skin blood flow and edema on epidermal thickness in the diabetic foot. Diabetes Technol Therapeut 2012;14(7):602–9.
[36] Assaad-Khalil SH, Zaki A, Abdel Rehim A, Megallaa MH, Gaber N, Gamal H, Rohoma KH. Prevalence of diabetic foot disorders and related risk factors among Egyptian subjects with diabetes. Prim Care Diabetes 2015;9(4):297–303.
[37] Yazdanpanah L, Shahbazian H, Nazari I, Hesam S, Ahmadi F, Cheraghian B, Arti HR, Mohammadianinejad SE. Risk factors associated with diabetic foot ulcer-free survival in patients with diabetes. Diabetes Metabol Syndr 2018;12(6):1039–43.
[38] Kaminski MR, Raspovic A, McMahon LP, Strippoli GF, Palmer SC, Ruospo M, Dallimore S, Landorf KB. Risk factors for foot ulceration and lower extremity amputation in adults with end-stage renal disease on dialysis: a systematic review and meta-analysis. Nephrol Dial Transplant 2015;30(10):1747–66.
[39] Pham H, Armstrong DG, Harvey C, Harkless LB, Giurini JM, Veves A. Screening techniques to identify people at high risk for diabetic foot ulceration: a prospective multicenter trial. Diabetes Care 2000;23(5):606–11.
[40] Yusuf S, Okuwa M, Irwan M, Rassa S, Laitung B, Thalib A, Sugama J. Prevalence and risk factor of diabetic foot ulcers in a regional hospital, eastern Indonesia. Open J Nurs 2016;6(1):1–10. 2016.
[41] Navarro-Pérez D, Tardáguila-García A, García-Oreja S, López-Moral M, García-Madrid M, Lázaro-Martínez JL. Onychomycosis associated with diabetic foot syndrome: a systematic review. Mycoses 2023;66(6):459–66.