International Egyptian Journal of Nursing Sciences and Research (IEJNSR)

Original Article

Patterns and Risk Factors of Diabetic Foot Ulcers among Elderly with Diabetes

[1] **Ghada Mohamed Abd-Elsalam Elhgry, [2] Shaimaa A. Shaala, [3]Ahmad Mohamed Albatahgy.**

[1,]Lecturer of Geriatric Nursing, Faculty of Nursing, Menofia University, Egypt.
[2]Lecturer of Medical Surgical Nursing, Faculty of Nursing, Menofia University, Egypt.
[3]Egyptian followship, vascular surgery, Shebin Elkom Teaching hospital, Egypt.
***Corresponding author:** Ghada Mohamed Abd-Elsalam Elhgry*
E-mail Ghada.elhagary.13@nursing.menofia.edu.eg; yaaqeenabdelrhman@gmail.com

ABSTRAC

Background: Diabetic foot ulcers are critical complications and challenging health concerns for the elderly that can lead to hospitalization and amputation. **Aim:** This study aimed to assess patterns and risk factors of diabetic foot ulcers among elderly with diabetes. **Design and setting:** A case-control research method was used to conduct this study at the outpatient clinics and inpatient department of Menofia University Hospital and Shebin Elkom Teaching Hospital, Egypt. **Subject:** A total sample of 100 elderly with diabetes was selected and allocated into two groups (group a: Elderly with DFUs (n=50) and group b: Elderly without DFUs (n=50)). **Tools of data collection:** (I): interviewing questionnaire. (II): Ten rules of the foot care questionnaire (III): Meggitt–Wagner classification. (IV): Diabetic neuropathy symptom (DNS) scores. **Results:** Studied elderly mean age was 66.81±7.55. Regarding DFU risk factors, rural residence (60%), illiteracy (52%), unemployment (70%), smoking (50%), history of DFU (58%), callus (74%), cracked skin (58%), poor foot care (78%), lack of protective sensation (78%), lack of peripheral pulse (50%), elevated blood glucose (M±SD 199.54±71.0) and increased BMI (M±SD 29.35 ± 7.52), all represented significant risk factors for DFU in the current study. **Conclusion:** The study concluded that illiteracy, rural residence, no work, smoking, obesity, callus, cracked skin, and foot deformity, uncontrolled blood glucose, previous history of DFU, absent distal pulse, loss of protective sensation, and lack of proper foot care were all of the most risk factors for DFUs in this study. **Recommendations:** Design educational programs for the elderly with diabetes about foot care and risk factors for diabetic foot ulcer (DFU). Screen the at-risk elderly diabetic patients regularly for early detection and appropriate management of diabetic foot ulcer (DFU).

Keywords*:* Elderly with diabetes, Diabetic foot ulcer (DFU), Risk factors.

Introduction

Numerous biological and genetic trajectories dominate the aging process, which influences lifespan and causes age-related diseases (Li et al., 2021). One of the common chronic diseases affecting older people is diabetes mellitus (DM), which has become an international health concern (Sharoni et al., 2017; International Diabetes Federation, 2017), increasing morbidity and mortality (Alsaleh et al., 2021), impacting the societal, commercial, and evolution of developing countries (Mekonen & Gebeyehu Demssie, 2022).

By 2045, there will be 135.7 million people with diabetes worldwide, up from 537 million in 2021. Egypt is part of the IDF MENA region, which consists of 21 countries and territories. A total of 10.930.700 cases of diabetes were registered in Egypt in 2022 (IDF, 2022).

DFUs are common and depleting complications of diabetes mellitus (Tuglo et al., 2022), leading to costly complications including infection, considerable pain (Jia et al., 2022), poor quality of life, lower-extremity amputation (Mekonen & Gebeyehu Demssie, 2022), hospital admissions, mortality (El-Sedawy & Behairy, 2016; Marzouk et al., 2017) and cost to individuals and society (Schaper et al., 2020; Eleftheriadou et al., 2019).

International Working Group (2019) defines diabetic foot as " ulceration, destruction, or infection of foot tissues associated with neuropathy in the lower extremity of a person with diabetes mellitus". Peripheral neuropathy and uncontrolled diabetes are core risk factors for DFUs (Dòria et al., 2016).

In a meta-analysis study, Zhang et al. (2017) reported that 6.3% of the total DM patients worldwide had DFUs. North America has the highest prevalence (13.0%), followed by Africa (7.2%) and Asia (5.5%). In Egypt, 6.1% to 29.3% of diabetes patients have DFUs (Galal et al., 2021).

Diabetes foot ulcers accounted for 85% of lower limb amputations (Eleftheriadou et al., 2019; Adem et al., 2020), followed by a mortality rate ranging from 24.6% within five years to 45.4% within ten years (Jeyaraman et al., 2019). On the other hand, amputations in diabetic patients lead to stable frailty and loss of mobility in approximately 52% to 68% of cases (Kasiya et al., 2017).

Significance of the study

Diabetes foot problems are a prominent cause of death in seniors (Abd-Allah et al., 2016; Moussa & Gida, 2017). Patients with diabetes have an amputation rate of 15 to 40 times higher than patients without the disease (Fernández et al., 2020).

Because 44-85% of diabetic foot problems can be prevented, incorporating the effort of physicians, nurses, other health professionals with patients, and caregivers provide an optimal resolution for this problem (Khan et al., 2017).

Also detecting high-risk diabetic patients through early assessment is essential to prevent serious complications (Fernández et al., 2020).

To our knowledge, few studies have addressed DFU issues among elderly patients. Therefore, this study was performed to discover the predictors and pattern of DFUs among older individuals with diabetes.

Aim of study:

The ongoing study aimed to assess the patterns and risk factors of diabetic foot ulcers among the elderly with diabetes.

Research question

Q1. What are the factors predicting diabetic foot ulcers among the elderly with diabetes?

Q2. What are the patterns of diabetic foot ulcers among the elderly with diabetes?

Operational Definition:

Diabetic foot ulcer (DFU) is a full-thickness wound (an active ulcer) below the ankle in elderly diabetic patients at the time of the study.

Subjects and method

Research Design: A case-control study was implemented.

Setting and sample recruitment:

The study was implemented in the inpatient department of surgery and outpatient clinics of internal medicine and diabetic foot at Menofia University Hospital and Shebin Elkom Teaching hospital, Egypt, from March to June 2022. These settings offer multidisciplinary medical services for diabetic patients with multi clinics such as medicine, cardiology, nephrology, ophthalmology, neurology, surgery and a specialized foot care clinic.

Sampling

A purposive sample of 100 elderly with diabetes was recruited for the current study and distributed into two groups (group a: patients with DFUs (n = 50), and group b: patients without DFUs (n=50) with matching age and sex.

Calculation of sample size

Based to Salama et al., 2017, neuropathy and duration of diabetes mellitus are independent risk factors for diabetic foot, with 75% of diabetic foot patients having had diabetes longer than five years, while this percentage was 58% for patients without foot injury, at 80% confidence level, 0.05 alpha, and a case-control ratio of 1:1, the sample size was 50 patients in each group.

Formula:

$$N = \frac{r+1/2\ [P\ (P-1)^*\ (Z\beta + Z\alpha)2]}{(P1 - P2)2}$$

r = the ratio of cases to controls

P = difference between the 2 percentage, P 1 = percentage of group 1, P2 = percentage of group2

Zβ = the desired power, at 80% = 0.84

Zα = the alpha error of 0.05 = 1.96.

Inclusion criteria: Elderly aged 60 years or older diagnosed with diabetes mellitus for at least one year, with or without diabetic foot.

Exclusion Criteria: Elderly who have mental problems prevent informed consent.

Tools for data collection:

Tool (1): Interview questionnaire: The questionnaire was adopted by the study researchers based on an extensive literature review, which consists of the following:

a) Socio-demographic data: Participants' general characteristics, such as age, gender, education, income, marital status, working status, and residence.

b) Clinical data: including physical illness, duration of diabetes mellitus, a treatment used, family history, history of DFU, fasting blood glucose level (FBG; mmol/l), was collected from the latest patients laboratory data, the history of amputation, receiving foot care teaching, foot care practice, and regular follow-up. Body Mass Index (BMI) was calculated according to the (weight in Kg, divided by the square of height /m2) Equation.

c) Lifestyle risk factors: included self-reported smoking status, physical activity, and adequate footwear .

d) Physical assessment: based on clinical practice recommendations on diabetic feet of the International Diabetes Federation (2017), includes:

Assessment of dermatological status: Skin status, cracked skin, foot deformity (callus, hummer, claw toe, and flat foot).

Assessment of Vascular status: distal pulse (dorsalis pedis and posterior tibial pulses), skin color, and feet skin temperature (warm or cold).

Neurological status Assessment: the 10 g Semmes-Weinstein monofilament test is easy, inexpensive, and the best measure for evaluating the loss of protective sensation (Dros et al., 2009). It is a ten g force used on nine different sites, including (the heel, great toe, third toe, and fifth toe; first, third, and fifth metatarsal heads, medial foot, and lateral foot), avoiding the areas of the callus. A feeling of seven or more sites during the test by the patients indicated good neurological status (Assaad-Khalil et al., 2014).

Tool (II): Diabetic neuropathy symptom (DNS) score: a screening instrument used to assess distal diabetic polyneuropathy. It was adopted and validated by Meijer et al. (2002) for use by healthcare providers in an outpatient setting. The tool contained a yes or no question on foot sensation with a ‘yes’ =1 if the symptom had arisen numerous times last two weeks or with a ‘no’ =0 if it had not (Kamel et al., 2015).

Scoring: the instrument consists of four items, the maximum DNS score is four points, and one score or more indicates diabetic neuropathy (Meijer et al., 2002).

Validity and reliability:

The DNS is a valid, easy, and fast test with great predictive value when screening diabetic polyneuropathy. Its reliability score was 0.64 (Meijer et al., 2002). The Cronbach's α coefficient in this study was 0.71.

Tool (III): Ten rules of foot care: the questionnaire adopted by Antohe & Popa, 2021, to assess preventive foot self-care practice for patients with diabetes. It is a valid and reliable instrument, consisting of 10 questions on foot care.

The scoring: based on the yes/no scale, each correct answer takes one score, while wrong answers take zero points, with a total score of zero to ten. Based on the maximum score of the foot care questionnaire, a good or poor level of practice is indicated. Scores of 7-10 (≥70%) are considered good.

Validity and reliability: the tool is valid with internal consistency assessed by Cronbach's alpha at 0.73 (Antohe & Popa, 2021). In the present study, Cronbach's α coefficient was 0.80.

Tool (IV); Classification by Meggitt-Wagner: developed by Meggitt (1976) and modified by Wagner (1981). The Meggitt–Wagner classification is one of the most famous valid classifications for diabetic foot ulcers (Alexiadou & Doupis, 2012). Foot ulcer grades are as follows: 0=no ulcer, 1=superficial ulcer; 2=ulcer with deep infection but no bone involvement; 3=ulcer with osteomyelitis; 4=localized gangrene; and grade 5=gangrene of the entire foot (Mariam et al., 2017).

Pilot Study

The study questionnaire was evaluated as a part of a pilot study to ensure clarity, feasibility, and applicability. Researchers randomly selected ten elderly (representing about 10% of the study subjects) to participate in the pilot study and then excluded them.

Content validity and reliability:

A jury of three experts in geriatric nursing, vascular surgery, and medical surgical nursing evaluated the tools' content validity. The researchers performed the modification of the study tools. Based on the scientific Jury's opinions, the tools' format and consistency were valid. In terms of the reliability of the study tools, Cronbach's alpha coefficient was 0.80.

The Field of Work: Permission of the director of Menofia University Hospital and Shebin Elkom Teaching hospital was obtained at first. The study began from March to June 2022, over three months. The researchers schedule three days a week for data collection. The elderly voluntarily participated during this phase. The researchers explained the study's aim to secure informed consent before collecting data. The withdrawal was allowed at any time. The researchers assigned 100 participants and divided them into two groups according to their eligibility (group a: participants with DFU (n=50), and group b: participants without DFU (n=50) with matching age and sex). Data was collected using study tools. The researchers collected the demographic and medical data and implemented physical examinations after

explaining the procedure to the patients. The interview was conducted individually to maintain privacy and cooperation. Each participant's face-to-face interview took an average of 40 minutes to complete.

Ethical considerations

- This study was approved by the Ethics Committee, Faculty of Nursing, Menofia University.
- Elderly informed consent was obtained after clarification of the study aim and, the participation was voluntary.
- Withdrawal right from the study was protected.
- Privacy of the participants was respected and data confidentiality was preserved.
- There are no risks for the participants present in this study.

Data analysis

The data was managed and compared by the SPSS version 22 using the Chi-square and the Independent Samples T-test with the significance level accepted at a p-value of < 0.05.

Results

Table (1) revealed that most of the studied elderly were male (62%), with a mean age of 66.81±7.55 years old, not working (95%), illiterate (40%), and married (64%).

With Regard to DFU risk factors, age cohort 60-70 years old (92%), illiteracy (52%), rural habitat (60%), unemployment (70%), were a statistical significance risk factors to DFU in this study at p-value (p=0.017), (p=0.000), (p= 0.009), and (p=.021) respectively.

Table (2) indicated a significant relationship between diabetic foot ulcer incidence and insulin use (56%), smoking (50%), history of DFU (58%), and poor foot care (78%) at a p-value = 0.009, 0.002, 0.001 and 0.000, respectively. Family history of diabetes was found in 100% of elderly participants without DFUs compared to 82% of elderly with DFUs, and this was a statistical significance difference at p = 0.002. Regarding foot care education, 100% of the elderly patients without foot ulcers received foot care education compared to 78% of the diabetic elderly with foot ulcers, with a statistically significant difference at p = 0.000. Regarding the duration of diagnosis, 40% of the participants in the foot ulcers group had been diagnosed with long-term diabetes, compared to 32% of participants without DFUs, and this didn't contribute any statistically significant difference.

Table (3) revealed statistically significant differences between the study groups related to BMI and fasting blood glucose mean and SD (29.35±7.52 versus 26.73±3.93; p = 0.007) and (199.54±71.08 versus 161.08±26.04; p = 0.000), respectively.

Table (4) illustrated that on physical assessment, foot deformity (callus and hammer toe or claw toe) created a statistically significant risk factor for DFUs in the current study, whereas callus (26%) and Hammer or claw toe (28%) were found in the elderly with DFUs compared to (4%) and (0%) in the elderly without DFUs at (p = .002; p = 0.000)

respectively. Cracked skin (58%), skin discoloration (64%), cold feet (62%), and lost peripheral pulse (50%) all found in of elderly with DFUs and this was a statistically significant difference at (p = 0.000; p = 0.001; p = 0.028; p = 0.000) respectively. Loss of protective sensation was another statistically significant risk factor for DFUs, as 76% of the elderly participant with DFUs lost the Monofilament 10g test compared to 28% of the elderly without DFUs at (p = 0.000).

Figure (1) exposed that preventive foot care (good practice) was more prevalent in a non-DFUs group than in the DFUs group (52% versus 22%, respectively).

Table (5) showed that the majority (48.0%) of the foot ulcers in the study group were classified as stage 1 (superficial ulcers), followed by (36.0%) located at stage 4 (limited gangrene to part of the foot) according to Meggitt–Wagner DFUs classification.

Table (1): Comparison between The Elderly Diabetic Patients With and Without DFUs Concerning Socio-Demographic Characteristics (n=100).

Socio-demographic characteristics	Elderly with DFUs n=50	Elderly without DFUs n=50	All participants (n=100)	Chi-square test	
				X^2	P-value
Age:	Mean± SD 66.81±7.55				
60-70	46(92%)	36(72%)	82(82%)		
71-80	4(8%)	9(18%)	13(13%)	8.143	.017*
81+	0(0%)	5(10%)	5(5%)		
Gender :					
Male	34(68%)	28(56%)	62(62%)	1.528	.216
Female	16(32%)	22(44%)	38(48%)		
Marital status:					
Single	3(6%)	0(0%)	3(3%)	4.750	.191
Married	34(68%)	30(60%)	64(64%)		
Widow	10(20%)	15(30%)	25(25%)		
Divorced	3(6%)	5(10%)	8(8%)		
Education:					
Illiterate	26(52%)	14(28%)	40(40 %)	31.177	.000**
Basic education	10(20 %)	17(34%)	27 (27%)		
Secondary	12(24%)	0(0%)	12(12 %)		
High education	2(4 %)	19(38%)	21(21%)		
Occupational status:	10(30%)	26(52%)	44(44 %)	5.002	.025*
Still Work	35(70%)	24(48%)	59(59 %)		
Not work					
Income:					
Enough	36(72%)	45(90%)	81(81%)	5.882	.053
Not enough	12(24%)	5(10%)	17(17%)		
Enough and save	2(4%)	0(0%)	2(2%)		
Residence :					
Rural	30(60%)	17(34%)	47(47%)	6.784	.009*
Urban	20(40%)	33(66%)	53(53%)		

** $p \leq 0.001$ is statistically highly significant

* $p < 0.05$ is statistically significant

Table (2): Comparison between The Elderly Diabetic Patients Subjects With and Without DFUs Concerning Medical Data and Lifestyle Variables (n=100).

Medical data and life style variables	Elderly with DFUs n=50	Elderly without DFUs n=50	All participants (n=100)	Chi-square test	
				X^2	p-value
Family history of diabetes:					
Yes	41(82%)	50(100%)	91(91%)	9.890	.002*
No	9 (18%)	0 (0 %)	9 (9%)		
Comorbidities disease:					
Hypertension	18(36%)	21(42%)	39(39%)	3.824	.281
Cardiovascular disease	2 (4%)	5(10%)	7(7%)		
Kidney Disease	2(4%)	0 (0%)	2(2 %)		
No	28(56%)	24(48%)	52(52%)		
Duration of diabetes:					
Less than 5 years	16(32%)	15 (30%)	31(31%)	1.234	.539
5-10 years	14(28%)	19(38%)	33 (33%)		
More than 10 years	20(40%)	16 (32 %)	36 (36%)		
Diabetic medication:					
Insulin treatment	28(56 %)	5(10 %)	33(33 %)	31.602	.000**
Oral anti diabetic medication(OHAs)	18(36%)	45(90 %)	63(63 %)		
Both of oral anti diabetic and insulin	4 (8%)	0(0 %)	4(4%)		
Smoking					
Yes	25 (50%)	9 (18%)	34(34%)	11.408	.001**
No	25 (50%)	41(82%)	66 (66%)		
Physical exercise					
Yes	35(70%)	40(80%)	75(75%)	1.333	.248
No	15(30%)	10(20%)	25(25%)		
History of DFUs:					
Yes	29(58%)	16(32%)	45(45%)	6.828	.009*
No	21(42%)	34(68%)	55(55%)		
Previous history of Amputation:					
Yes	19(38%)	10(20%)	29(29%)	3.934	.047
No	31(62%)	40(80%)	71(71%)		
Regular follow-up to the diabetic clinic:	30(60%)	33(66%)	63(63%)	.386	.534
Yes	20(40%)	17(34%)	37(37%)		
No					
Received foot care teaching:					
Yes	39(78%)	50(100)	89(89%)	12.360	.000**
No	11(22%)	0(0%)	11(11%)		
Adequate foot care:					
Yes	11(22%)	26 (52%)	37(37%)	9.653	.002*
No	39(78%)	24(48%)	63(63%)		

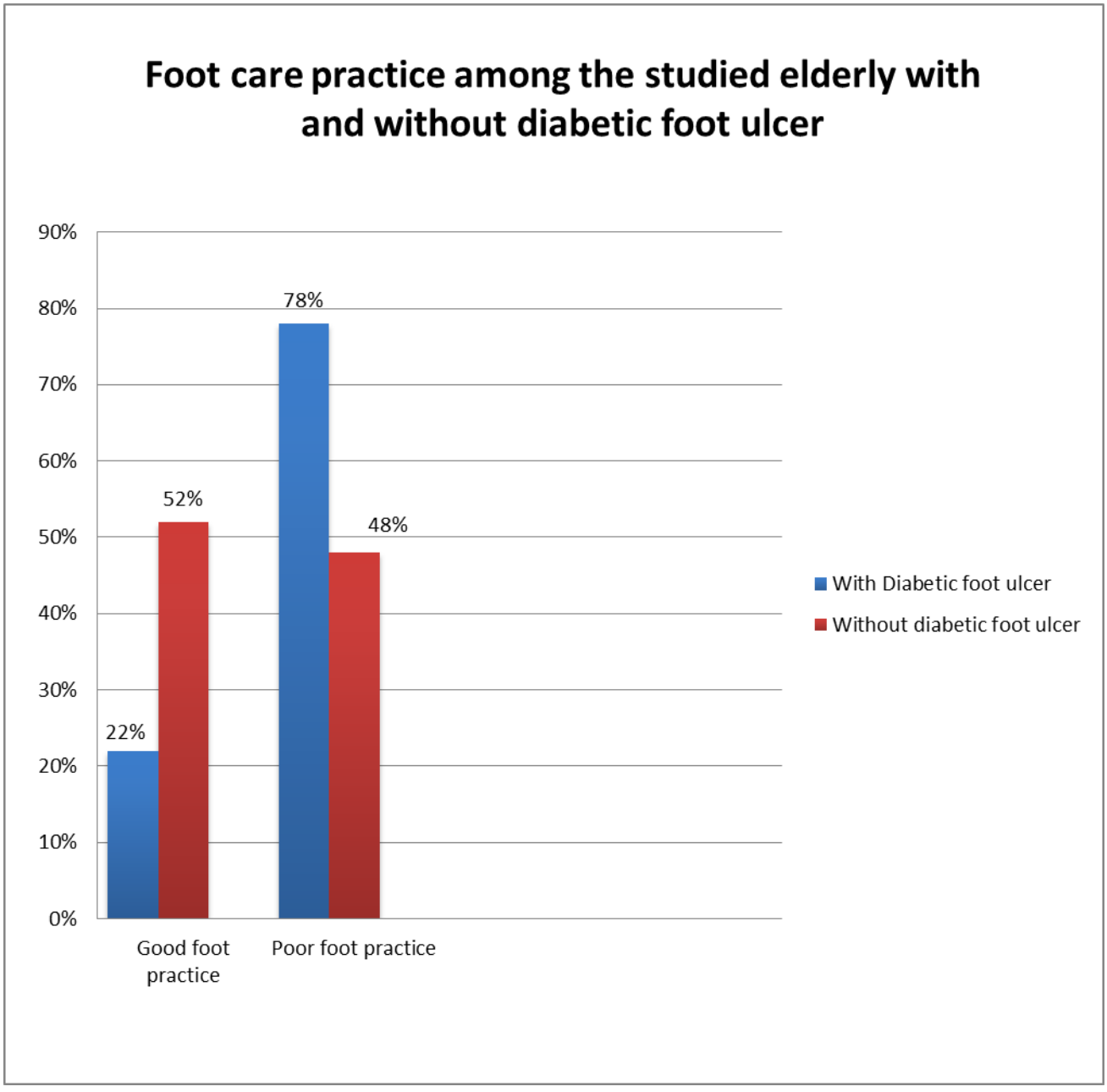

Figure (1): Distribution of The Elderly Diabetic Patients With and Without DFU regarding Preventive Foot Care Practice: (n=100).

Table (3): Comparison between The Elderly Diabetic Participants With and Without DFUs regarding BMI and Fasting Blood Glucose.

Variable	Elderly with DFUs (mean ± SD) n=50	Elderly without DFUs (mean ± SD) n=50	t- test	p-value
BMI (kg/m²)	29.3570 ± 7.52239	26.7372 ±3.93419	2.182	.007*
Fasting blood glucose	199.5400±71.08868	161.0800±26.04771	3.592	.000**

Table (4): Comparison between The Elderly Diabetic Participants With and Without DFUs regarding Physical Assessment (n=100).

Physical examination items:	Elderly with DFUs n=50	Elderly without DFUs n=50	All participants (n=100)	Chi-square test	
				X^2	P-value
Callus:					
Yes	13(26%)	2(4%)	15(15%)	9.490	.002*
No	37(74 %)	48(96%)	85(85%)		
Hammer toe or claw toe:					
Yes	14(28%)	٠ (0%)	١٤(14%)	16.279	.000*
No	36(72%)	٥٠ (100%)	86(86%)		
Flat foot:					
Yes	11(22%)	١٧(34%)	٢٨(28%)	1.786	.181
No	39(78%)	(66%)٣٣	72(72)		
Cracked skin:					
Yes	29(58%)	9(18%)	38(38%)	16.978	.000*
No	21(42%)	41(82%)	62(62%)		
Adequate foot wear:					
Yes	22(44 %)	٣١ (62%)	٥٣(53%)	3.252	.071
No	28(56 %)	19(38%)	٤٧(47%)		
Monofilament 10g test:					
Lost	38(76%)	14(28%)	52(%)	23.077	.000*
Intact	12(24%)	36(72%)	48(%)		
Distal polyneuropathy					
Yes	47(94%)	41(82%)	88(%)		
No	3(6%)	9(18%)	12(%)	3.409	.065
Distal Pulse:					
Present	25(50 %)	45(90%	٧٠(70%)	19.048	.000*
Absent	25(50 %)	٥(10%)	٣٠(30%)		
Foot skin Temperature:					
Warm	19(38 %)	٣٠(60%)	49(49%)	4.842	.028*
Cold	31(62 %)	٢٠(40%)	51(51%)		
Discoloration of the skin:					
Yes	32(64 %)	15(30%)	47(47%)	11.602	.001*
No	18(36%)	35(70%)	53(53%)		

** $p \leq 0.001$ is statistically highly significant * $p < 0.05$ is statistically significant

Table (5): Distribution of The Elderly Diabetic Patients With DFUs (n= 50) according to Wagner's DFU Classification.

Meggitt-Wagner's DFU classification	**Elderly participants with DFUs (n= 50)**	
	n	**%**
0. Healed or pre-ulcerative wound	0	0.0
1. Superficial ulcer without penetrating to deeper layers	24	48.0
2. Deeper ulcer and reaches tendon, bone or joint capsule	8	16.0
3. Osteomyelitis, or tendinitis	2	4.0
4. Limited gangrene (part of the foot)	13	36.0
5. Extensive gangrene (whole foot)	3	6.0

Discussion

The current study aims to assess the patterns and risk factors of diabetic foot ulcers among the elderly with diabetes.

The present study revealed that most of the studied elderly (62%) are male, with a mean age of 66.81±7.55 years, not working (95%), illiterate (40%), and married (64%).

Regarding risk factors of DFU, the age cohort of 60–70 years is significantly higher (92%) among the elderly patients with DFUs at p=0.017. A possible interpretation of the current results is that the age cohort 60–70 years is more active than other older cohorts and participates in more outdoor activities, making them more susceptible to multiple foot risks and advanced plantar pressure on their feet. On the other hand, Al-Rubeaan et al. (2015) reported no association between age and diabetic foot development. While Fawzy et al. (2019) illustrated that older patients with a mean age of 56 years were more eligible for DFU occurrence in Saudi Arabia.

In the current study, there is no statistically significant difference between the two groups regarding sex. Thus, this result supports the assumption that with aging, the chance of developing a foot ulcer depends on the presence of contributing factors, not on sex. In agreement with Galal et al., 2021, they reported that gender was not associated with DFU development in Egypt. Similarly, Al Kafrawy et al. (2014) illustrated that sex was not a risk factor for DFU incidence. In contrast, Yazdanpanah et al. (2018) identified male sex as a risk factor for DFU in Iran. However, Fawzy et al. (2019) reported that female patients in Saudi Arabia were more liable to DFUs than male patients. These differences could be related to variances in the study participants and methodology used.

In this study, illiteracy was significantly higher among elderly patients with DFUs (52%) at (p = 0.000). As a result, educated people are more inclined to seek medical advice, follow healthy lifestyles, and practice preventive measures versus illiterate people. In the same line, Galal et al., 2021, reported that illiteracy was a significant risk factor for DFUs. Also, Cardoso et al. (2019) reported illiteracy as a risk factor among Brazilian patients.

Regarding working status, unemployment considers a significant risk factor for DFU at (p =.021), as 70% of the elderly patients with DFUs did not work compared to 48% in the other group. In general, work routines can reduce obesity, fill free time, decrease stress, and provide the elderly with an income to care for their health. Anxiety and obesity contribute to uncontrolled diabetes, which leads to peripheral neuropathy and ulceration.

In this study, countryside living is significantly higher in the elderly diabetic foot ulcers group (60%) versus (34%) in the other group (p = 0.009). In agreement with Mariam et al., 2017, rural zones were associated with DFU incidence among Ethiopian diabetics. Salama and Zorin, 2017, in Egypt and Tolossa et al., 2020, in

Ethiopia reported similar results. Obaid and Eljedi's (2015) study found that a higher percentage of diabetes foot patients (56%) lived in refugee camps with unhygienic living conditions in Gaza's middle area. Furthermore, Yimam et al., 2021, found that rural diabetics were eight times more likely to develop diabetic foot ulcers than urban diabetics. The possible interpretation of these results is that rural dwelling promotes poor foot care practice and barefoot walking. **Table (1);** In this study, insulin treatment represents a statistically significant relation with DFU incidence as 56% of the elderly patients with DFUs used insulin treatment compared to 10% of the elderly patients without DFUs (p = 0,001). In agreement with Yazdanpanah et al. (2018), they found that patients who used insulin were more likely to develop foot ulcers than patients managed with oral anti-diabetic medication. Elderly patients with diabetes may start insulin when they already have uncontrolled diabetes with complications. Moreover, this finding is compatible with Jiang et al. (2015) in China and Al-Rubeaan et al. (2015) in Saudi Arabia. In Egypt, Salama & Zorin (2017) found that 71.7% of diabetic foot patients were treated with insulin before and during ulcer formation, compared to 29.5% of non-diabetic foot patients. Nevertheless, Galal et al. (2021) found that treatment modalities in the form of diet, oral hypoglycemic medication, and insulin are protective predictors of diabetic foot ulcers.

Smoking is another significant risk factor in this study, as 50% of the elderly patients with DFUs were smokers (p = 0.001).In agreement with our results, Galal et al.(2021), Salama & Zorin(2017), and Al Kafrawy et al. (2014) all illustrated that smoking was a predictive factor for diabetic foot ulcers. In conclusion, smoking is one of the main risk factors associated with DFU and peripheral vascular disease. In addition, Obaid & Eljed (2014) reported that smoking increases the risk of developing diabetic feet even in ex-smokers.

According to the current finding, a history of foot ulcers is a statistically significant risk factor among elderly patients with DFUs (58%) at p =.009. This result agrees with Abdissa et al. (2020) in Ethiopia, who stated that the patient's history of foot ulcers was significantly associated with another advanced ulcer in the future. Similarly, Amissah & Boateng (2014) in Ghana, Khalil et al. (2014), Al Kafrawy et al. (2014), and Yazdanpanah et al. (2018) all mentioned the same result.

Moreover, 100% of the DFUs group compared to 82% of the other group had a family history of diabetes which was a statistically significant protective variable at p = 0.002. The present finding can interpret as the prior knowledge of diabetic foot problems as a result of previous experiences with a relative making the patient more committed to foot monitoring and care.

In the current study, foot care and foot care education were statistically significant protective variables against the incidence of DFU at p=0.000 and p =.002 respectively. In the same line, Mariam et al. (2017) reported diabetic foot ulcers were linked to poor foot self-care practice 2.52 times more than good foot self-care. Also, Ali et al. (2019) studied the health education program's effect on self-care of foot and the risks of foot ulcers and reported that diabetic foot ulcers

decreased in the intervention group. In contrast to the current study, Yazdanpanah et al. (2018) mentioned that training on feet didn't constitute any significant impact on foot ulcers. However, Salama & Zorin (2017) and Obaid & Eljed (2015) all revealed that good foot care is a protective factor that decreases the risk of diabetic foot development. Tolossa et al., 2020 in a meta-analysis study on diabetic foot ulcer risk factors in Ethiopia, explained that foot ulcers were significantly associated with poor foot care practice. **Table (2), Figure (1);**

In the current study, body mass index (Mean and SD) was significantly higher in elderly diabetic patinents with DFUs than in the other group (29.35±7.52 versus 26.73±3.93; p=0.007). The findings are consistent with Tolossa et al. (2020); Adem et al. (2020); Yazdanpanah et al. (2018); Salama and Zorin (2017); Al-Rubeaan et al. (2015), all of which illustrated that increasing body mass index is a significant predictor of diabetic foot ulcers. These results may be related to the effect of obesity on plantar pressure and poor diabetic control. Otherwise, Fawzy et al. (2019), Liaofang et al. (2015), and Al Kafrawy et al. (2014) discovered no link between BMI and the occurrence of diabetic foot.

In the present study, fasting blood glucose (Mean and SD) represented a statistically significant risk factor for diabetic foot ulcers (199.54±71.08 for a group with DFUs versus 161.08±26.04 for a group without DFUs; p = 0.000). This finding was consistent with Salama & Zorin, 2017; Al Kafrawy et al., 2014; and Fawzy et al., 2019, all of which identified a strong correlation between poor glycemic control and DF problems. Furthermore, blood glucose control is the most effective management for reducing diabetic foot disease incidence (Sharma et al., 2016). **Table (3);**

On physical assessment, foot deformity (callus (26%) and hammer's toe or claw toe (28%)) revealed a statistically significant risk factor for DFUs incidence at p =.002 and p = 0.000. Cracked skin represents another statistically significant risk factor at p = 0.000. It confirms Yazdanpanha et al. (2018), Galal et al. (2021), and Cardoso et al. (2019). Similar findings by Assaad-Khalil et al., 2014, and Tolossa et al., 2020, demonstrated that feet callus was a risk factor for diabetic foot ulcers. Talossa added that this could be due to a decrease in blood supply leading to poor healing. Al Kafrawy et al., 2014, demonstrated that diabetic patients develop callus due to peripheral neuropathy, leading to a lack of sensation and deformity, with persistent abnormal pressure on the foot.

In the current study, peripheral vascular problems constitute significant risk factors for DFU incidence as discoloration of the skin (64%), cold feet (62%), and lost peripheral pulse (50%) present in the DFUs group at p=0.001, p=0.028 and p = 0.000 respectively. A similar result by Cardoso et al. (2019), Brito et al. (2017), and Yazdanpanah et al. (2018), identified alteration in peripheral pulse palpation as one of the risk factors for DFU. Likewise, Sharma et al. (2016)

reported that 17.62 % of their patients had signs of peripheral vascular disease. In contrast, Refaat et al. (2019) stated that the absence of peripheral pulse was not detected in any of their patients with or without diabetic feet when assessing diabetic foot risk factors among Egyptian patients.

The loss of the monofilament 10g test constitutes another significant risk factor for DFU in the present study at p = 0.000. 76% of the elderly patient with DFUs lost the Monofilament 10g test. The current finding agrees with Abdissa et al. (2020), who reported that diabetic foot ulcers were 11.2 times more likely to develop in participants with peripheral neuropathy. Likewise, Cardoso et al. (2019) demonstrated that more than half of the participants in their study had poor scores on the monofilament exam. Also, Assaad-Khalil et al. (2014) found monofilament insensitivity a highly significant risk factor associated with diabetic foot complications. **Table (4);**

Regarding the pattern of DFU among the studied elderly with DFUs group and based on Meggitt–Wagner's classification, nearly half of the diabetic foot ulcers in the study group classify as superficial ulcers (stage 1) and limited gangrene to part of the foot (stage 4) represents one-quarter of the studied ulcers. This result came in partial agreement with Gershater & Apelqvist (2021), who studied the probability of healing among Swedish elderly patients with diabetic foot ulcers and illustrated that more than half of the studied diabetic foot ulcer cases were located at stage 1 while disagreeing with the current study in that the second largest group of diabetic foot ulcers were deeper ulcers that reached tendon, bone, or joint capsule (stage 2). Interpretation of these differences can be early medical advice-seeking behavior, early diagnosis, and early treatment, which prevent further complications based on economic and educational variances between the studied samples. **Table (5)**

Conclusion

The current study concluded that: illiteracy, rural residence, non-work, smoking, increasing body mass index, callus, cracked skin, foot deformity, uncontrolled blood glucose level, previous history of DFUs, absent distal pulse, loss of protective sensation, and lack of proper foot care all were of the most risk factors for DFUs among elderly diabetic patients.

Recommendation

In the light of the current study, findings recommended that:

- Assessment of the at-risk diabetic elderly regularly for early detection and appropriate management of DFU.
- Provide regular educational programs in all health care centers about foot care and risk factors of DFU for elderly patients with diabetes.
- Establish a database for all elderly diabetic patients to facilitate regular follow-up.

Abbreviations

DM, Diabetes Mellitus; BMI, Body Mass Index; DFU, Diabetic Foot Ulcer, IDF, International

Diabetes Federation

Acknowledgment

The authors appreciate the cooperation of the study participants as well as medical and nursing staff of the internal medicine and diabetic foot clinics.

Conflict of Interest

The researchers had no conflict of interest in the present study and no external funds.

References

Abd-Allah, E., Hagrass, S., & Mohamed, S. S. (2016): Diabetic foot among Elderly at Zagazig City: Risk factors and foot care practices. American Journal of Nursing Science, 5(1), 22-http://www.sciencepublishinggroup.com/j/ajns

Abdissa, D., Adugna, T., Gerema, U., & Dereje, D. (2020): Prevalence of diabetic foot ulcer and associated factors among adult diabetic patients on follow-up clinic at Jimma Medical Center, Southwest Ethiopia, 2019: an institutional-based cross-sectional study. Journal of diabetes research, 2020. https://downloads.hindawi.com/journals/jdr/2020/4106383.pdf

Adem, A. M., Andargie, A. A., Teshale, A. B., & Wolde, H. F. (2020): Incidence of diabetic foot ulcer and its predictors among diabetes mellitus patients at Felege Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia: a retrospective follow-up study. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 13, 3703. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7569060/

Al Kafrawy, N. A. E. F., Mustafa, E. A. A. E. A., Abd El-Salam, A. E. D., Ebaid, O. M., & Zidane, O. M. A. (2014): Study of risk factors of diabetic foot ulcers. Menoufia Medical Journal, 27(1), 28. https://www.mmj.eg.net/temp/MenoufiaMedJ27128-6253022_172210.pdf

Alexiadou, K., & Doupis, J. (2012): Management of diabetic foot ulcers. Diabetes Therapy, 3(1), 1-15. https://link.springer.com/article/10.1007/s13300-012-0004-9

Ali, M. M., & Ghonem, S. E. (2019): Effectiveness of health education program regarding foot self-care on risk for developing foot ulcer among patients with diabetes. American Journal of Nursing, 8(5), 280-93. https://fnur.stafpu.bu.edu.eg/Medical%20and%20Surgical%20%20Nursing/1876/.pdf

Al-Rubeaan, K., Al Derwish, M., Ouizi, S., Youssef, A. M., Subhani, S. N., Ibrahim, H. M., & Alamri, B. N. (2015): Diabetic foot complications and their risk factors from a large retrospective cohort study. PloS one, 10(5),e0124446.https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0124446

Alsaleh, F. M., AlBassam, K. S., Alsairafi, Z. K., & Naser, A. Y. (2021): Knowledge and practice of foot self-care among patients with diabetes attending primary healthcare centres in Kuwait: A cross-sectional study. Saudi Pharmaceutical Journal, 29(6), 506-515: https://www.sciencedirect.com/science/article/pii/S1319016421000633 (accessed: 20 July 2022)

Amissah and M. Amoako-Boateng, (2014): Prevalence of diabetes mellitus complications among people with type 2 diabetes mellitus attending a teaching hospital in Ghana: a clinical audit," International Journal of Science and Research, vol. 3, no. 11, pp. 2104–2109. https://scholar.google

Assaad-Khalil, S. H., Zaki, A., Rehim, A. A., Megallaa, M. H., Gaber, N., Gamal, H., & Rohoma, K. H. (2015): Prevalence of diabetic foot disorders and related risk factors among Egyptian subjects with diabetes. Primary care diabetes, 9(4), 297-303.https://www.researchgate.net/profile/Noha-Egyptian-subjects-with-diabetes.pdf

Brito, D., Correia, H., Ferreira, A. V., Jorge, S., & Caniço, H. (2017): Doença arterial periférica em doentes com diabetes nos cuidados de saúde primários:

estudo observacional. Revista Portuguesa de Medicina Geral e Familiar, 33(4), 290-6.

Camilleri A, Gatt A, Formosa C. (2020). Inter-rater reliability of four validated diabetic foot ulcer classification systems. J Tissue Viability. 29: 284-290. https://www.sciencedirect.com/science/article/abs/pii/S0965206X20301170?via%3Dihub

Cardoso, H. C., Zara, A. L. D. S. A., Rosa, S. D. S. R. F., Rocha, G. A., Rocha, J. V. C., Araújo, M. C. E. D., ... & Mrué, F. (2019). Risk factors and diagnosis of diabetic foot ulceration in users of the Brazilian Public Health System. Journal of diabetes research. .https://www.hindawi.com/journals/jdr/2019/5319892/

International Diabetes Federation, IDF Diabetes Atlas 8th Edition (2017): global fact sheet. https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figur

Dòria M, Rosado V, Pacheco LR, Hernández M, Betriu A, Valls J , Franch-Nadal J, Fernández E, and Mauricio D.(2016): Prevalence of Diabetic Foot Disease in Patients with Diabetes Mellitus under Renal Replacement Therapy in Lleida, Spain. Biomed Res Int;2016:1-17. https://doi.org/10.1155/2016/7217586

Eleftheriadou I, Kokkinos A, Liatis S. (2019):Atlas of the Diabetic Foot. 3rd ed. Malden, MA: Wiley-Blackwell. https://www.dovepress.com/getfile.php?fileID=73650

El-Sedawy, D. S. E. D., & Behairy, A. S. (2016): Impact of Preventive Diabetic Foot Nursing Intervention on Foot Status among Patients with Diabetes. Journal of Health, Medicine and Nursing, 25(1), 104-114. https://www.researchgate.net/profile/Dalia-El-Sedawy/publication/333429215.pdf

Fawzy, M. S., Alshammari, M. A., Alruwaili, A. A., Alanazi, R. T., Alharbi, J. A., Almasoud, A. M. R., ... & Toraih, E. A. (2019): Factors associated with diabetic foot among type 2 diabetes in Northern area of Saudi Arabia: a descriptive study. BMC research notes, 12(1), 1-7. https://bmcresnotes.biomedcentral.com/articles/10.1186/s13104-019-4088-4

Fernández-Torres, R., Ruiz-Munoz, M., Perez-Panero, A. J., Garcia-Romero, J. C., & Gónzalez-Sánchez, M. (2020): Clinician assessment tools for patients with diabetic foot disease: a systematic review. Journal of clinical medicine, 9(5), 1487. ; doi:10.3390/jcm9051487

Galal, Y. S., Khairy, W. A., Taha, A. A., & Amin, T. T. (2021): Predictors of Foot Ulcers Among Diabetic Patients at a Tertiary Care Center, Egypt. Risk Management and Healthcare Policy, 14, 3817. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8458748/

Gershater, M. A., & Apelqvist, J. (2021): Elderly individuals with diabetes and foot ulcer have a probability for healing despite extensive comorbidity and dependency. Expert review of pharmacoeconomics & outcomes research, 21(2), 277-284. https://www.tandfonline.com/doi/pdf/10.1080/14737167.2020.1773804

International Diabetes Federation(2022): IDF Diabetes Atlas, 10th edn. Brussels, Belgium. https://diabetesatlas.org/atlas/tenth-edition/

Jeyaraman K, Berhane T, Hamilton M, (2019):Mortality in patients with diabetic foot ulcer: A retrospective study of 513 cases from a single Centre in the Northern Territory of Australia. BMC Endocr Disord.;19:1. https://doi.org/10.1186/s12902-018-0327-2

Jia, H., Wang, X., & Cheng, J. (2022): Knowledge, Attitudes, and Practices Associated With Diabetic Foot Prevention Among Rural Adults With Diabetes in North China. Frontiers in Public Health, 10. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9163951/

Jiang, Y., Wang, X., Xia, L., Fu, X., Xu, Z., Ran, X., ... & Li, Q. (2015): A cohort study of diabetic patients and diabetic foot ulceration patients in China. Wound Repair and Regeneration, 23(2), 222-230. https://onlinelibrary.wiley.com/doi/pdf/10.1111/wrr.12263

Kamel, S. R., Hamdy, M., Abo Omar, H. A., Kamal, A., Ali, L. H., & Abd Elkarim, A. H. (2015): Clinical diagnosis of distal diabetic polyneuropathy using neurological examination scores: correlation with nerve conduction studies. Egyptian Rheumatology and Rehabilitation, 42(3), 128-136. https://erar.springeropen.com/track/pdf/10.4103/1110-161X.163945.pdf

Kasiya MM, Mang'anda GD, Heyes S, (2017): The challenge of diabetic foot care: review of the literature and experience at queen Elizabeth central Hospital in Blantyre, Malawi. Malawi Med J.;29:218-223. https://scholar.google.

Khan, Y., Khan, M. M., & Farooqui, M. R. (2017): Diabetic foot ulcers: a review of current management. International Journal of Research in Medical Sciences, 5(11), 4683-4689. DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20174916

Li, Z., Zhang, Z., Ren, Y. (2021): Aging and age related diseases: from mechanisms to therapeutic strategies. Biogerontology 22, 165–187. https://doi.org/10.1007/s10522-021-09910-

Liaofang Wu, Qian Hou, Qiuhong Zhou, Fang Peng.(2015): Prevalence of risk factors for diabetic foot complications in a Chinese tertiary hospital. Int J Clin Exp Med 2015;8(3):3785-3792. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4443109/

Mariam, T. G., Alemayehu, A., Tesfaye, E., Mequannt, W., Temesgen, K., Yetwale, F., & Limenih, M. A. (2017): Prevalence of diabetic foot ulcer and associated factors among adult diabetic patients who attend the diabetic follow-up clinic at the University of Gondar Referral Hospital, North West Ethiopia, 2016: institutional-based cross-sectional study. Journal of diabetes research. https://downloads.hindawi.com/journals/jdr/2017/2879249.pdf

Marzouk, D., El-Hilaly, R. A., Sos, D. G., & Fakkar, N. (2017): Foot care knowledge assessment among type 2 diabetic patients attending three family medicine centers in Cairo. The Egyptian Journal of Community Medicine, 35(3), 43-53. https://ejcm.journals.ekb.eg/article_4098_3bdb69bf88951c634ed7dada7b398ab1.pdf

Meijer, J. W. G., Smit, A. J., Sonderen, E. V., Groothoff, J. W., Eisma, W. H., & Links, T. P. (2002): Symptom scoring systems to diagnose distal polyneuropathy in diabetes: the Diabetic Neuropathy Symptom score. Diabetic Medicine, 19(11), 962-965. https://onlinelibrary.wiley.com/doi/pdf/10.1046/j.1464-5491.2002.00819.x

Mekonen, E. G., & Gebeyehu Demssie, T. (2022): Preventive foot self-care practice and associated factors among diabetic patients attending the university of Gondar comprehensive specialized referral hospital, Northwest Ethiopia, 2021. BMC Endocrine Disorders, 22(1), 1-11. https://link.springer.com/article/10.1186/s12902-022-01044-0

Moussa, M., & Gida, N. (2017): Effect of Foot Self-care Program among Diabetic Elderly Adults in Geriatrics Home. IOSR Journal of Nursing and Health Science (IOSR-JNHS), 6(3), 41-51. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Effect+of+Foot+Self-care+Program+among+Diabetic+Elderly+Adults+in+Geriatrics+Home.+I&btnG=

Obaid, H. A. A., & Eljedi, A. (2015): Risk factors for the development of diabetic foot ulcers in Gaza Strip: a

case-control
study. Age, 34,https://www.researchgate.net/profile/Hassan-Abu-Obaid/publication/Diabetic-Foot-Ulcers-in-Gaza-Strip-A-Case-Control-Study.pdf

Rakesh Sharma, Rajesh Kapila, Ashwani K Sharma, Jagsir Mann, (2016): Diabetic Foot Disease—Incidence and Risk Factors:A Clinical Study. The Journal of Foot and Ankle Surgery (Asia-Pacific), January-June 2016;3(1):41-46 10.5005/jp-journals-10040-1046
https://www.jfasap.com/doi/JFASAP/pdf/10.5005/jp-journals-10040-1046

Refaat, D. O. Bahaa El Din, R. M., & Aboelezz, G. A., (2021): Assesment of diabetic foot Risk factor among patients with diabetes attending to zagazig university hospital. Zagazig University Medical Journal, 27(1), 155-165. https://journals.ekb.eg/article_44855_317c0ccada72a6e5e6e6cee46d427772.pdf

Salama, A. A., & Zorin, S. K. (2018). Risk factors of diabetic foot in type 2 diabetic patients, Menoufia University Hospital, Egypt. Egypt J Comm Med, 36(1), 87-98.
https://ejcm.journals.ekb.eg/article_11054_b469564cb93e3a38a502979927bc7527.pdf

Schaper NC, Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA.(2020): Practical guidelines on the prevention and management of diabetic foot disease
(IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1). https://doi.org/10.1002/dmrr.3266

Sharoni,SKA., Rahman,HA.,Minhat,HS., Ghazali,SS&Ong, MHA.(2017): A selfefficacy education programme on foot self-care behaviour among older patients with diabetes in a public long term care institution, Malaysia: a Quasi experimental Pilot Study .BMJ ;7:e014393. https://bmjopen.bmj.com/content/7/6/e014393.abstract

Tolossa, T., Mengist, B., Mulisa, D., Fetensa, G., Turi, E., & Abajobir, A. (2020): Prevalence and associated factors of foot ulcer among diabetic patients in Ethiopia: a systematic review and meta-analysis. BMC Public Health, 20(1), 1-14. https://link.springer.com/article/10.1186/s12889-019-8133-y

Tuglo, L. S., Nyande, F. K., Agordoh, P. D., Nartey, E. B., Pan, Z., Logosu, L., ... & Chu, M. (2022): Knowledge and practice of diabetic foot care and the prevalence of diabetic foot ulcers among diabetic patients of selected hospitals in the Volta Region, Ghana. International Wound Journal, 19(3), 601-614. https://onlinelibrary.wiley.com/doi/pdf/10.1111/iwj.13656

van Netten JJ, Bus SA, Apelqvist J, Lipsky BA, Hinchliffe RJ, Game F, (2019):Definitions and criteria for diabetic foot disease. Diabetes Metab Res Rev. 2019:e3268. https://doi.org/10.1002/dmrr.3268.

Wagner FW. (1981): The Dysvascular foot: A system for diagnosis and treatment. Foot Ankle. 1981 Feb;2(2):64–122. https://journals.sagepub.com/doi/pdf/10.1177/107110078100200202

Yazdanpanah, L., Shahbazian, H., Nazari, I., Arti, H. R., Ahmadi, F., Mohammadianinejad, S. E., ... & Hesam, S. (2018): Incidence and risk factors of diabetic foot ulcer: a population-based diabetic foot cohort (ADFC study)—two-year follow-up study. International journal of endocrinology. doi.org/10.1155/2018/7631659
https://downloads.hindawi.com/journals/ije/2018/7631659.pdf

Yimam, A., Hailu, A., Murugan, R., & Gebretensaye, T. (2021): Prevalence of diabetic foot ulcer and associated factors among diabetic patient in Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. International Journal of Africa Nursing Sciences, 14, 100285.https://www.sciencedirect.com/science/article/pii/S2214139121000081

Zhang, P., Lu, J., Jing, Y., Tang, S., Zhu, D., & Bi, Y. (2017): Global epidemiology of diabetic foot ulceration: a systematic review and meta-analysis. Annals of medicine, 49(2), 106-116. https://www.tandfonline.com/doi/pdf/10.1080/07853890.2016.123193