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Original Article

Clinical and Behavioral Determinants of Active Diabetic Foot Ulcers: A Cross-Sectional Analysis from Diwaniyah, Iraq

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Abstract

Background Diabetic foot ulceration (DFU) is a severe, costly complication of diabetes mellitus carrying high morbidity and amputation risks. Identifying local predictors is vital for prevention.

Objective To estimate active DFU point prevalence and identify independent clinical and behavioral predictors among diabetic patients in Diwaniyah, Iraq.

Methods A hospital-based cross-sectional study screened 883 diabetic patients to estimate point prevalence. An analytical sample of 170 participants (46 cases, 124 controls) was enrolled using purposive sampling. Factors were analyzed using bivariate tests and multivariable logistic regression.

Results Active DFU point prevalence was 6.57% (58/883). Bivariate analysis showed significant associations with male sex (P=0.003), age >60 years (P<0.001), neuropathy, previous DFU, deformity, fungal infection, and amputation (all P<0.001). Multivariable regression identified four independent predictors: previous DFU (AOR=19.41, 95% CI: 6.02-62.53, P<0.001), neuropathy (AOR=18.12, 95% CI: 3.53-93.07, P=0.001), HbA1c (AOR=1.63, 95% CI: 1.04-2.56, P=0.035), and self-care practices which had a strong protective effect (AOR=0.54, 95% CI: 0.41-0.72, P<0.001).

Conclusion Neuropathy, prior DFU, poor self-care, and high HbA1c independently predict active DFU. Routine clinical screening with 10-g monofilaments and structured foot self-care education in simple local language are recommended to prevent amputations.

Keywords Diabetic Foot; Peripheral Neuropathies; Glycated Hemoglobin A.

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Introduction

The global surge in diabetes mellitus is a major public health emergency. In 2021, the International Diabetes Federation (IDF) estimated that 537 million adults were living with the disease, a number expected to hit 783 million by 2045, with low- and middle-income countries bearing the heaviest burden.[1] Among the many complications of chronic, poorly managed blood glucose, diabetic foot ulcers (DFUs) are some of the most destructive and expensive, yet they are largely preventable. Defined as full-thickness skin wounds below the ankle, DFUs develop from a combination of nerve damage, peripheral arterial disease (PAD), and minor mechanical trauma. Around 19% to 34% of diabetic patients will experience a foot ulcer in their lifetime, and these wounds are responsible for 40 to 70% of all non-traumatic lower-limb amputations globally.[2,3]

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The path leading to a diabetic foot ulcer is complex. Persistent high blood sugar causes progressive nerve and blood vessel damage, resulting in symmetric peripheral neuropathy and vascular disease. When sensorimotor neuropathy destroys the protective sensation in the feet, minor cuts, friction from tight shoes, or accidental burns go unnoticed. Meanwhile, autonomic nerve damage stops sweating, leaving the skin dry and cracked. This cracked skin acts as an entry point for bacteria and fungi. At the same time, peripheral artery disease limits blood flow, which delays healing and weakens the foot's ability to fight off infection. Without early intervention, minor surface wounds can quickly turn into deep tissue death, bone infections, or life-threatening sepsis. This progression often ends in amputation, heavily reducing patient survival and quality of life.[4,9,10]

We believe that risk factors for DFUs in Al-Diwaniyah, Iraq, are different from other places. Al-Diwaniyah is a historically under-resourced governorate with a largely rural population, lower literacy rates, and a high concentration of farming and manual labor. Working in fields and workshops exposes these individuals to frequent minor foot injuries and mechanical trauma, often worsened by the cultural habit of walking barefoot or wearing inadequate footwear. On top of that, local patients face severe systemic hurdles. An overwhelming 95.7% of local DFU patients report struggle with healthcare costs, public transport is limited, and the entire province lacks a specialized, multidisciplinary diabetic foot clinic. Because of these barriers, patients in Diwaniyah are highly likely to seek medical help very late, often presenting with advanced wounds. They also suffer from severe gaps in foot-care knowledge, with 0% of the local DFU cohort having ever received formal foot-care education. These conditions make behavioral risk factors exceptionally influential. Designing practical, low-cost screening and educational programs requires localized, solid evidence that matches this specific clinical and social environment.

Methods

This hospital-based cross-sectional study was conducted at the Diabetes and Endocrinology Center (DEC) of Al-Diwaniyah Teaching Hospital, the main specialty referral hub for diabetic patients in the Al-Diwaniyah Governorate, Iraq. We collected data between February 1 and April 30, 2026, in two parallel phases. The first phase involved a total enumeration of all attending diabetic patients to calculate the point prevalence of active ulcers. The second phase used an analytical comparative design with a 1:2.7 case-to-control ratio to investigate the independent clinical and behavioral risk factors driving ulceration.

Operational Definitions

Active Diabetic Foot Ulcer (Active DFU): A full-thickness skin wound located below the ankle (such as on the sole, top of the foot, or between the toes) in a patient diagnosed with diabetes. The wound must show clear clinical signs of active ulceration, fluid drainage, or non-healing tissue during our clinical exam or be officially documented as active in the medical records at enrolment.

Inactive/ Healed Diabetic Foot Ulcer (Inactive DFU): Complete skin closure (epithelialization) of a previous diabetic foot ulcer, showing no fluid drainage, skin breaks, or active clinical signs of

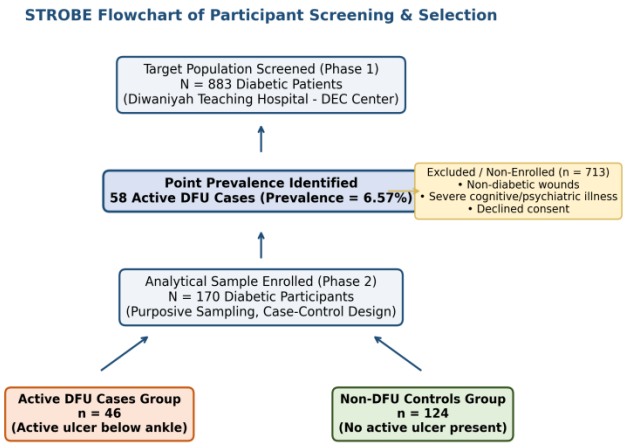


Figure 1 Flowchart of the study participant screening, selection, and enrolment pathway (STROBE format).

ulceration during the exam. Patients with healed ulcers and no active wounds were placed in the non-DFU comparison group, though their history was captured under the "previous DFU history" clinical variable.

To determine the minimum sample size needed for a statistically sound comparison, we used Cochran's sample size formula for cross-sectional study designs:

$$n = \frac{Z^2 \times p \times (1-p)}{d^2}$$

Where: n= target minimum sample size; Z= 1.96 (95% confidence interval); p= expected DFU prevalence in regional hospital cohorts (estimated at 9.8% or 0.098 based on Middle Eastern epidemiological data by Altoijry et al., 2021); d= margin of error, set at 0.05 (5%).

Substituting the values into the equation: n = [(1.96)² x 0.098 x (1 - 0.098)] / (0.05)² = 135.8 ≈ 136 patients. Allowing for a 10% non-response or incomplete data rate, we adjusted our target sample size to a minimum of 150 participants. Our final enrolled sample of 170 individuals (46 active DFU patients and 124 controls) easily exceeded the 136-patient minimum, ensuring strong statistical power. For the multivariable logistic regression, having 46 active DFU cases satisfied the established "10 events per variable" (EPV) rule of thumb for the 4 independent predictors in our final model, minimizing the risk of model over-fitting.

We included patients who met the following criteria: (1) a confirmed diagnosis of Type 1 or Type 2 diabetes with active registration at Al-Diwaniyah DEC; (2) age 18 or older; and (3) formal consent to participate. Patients in the case group also had to present with a clinically verified active foot ulcer. We excluded patients with: (1) wounds not caused by diabetes (such as pure physical trauma or non-diabetic venous ulcers); (2) cognitive deficits, psychiatric conditions, or severe illness that would make a clinical interview unreliable; or (3) those who chose to withdraw their consent.

We used three validated instruments to collect our data. First, we conducted clinical interviews using a structured questionnaire that covered seven domains: demographics, socioeconomic and educational status, diabetes history, complications, lifestyle, foot self-care routines (including hygiene, nail cutting, and shoes), and psychosocial factors. Second, we assessed peripheral neuropathy objectively using a standardized 10-gram Semmes-Weinstein Monofilament (SWM) test. Loss of protective sensation (LOPS) was recorded if a patient failed to feel the monofilament at standard points on the sole of either foot with their eyes closed. Third, we measured weight (kg) and height (m) in the clinic using calibrated medical scales and a stadiometer to calculate Body Mass Index (BMI). Glycated hemoglobin (HbA1c) and other lab values were retrieved from patient medical charts or coordinated directly with the DEC laboratory.

The Institutional Review Board and Research Ethics Committee at Al-Furat Al-Awsat Technical University reviewed and approved our study protocol (REC approval: ATU-HC-2026-04). We also obtained administrative clearance from the Al-Diwaniyah Health Directorate and Diwaniyah Teaching Hospital. All participants provided written or verbal informed consent before enrollment. We maintained strict confidentiality and anonymized all patient data during analysis.

We analyzed our data using IBM SPSS Statistics version 26. We first used descriptive statistics to summarize patient characteristics. For bivariate analysis, we used Pearson's chi-square or Fisher's exact tests to explore relationships between categorical variables and active DFU status. We compared self-care and knowledge scores between groups using independent t-tests. Any variable showing a significant association ($P< 0.05$) in the bivariate stage was entered into a multivariable binary logistic regression model. This allowed us to calculate adjusted odds ratios (AOR) with 95% confidence intervals (CI). We evaluated the calibration and fit of our final regression model

using the Hosmer-Lemeshow test and Nagelkerke's R^2 coefficient.

Result

Screening 883 diabetic patients who visited the Diwaniyah DEC during the study period revealed 58 active diabetic foot ulcers, which translates to a point prevalence of 6.57%. For the analytical phase, we enrolled 170 participants: 46 with active ulcers (cases) and 124 without (controls), maintaining a group ratio of 1:2.7.

Our analytical sample had a mean age of 57.8 years. Bivariate analysis showed that both age and sex were strongly linked to having an active ulcer. Patients over the age of 60 made up 60.9% (n=28) of the DFU group, but only 29.8% (n=37) of the non-DFU group (χ^2 = 16.261, *P*<0.001). Men were also disproportionately affected, representing 76.1% (n=35) of DFU cases compared to 49.2% (n=61) of the controls (χ^2 = 8.809, *P*=0.003). We found no significant links for geographic residence or marital status. From a socioeconomic standpoint, lower literacy was associated with active DFU (χ^2=13.213, *P*=0.040); 19.6% of DFU patients had no formal schooling, compared to 6.5% of non-DFU patients. Job type also mattered (χ^2 = 12.348, *P*=0.030), with retired individuals making up 43.5% of the DFU group.

Table 2 outlines the bivariate connections between medical history, clinical complications, and DFU status. Objective monofilament testing revealed that 95.7% (n=44) of DFU patients had peripheral neuropathy, compared with only 23.4% (n=29) of the controls. This made nerve damage the strongest bivariate clinical predictor (χ^2 = 68.595, *P*<0.001). Foot deformities (84.8% vs. 16.1%; χ^2=66.791, *P*<0.001) and a history of previous foot ulcers (63.0% vs. 6.5%; χ^2=59.828, *P*<0.001) were also highly significant. Other factors clearly linked to active wounds included a history of lower-limb amputation (26.1% vs. 2.4%; χ^2=20.513, *P*<0.001),

Table 1 Sociodemographic characteristics of diabetic patients with and without active diabetic foot ulcers (n = 170).

Sociodemographic Variable	*Categories*	*DFU Present n=46 (%)*	*DFU Absent n=124 (%)*	*P-value*
Sex	Male	35 (76.1%)	61 (49.2%)	χ^2 = 8.809;
	Female	11 (23.9%)	63 (50.8%)	p = 0.003 (S)*
Age Group	< 50 years	3 (6.5%)	35 (28.2%)	χ^2 = 16.261;
	50–60 years	15 (32.6%)	52 (41.9%)	p < 0.001 (S)*
	> 60 years	28 (60.9%)	37 (29.8%)	
Residence	Urban	12 (26.1%)	31 (25.0%)	χ^2 = 0.000;
	Rural	34 (73.9%)	93 (75.0%)	p = 1.000 (NS)
Educational Level	Low (Illiterate - Primary)	38 (82.6%)	78 (62.9%)	χ^2 = 13.213;
	High (Intermediate+)	8 (17.4%)	46 (37.1%)	p = 0.040 (S)*

Note. * Statistically significant at p < 0.05. NS = Non-significant; S = Significant; χ^2 = Chi-Square statistic.

Table 2 Clinical Complications and Medical History as Determinants of Active DFU (N=170).

Clinical Characteristic	*Categories*	*DFU Present n=46 (%)*	*DFU Absent n=124 (%)*	*Statistical Test (χ^2) / p-value*
Peripheral Neuropathy	Present	44 (95.7%)	29 (23.4%)	χ^2 = 68.595;
	Absent	2 (4.3%)	95 (76.6%)	p < 0.001 (S)*
Previous DFU	Positive History	29 (63.0%)	8 (6.5%)	χ^2 = 59.828
	Negative History	17 (37.0%)	116 (93.5%)	p < 0.001 (S)*
Foot Deformity	Present	39 (84.8%)	20 (16.1%)	χ^2 = 66.791
	Absent	7 (15.2%)	104 (83.9%)	p < 0.001 (S)*
Fungal Infection	Present	25 (54.3%)	14 (11.3%)	χ^2 = 32.794
	Absent	21 (45.7%)	110 (88.7%)	p < 0.001 (S)*
Previous Amputation	Positive History	12 (26.1%)	3 (2.4%)	χ^2 = 20.513
	Negative History	34 (73.9%)	121 (97.6%)	p < 0.001 (S)*

Note. * Statistically significant at p < 0.05. NS = Non-significant; S = Significant; χ^2 = Chi-Square statistic.

Table 3 Multivariable Binary Logistic Regression Model for Independent Predictors of Active DFU (N = 170).

Independent Predictor	*Unadjusted B*	*SE*	*Adjusted OR (95% CI)*	*P-value*
Peripheral Neuropathy (LOPS)	2.897	0.835	18.12 (3.53 – 93.07)	0.001 (S)*
Previous DFU (Positive History)	2.966	0.596	19.41 (6.02 – 62.53)	< 0.001 (S)*
Foot Care Practice Score (1-pt increase)	-0.613	0.145	0.54 (0.41 – 0.72)	< 0.001 (S)*
HbA1c level (1% increase)	0.488	0.231	1.63 (1.04 – 2.56)	0.035 (S)*

* Statistically significant at $P<0.05$. Hosmer-Lemeshow $\chi^2=5.493$, df=8, $P=0.704$; Nagelkerke $R^2 = 0.745$.
B = unadjusted regression coefficient; SE = standard error; AOR = adjusted odds ratio; CI = confidence interval

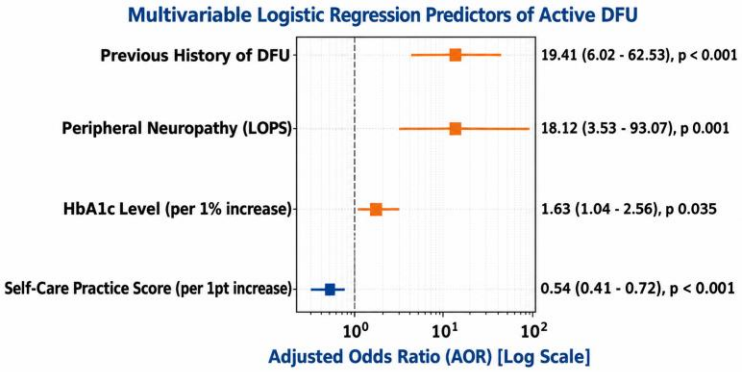


Figure 2 Forest plot of the multivariable binary logistic regression model showing adjusted odds ratios (AOR) with 95% confidence intervals (CI) for independent predictors of active DFU on a logarithmic scale.

fungal foot infections (54.3% vs. 11.3%; $\chi^2=32.794$, $P<0.001$), and abnormal blood lipids (60.9% vs. 40.3%; $\chi^2=4.907$, $P=0.027$). High blood pressure and BMI scores did not show significant differences between groups. Looking at continuous metrics, patients with active ulcers had lived with diabetes much longer (14.28±6.07 years vs. 10.43±6.64 years; $t=3.421$, $P=0.001$) and presented with significantly higher HbA1c levels (10.02±1.86% vs. 8.99±1.95%; $t=3.145$, $P=0.002$).[4,7,8]

We built a multivariable logistic regression model to isolate the independent predictors of active DFUs, adjusting for all demographic, medical, and behavioral factors that were significant in the bivariate tests. Four variables remained as strong, independent predictors of active ulcers **(Table 3)**. Peripheral neuropathy (LOPS) was associated with an 18-fold increase in active DFU odds (AOR=18.12; 95% CI: 3.53-93.07; $P=0.001$). A history of previous ulcers was the strongest risk factor in our model, associated with a 19-fold increase in risk (AOR=19.41; 95% CI: 6.02-62.53; $P<0.001$). Each 1% increase in HbA1c levels boosted the odds of an active ulcer by 63% (AOR= 1.63; 95% CI: 1.04-2.56; $P=0.035$). On the other hand, the aggregated foot self-care practice score had a powerful protective effect: each 1-point improvement in the self-care score reduced the odds of developing an active DFU by 46% (AOR = 0.54; 95% CI: 0.41–0.72; $P<0.001$). The predictive model fit our data exceptionally well (Hosmer-Lemeshow $\chi^2=5.493$, df=8, $P=0.704$; Nagelkerke $R^2=0.745$).[4,7,8,11]

This research offers some of the first localized, analytical data on diabetic foot complications in Al-Diwaniyah, Iraq. Our calculated point prevalence of active ulcers (6.57%) is very close to the global pooled estimate of 6.3% reported by Fan et al. (2025) in a massive meta-analysis of over 60 studies spanning 52 countries.[7] It is slightly higher than the hospital rate of 4.1% observed in China by Wang et al. (2022), but falls below the 8.3% rate reported in South Africa by Ntuli (2025).[4,8] These minor regional differences are normal and usually stem from variations in who is being screened, local healthcare access, and the exact clinical criteria used to define an active wound.

Comparing our results to older Iraqi research reveals an interesting gap. Mansour (2009) recorded a much lower DFU prevalence of 2.7% in Basra, in southern Iraq.[5] There are two clear scientific reasons for this difference. First, Mansour's study was published over fifteen years ago. Since then, the diabetes epidemic in Iraq has grown significantly, and microvascular complications have increased alongside it. Second, Mansour recruited participants from primary care clinics, whereas our work was based at a specialized tertiary DEC. Specialty centers naturally attract patients with advanced,

long-standing, or poorly managed diabetes. This difference in clinical settings explains why we observed a higher rate of active ulcers (6.57%).

Our multivariable model confirmed that nerve damage is a dominant clinical driver of foot ulcers, with neuropathy increasing the odds of an active wound 18-fold.[4] This aligns perfectly with what we know about diabetic pathology. When a patient loses protective sensation, they enter a pain-free sensory void. Minor mechanical stress or injury-like stepping on a sharp object or walking on hot pavement-goes completely unnoticed. The damage continues until a deep ulcer forms. This vulnerability is heavily compounded if a patient has a history of previous foot ulcers (adjusted OR=19.41). These patients are caught in a recurring cycle because healed ulcers leave scar tissue, damaged blood vessels, and chronic sensory deficits that create permanent risk.[2,11] On top of that, persistent high blood sugar-evident in elevated HbA1c levels-damages microvascular networks, slows down collagen production, and weakens the immune system, leaving the foot highly vulnerable to rapid infections.[4,10]

Importantly, our data highlight that behavioral choices are highly modifiable risk factors. Higher scores on our foot-care practice scale showed a massive protective effect (adjusted OR=0.54). This demonstrates that proper foot hygiene, wearing protective shoes, and avoiding walking barefoot can slash DFU risk by 46% for every point increase on the scale-even for patients with severe nerve damage.[11] Unfortunately, the baseline behavioral risk in Al-Diwaniyah is extremely high. Not a single patient (0%) in our active DFU group had ever received formal foot-care education. This has led to widespread and dangerous deficits in daily self-care routines. This striking gap reveals an urgent, unmet need for structured, local educational interventions.

Study Limitations

This study has several methodological limitations that deserve attention. First, its cross-sectional design means we cannot establish direct temporal sequences or make definitive claims about cause and effect. Second, our use of a non-probability, purposive sampling approach at a single specialty referral center means these findings might not represent all diabetic populations in Al-Diwaniyah, especially those in distant, rural communities who cannot easily access tertiary care. Third, our measures of self-care and lifestyle were self-reported, which introduces the possibility of recall bias or socially desirable answers. Finally, because we could not perform objective vascular assessments like Doppler ultrasound or ankle-brachial index tests, we could not fully account for how peripheral arterial disease might have contributed to these wounds.

Conclusions

Active foot ulcers represent a major, yet largely preventable, public health problem in Iraq's Al-Diwaniyah Governorate, showing a point prevalence of 6.57%. This clinical burden is driven by specific medical complications—mainly peripheral nerve damage and previous ulceration—and is worsened by poor glycemic control and a lack of daily self-care. Although our cross-sectional design limits our ability to prove causation, the exceptionally strong, independent connections we found suggest that targeted local screenings and educational programs could significantly reduce diabetic foot complications in this region.

Recommendations

1. Standardize Bedside Screenings: Clinic teams must establish routine, mandatory foot checks at every visit. These screenings should use 10-gram Semmes-Weinstein monofilaments to catch early sensation loss, alongside visual checks for physical deformities, fungal infections, and dry or cracked skin.
2. Design Culturally Tailored Education: We recommend building and launching straightforward educational programs about daily self-care. All educational materials must be

written in simple, local Arabic and focus on daily practical tasks (such as inspecting the soles daily, cutting nails safely, wearing protective shoes, and seeking medical help immediately if skin changes occur). Including clear visual guides is essential to support patients who cannot read.

3. Build Follow-Up and Tracking Databases: The Al-Diwaniyah DEC should establish a structured registry to recall and monitor high-risk patients. Individuals with documented neuropathy, previous ulcers, or prior lower-limb amputations should be scheduled for quarterly clinical foot checks.
4. Offer Smoking Cessation Support: Since smoking is highly prevalent among active DFU patients in our cohort, offering tobacco cessation counseling and support within routine diabetes clinics is critical to prevent further damage to small and large blood vessels.
5. Address Financial and Social Barriers: Healthcare administrators and policymakers must develop social support mechanisms to lower out-of-pocket expenses for basic diabetes medications and appointments. This directly addresses the severe financial struggles that prevent local patients from managing their disease.
6. Expand Longitudinal Research: We recommend setting up longitudinal cohort studies in other Iraqi governorates. This research is needed to evaluate how cost-effective and clinically successful specialty foot clinics and patient recall databases are in reducing amputation rates over time.

Declaration of patient consent Authors certify that they have obtained all appropriate patient consent.

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Conflict of interest No conflict of interest.

Author's contribution

MFS: Substantial contribution to study design, acquisition and analysis of data and manuscript writing.

ANHA: Substantial contribution to concept and supervision, revising the manuscript critically for important intellectual content.

Every author has given final approval of the manuscript version to be published and agreed to be accountable for all aspects of the work.

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