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Diabetic Foot Risk and Ulcer Burden Among Community-Dwelling Adults With Diabetes: A Multisite Study

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ABSTRACT

Objective
The extent of clinical issues related diabetic foot risk within the community remains undetermined. This study, therefore, aims to examine the prevalence of diabetic foot neuropathy and associated clinical problems in a community context.

Methods
A multisite cross-sectional study was conducted in 2025 among adults with diabetes mellitus (DM) enrolled in the Prolanis program across four public health centers. A total of 130 eligible participants were included and completed standardized interviews and diabetic foot assessments. Diabetes-related foot conditions and Diabetic peripheral neuropathy (DPN) were assessed using a standardized diabetic foot examination protocol (using monofilament test) conducted by certified wound care. Data were analyzed and summarized descriptively; associations with neuropathy status were tested using appropriate bivariate tests.

Results
The mean age of participants was 54.97 ± 8.42 years. Neuropathy was identified in 80.16% of respondents. The most common clinical diabetic foot problems were onychomycosis (68.85%),

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dry skin (54.92%), dirty skin (40.98%), claw toe deformity (33.61%), hammer toe deformity (31.97%), and ingrown nails (28.69%). Significant associations with neuropathy status were observed for onychomycosis ($p = 0.026$), ingrown nails ($p = 0.041$), hammer toe deformity ($p = 0.010$), callus ($p = 0.026$), and corns ($p = 0.041$) than those without neuropathy.

Conclusion

This epidemiological study highlights the substantial burden of DPN and multiple diabetic foot problems among community-dwelling patients with DM enrolled in the Prolanis program, with onychomycosis, hammer toe, claw toe, dry skin, and poor foot hygiene identified as the most prevalent conditions.

Background

Diabetic Perhiperal Neuropathy (DPN), is one of the causes of diabetic foot ulcer (DFU) apart from peripheral angiopathy. Neuropathy leads to a loss of protective sensation, muscle atrophy, and deformity, causing unnoticed repetitive injuries (Aditya *et al.,* 2025). In the pathophysiology of DFU, DPN is major contributing factor (Volmer-Thole *et al.*, 2016). In the context of hyperglycemia, suppressed endothelial nitric oxide production contributes to microvascular atherosclerosis, inflammation, and abnormal intimal growth, while the combined effects of sensory, motor, and autonomic neuropathies promote callus formation, subcutaneous hemorrhage, and subsequent skin ulceration (Sen, Roy, & Khanna, 2022). The incidence of diabetic foot disease (DFD) was 12.81 and 24.97 per 1,000 person-years in the UK Biobank and CDR cohorts, respectively, with pooled estimates of 19.84 for peripheral neuropathy, 7.32 for foot ulcer, 2.56 for lower-extremity amputation, 2.56 for lower-extremity arterial disease, and 0.81 for gangrene (Xiang *et al.,* 2026). This condition is, of course, increasingly complex, considering that DPN not only leads to the occurrence of DFU, but also affects clinical problems of the diabetic foot.

In general, the clinical problems of diabetic foot affect the nails, foot shape, and skin. The condition of DPN leads to abnormalities in plantar pressure and repeated trauma that is not perceived by the patient, resulting in toenail damage (Yesudian, Nwabudike, & de Berker, 2022). Furthermore, neuropathy leads to dry skin, the formation of fissures and calluses, which increases the potential for pressure and trauma around the nail bed (Rastogi *et al.,* 2025). The prevalence of clinical problems in the diabetic foot includes dry skin (44%), infection (19.7%), and ingrown toenails (16.6%) (Rastogi *et al*., 2025). Other data show the variety of clinical problems of the diabetic foot, including peripheral hair loss in 185 (90.2%), xerosis in 168 (82%), anhydrosis in 162 (79%), plantar fissures in 136 (66.3%), and nail problems; common nail changes documented were onychomycosis in 165 (80.5%) and onychauxis in 53 (25.8%) (Dogiparthi *et al*., 2017). Unfortunately, this condition is still not adequately recognized by either healthcare workers or patients and their families, making this issue unreported.

Various studies have reported the prevalence of diabetic neuropathy in different regions. In Europe, the prevalence of DPN has been reported to be relatively low (23.3%) (Røikjer *et al.,* 2024). The results of a meta-analysis of community populations in Latin America and the Caribbean confirmed the predicted prevalence of neuropathy at 46.5% (Yovera-Aldanna *et al.,*

2021), which is consistent with the prevalence in Africa, 46% (95% CI:36.21–55.78%) (Shiferaw *et al.,* 2020), while in Asia, China reported a prevalence of 67.6% (Wang *et al.,* 2023). As one of the 10 countries with the largest number of DM patients, DPN data in Indonesia need to be investigated as baseline data for planning and preventive intervention. In Indonesia, a pooled meta-analysis involving 2,808 participants confirmed that the prevalence of DPN was 76.65% (95% CI 64.82-85.40) (Susanti *et al.,* 2025). Despite international recommendations for routine diabetic foot screening, early detection of DFU risk remains suboptimal. Delayed referral of patients with diabetes (Alsararatee *et al.,* 2025), inadequate healthcare infrastructure (Zhao & Wang, 2026), human resources (Zhao & Wang, 2026), and limited availability of screening equipment (Tan *et al.,* 2025) contribute to missed opportunities for identifying neuropathy and other early diabetic foot complications. As a result, many high-risk individuals remain undetected in community and primary care settings. Regrettably, the current data have not yet addressed clinical manifestations of diabetic foot, which serve as early indicators of DFU. Consequently, the extent of clinical issues within the community remains undetermined.

In Indonesia, non-communicable diseases (NCDs) represent a major challenge to the healthcare system, with diabetes mellitus (DM) being one of the leading contributors to morbidity and healthcare burden. To address this issue, the Indonesian government implemented the Community-Based Chronic Disease Management Program (Prolanis), a primary care–based initiative designed to promote preventive and health-promoting strategies for the management of DM and its complications. Previous studies have demonstrated that participation in Prolanis is associated with improved glycemic control (Alkaff *et al.,* 2021) and reduced serum cholesterol levels (Ahmad *et al.,* 2017). However, the program primarily focuses on monitoring metabolic outcomes, while the assessment of diabetes-related complications, particularly the risk of DFU, remains limited. Sinjai and Bantaeng Regencies, located in the southern region of South Sulawesi, are remote areas predominantly inhabited by the Bugis–Makassar population. Geospatial mapping of DM has identified these regencies as high-burden areas (Zainuddin *et al*., 2023), underscoring the importance of identifying DFU risk factors within these underserved communities. This study, therefore, aims to examine the prevalence of diabetic foot neuropathy and associated clinical problems in a community context.

Methods

Study Design and Respondents

This multisite cross-sectional study was conducted in 2025 at four community health centers (Puskesmas) located in the Sinjai and Bantaeng Regencies along the southern coast of South Sulawesi, Indonesia, where the prevalence of DM is relatively high (Zainuddin *et al.,* 2023). Sinjai and Bantaeng also were purposively selected as implementation sites for the Diabetes Foot Check-Up Program, a community-based initiative aimed at identifying individuals at risk of DFUs. Within each regency, two community health centers with the highest program participation rates were included in the study.

A total sampling approach was employed, whereby all eligible participants meeting the inclusion criteria (diagnosed with DM, able to respond to the study assessments, and having no history of major lower-limb amputation) were consecutively recruited during the data collection period in the two regencies. Consequently, the final sample of 130 participants represented the entire accessible population available at the selected study sites during the study period. As this was an observational cross-sectional study using total sampling, participant recruitment was based on the accessible population rather than a priori statistical power analysis.

DPN Assessement

DPN screening was conducted by a certified wound care nurse (SY, MZ) using the 10 g Semmes–Weinstein monofilament test at the three examination points recommended by the IWGDF (plantar hallux, metatarsal I, and IV) on both feet (Zantour *et al.,* 2020). Examination results were in the form of binary data (felt or not felt), with neuropathy status determined by the IWGDF criteria (if at least two points are not felt, then neuropathy is present) (Schaper *et al*., 2023).

Clinical problems of diabetic foot

The assessment of clinical issues related to diabetic foot is performed through visual inspection by a enterostomal theraph nurse (ETN) (SY) who possesses a doctoral degree and has over a decade of experience in diabetic foot evaluation. During the examination, digital photographs are taken to document the plantar and dorsal surfaces of the foot, which are subsequently subjected to visual analysis. Nail disorders are classified into Onychomycosis and Ingrown nail, while deformities are categorized as Hallux valgus, Charcot foot, Hammer toe, and Claw toe. Skin conditions identified include dirty skin, dry skin, callus, corn, and fissure (Yusuf *et al.,* 2016).

Data Analysis

Data were analyzed using statistical software IBM SPSS Statistics version 31.0 (IBM Corp., 2025). Prior to the analysis, data integrity checks were performed, including verification of patient ID duplication, variable coding consistency, and data completeness. The initial dataset included 130 respondents. Values defined as missing values were treated as missing data, and missing data were handled using an available-case approach. Therefore, descriptive analyses were calculated based on the valid number of observations for each variable, whereas bivariate analyses were conducted using respondents with complete data for both variables included in each specific test.

Descriptive analysis was used to describe the characteristics of the respondents, DM status, diabetic foot status, and neuropathy examination results. Categorical variables are presented as frequencies and percentages, with percentages calculated based on valid cases for each variable. Numerical variables are presented as mean ± standard deviation if normally distributed, or as median and minimum–maximum values if the data distribution is not normal. Of the 130 respondents, neuropathy status was available for 126 respondents because four respondents had incomplete monofilament assessment data. Clinical diabetic foot problem variables were available for 122 respondents because eight respondents had incomplete foot examination data. Neuropathy status was analyzed as a dichotomous variable: no neuropathy and neuropathy, with the neuropathy category including both unilateral and bilateral neuropathy.

The relationship between categorical variables and neuropathy status was analyzed using Pearson's chi-square test. If there were cells with small expected values, Fisher's exact test or the exact/Monte Carlo approach was used. For numerical variables, differences between groups were analyzed using the independent t-test if the data were normally distributed or the Mann–Whitney U test if the data were not normally distributed. Odds ratio (OR) values and 95% confidence intervals were reported for 2×2 categorical analyses, when available. Patients and families receive an explanation of the purpose and benefits of the examination at the registration desk, while research approval is obtained from the research ethics committee, Faculty of Nursing, Hasanuddin University Number: 548/UN4.183/TP.01.02/2025.

Results

A total of 130 respondents were enrolled. The mean age was 54.97 ± 8.42 years (range 31–77; valid n = 123), while the median BMI was 22.20 kg/m² (range 16.00–37.80; valid n = 43). Most respondents were female (87 respondents, 70.73%). The largest education group had completed

elementary school (34 respondents, 29.57%), followed by senior high school (27, 23.48%), no schooling (21, 18.26%), junior high school (18, 15.65%), and higher education (15, 13.04%). Most respondents were housewives (75, 64.10%) (Table 1).

Table 1. Demographic Characteristics of Respondents

Characteristic	Valid *n*	*f*	%
Age, years; mean ± SD	123	54.97 ± 8.42	
BMI, kg/m²; ; median (min–max)	43	22.20 (16.00–37.80)	
Sex	123		
Female		87	70.73
Male		37	29.27
Highest education level	115		
No schooling		21	18.26
Elementary school		34	29.57
Junior high school		18	15.65
Senior high school		27	23.48
Higher education		15	13.04
Occupation	117		
Housewife		75	64.10
Civil servant		10	8.55
Retired		11	9.40
Farmer		13	11.11
Entrepreneur/self-employed		4	3.42
Private employee		4	3.42
Ethnicity	112		
Makassar		53	47.32
Bugis		59	52.68
Religion	122		
Islam		122	100.00
Marital status	118		
Unmarried		2	1.69
Married		109	92.37
Divorced		7	5.94
Smoking history	73		
Never smoked		67	91.78
Current smoker		3	4.11
Former smoker		3	4.11
Puskesmas/Community health center	130		
Baruga		30	23.08
Campagaloe		30	23.08
Lappadata		32	24.62
Manimpahoi		38	29.22

Note. Percentages were calculated based on valid cases for each variable. BMI, body mass index; f, frequency; %, percentage; SD, standard deviation; min, minimum; max, maximum.

The median duration of DM was 2.00 years (range 1–20). Most respondents had DM for less than 5 years (n = 88, 72.13%). The most commonly used DM treatment was oral medication,

reported by 96 respondents (82.05%), followed by traditional treatment (31, 26.50%) and insulin (14, 11.97%). Most respondents had never experienced a diabetic foot ulcer (87, 76.32%), whereas 27 (23.68%) had previously or currently experienced a diabetic foot ulcer. The median random blood glucose and fasting blood glucose values were 200.00 mg/dL and 152.00 mg/dL, respectively (Table 2). A total of 101 respondents (80.16%) had neuropathy, whereas 25 (19.84%) did not. The most frequently identified clinical diabetic foot problems were onychomycosis (84, 68.85%), dry skin (67, 54.92%), dirty skin (50, 40.98%), claw toe (41, 33.61%), hammer toe (39, 31.97%), and ingrown nails (35, 28.69%) (Table 3).

Table 2. Clinical Characteristics and DM Status of Respondents

Characteristic	Valid n	*f*	%
Duration of DM, years; median (min–max)	**122**		2.00 (1–20)
Duration of DM	**122**		
< 5 years		88	72.13
5–10 years		30	24.59
> 10 years		4	3.28
Type of DM treatment	**117**		
Oral medication		96	82.05
Insulin		14	11.97
Traditional treatment		31	26.50
Diabetic foot ulcer status	**114**		
Never had a diabetic foot ulcer		87	76.32
Previously/currently had a diabetic foot ulcer		27	23.68
RBG, mg/dL; median (min–max)	**103**		200.00 (85–500)
FBG, mg/dL; median (min–max)	**17**		152.00 (85–400)

Note. Percentages were calculated based on valid cases for each variable. DM treatment was analyzed as a multiple-responsible variable. DM, diabetes mellitus; RBG, random blood glucose; FBG, fasting blood glucose; f, frequency; %, percentage; SD, standard deviation; min, minimum; max, maximum.

Loss of sensation at all three monofilament examination points was more frequent in the left foot than in the right foot. In the left foot, loss of sensation was observed at the plantar hallux in 101 respondents (80.16%), metatarsal I in 100 (79.37%), and metatarsal V in 96 (76.19%). In the right foot, the corresponding frequencies were 99 (78.57%), 97 (76.98%), and 88 (69.84%), respectively (Figure 1). Duration of DM was significantly associated with neuropathy status ($p = 0.035$). The median duration was 4.50 years (IQR 1.00–8.50) in respondents without neuropathy and 2.00 years (IQR 1.00–4.00) in those with neuropathy. Duration category was also associated with neuropathy status ($p = 0.030$), with the highest within-category proportion of neuropathy observed among respondents with DM duration <5 years (86.21%). Insulin use was associated with neuropathy status ($p = 0.040$). Diabetic foot ulcer status was also associated with neuropathy status ($p = 0.003$); the proportion with neuropathy was 86.05% among participants who had never experienced a diabetic foot ulcer and 59.26% among those who had previously or currently experienced an ulcer. Oral medication, traditional treatment, random blood glucose, fasting blood glucose, and BMI were not significantly associated with neuropathy status (Table 4). Several clinical diabetic foot problems were significantly associated with neuropathy status: onychomycosis ($p = 0.026$), ingrown nails ($p = 0.041$), hammer toes ($p = 0.010$), calluses ($p = 0.026$), and corns ($p = 0.041$). Hallux valgus, Charcot foot, claw toe, dirty skin, dry skin, and fissures were not significantly associated with neuropathy status (Table 5). Given the cross-sectional design and sparse cells for some conditions, particularly corn, these associations should not be interpreted causally.

Table 3. Prevalence of neuropathy and clinical diabetic foot problems

Variable	N Valid	Category	n	%
Prevalence of diabetic foot neuropathy	**126**	No neuropathy	25	19.84
		Neuropathy	101	80.16
Prevalence of clinical diabetic foot problems	**122**			
Nail problems		Onychomycosis	84	68.85
		Ingrown nail	35	28.69
Deformities		Hallux valgus	32	26.23
		Charcot foot	1	0.82
		Hammer toe	39	31.97
		Claw toe	41	33.61
Skin Problems		Dirty skin	50	40.98
		Dry skin	67	54.92
		Callus	19	15.57
		Corn	2	1.64
		Fissure	23	18.85

Note. The denominator varies across variables because analyses were performed using valid cases only. A total of 130 respondents were enrolled, 126 completed the monofilament examination, and 122 had complete diabetic foot assessment data.

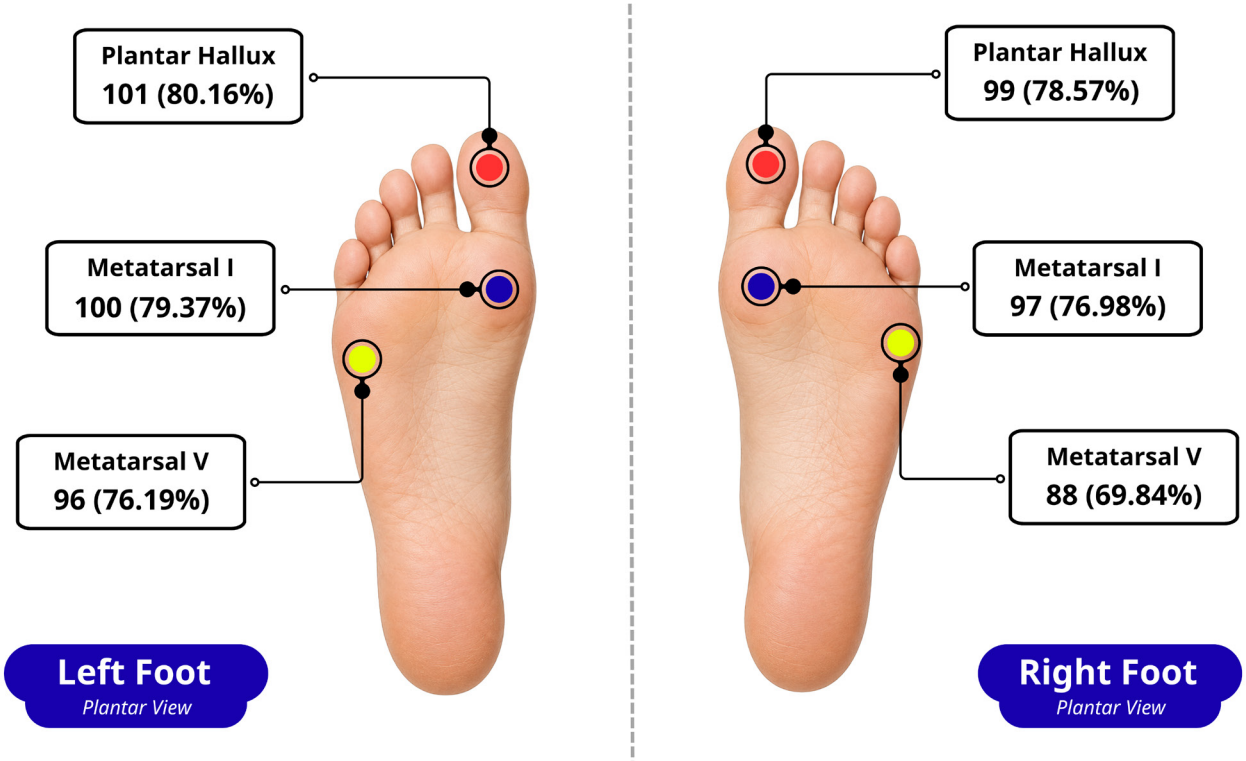

Figure 1. Prevalence of neuropathy based on the monofilament test in the left and right foot.

Table 4. Association of DM status and clinical indicators with neuropathy status

Variable	Neuropathy status		p-value
	No neuropathy n (%)	Neuropathy n (%)	
Duration of DM, years; median (IQR)	4.50 (1.00–8.50)	2.00 (1.00–4.00)	**0.035**[a]
Duration of DM			**0.030**[c]
< 5 years	12 (13.79%)	75 (86.21%)	
5–10 years	10 (33.33%)	20 (66.67%)	
> 10 years	2 (50.00%)	2 (50.00%)	
Oral medication			**0.697**[b]
No	5 (23.81%)	16 (76.19%)	
Yes	19 (20.00%)	76 (80.00%)	
Insulin treatment			**0.040**[d]
No	18 (17.65%)	84 (82.35%)	
Yes	6 (42.86%)	8 (57.14%)	
Traditional treatment			**0.678**[b]
No	17 (19.77%)	69 (80.23%)	
Yes	7 (23.33%)	23 (76.67%)	
Diabetic foot ulcer status			**0.003**[b]
Never had a diabetic foot ulcer	12 (13.95%)	74 (86.05%)	
Previously/currently had a diabetic foot ulcer	11 (40.74%)	16 (59.26%)	
RBG, mg/dL; median (IQR)	199 (168–270)	200 (150–260)	0.432[a]
FBG, mg/dL; median (IQR)	152 (150–166)	155 (130–160)	0.752[a]
BMI, kg/m²; median (IQR)	26.05 (24.65–26.58)	22.00 (20.60–25.15)	0.202[a]

Note. Continuous variables are reported as median (IQR); categorical variables are reported as n (%). Valid n varied by comparison because pairwise complete-case analysis was used: 121 for duration of DM, 116 for DM treatments, 113 for DFU status, 102 for RBG, 17 for FBG, and 43 for BMI. [a] Mann–Whitney U test; [b] Pearson chi-square test; [c] Monte Carlo test; [d] Fisher's exact test. A p-value < 0.05 was considered statistically significant. DM, diabetes mellitus; DFU, diabetic foot ulcer; RBG, random blood glucose; FBG, fasting blood glucose; BMI, body mass index; IQR, interquartile range.

Discussion

Prevalence of neuropathy in the community

Our study results showed a high prevalence of neuropathy in the community. This finding is consistent with previous research that reported the prevalence of diabetic neuropathy also occurs in several countries, such as Qatar (23%) (Ponirakis *et al.,* 2020), Egypt (18.5%) (Khedr *et al.,* 2016), Turkey (33,6%) (Akkus *et al.,* 2016), Germany (5.7%), and England (2.4%) (Kostev *et al*., 2014). This discrepancy should be interpreted with caution because prevalence estimates are highly dependent on study population characteristics, screening methods, and diagnostic criteria. In this study, peripheral neuropathy was assessed using the 10-g Semmes–Weinstein monofilament test, a validated screening tool recommended for community-based diabetic foot assessment. In

Table 5. Association Between Clinical Diabetic Foot Problems and Neuropathy Status

Variable	Neuropathy status		p-value
	No neuropathy n (%)	Neuropathy n (%)	
Nail problems			
Onychomycosis			**0.026**[b]
Absent	3 (7.89%)	35 (92.11%)	
Present	21 (25.30%)	62 (74.70%)	
Ingrown nail			**0.041**[b]
Absent	13 (15.12%)	73 (84.88%)	
Present	11 (31.43%)	24 (68.57%)	
Deformities			
Hallux valgus			0.858[b]
Absent	18 (20.22%)	71 (79.78%)	
Present	6 (18.75%)	26 (81.25%)	
Charcot foot			0.198[d]
Absent	23 (19.17%)	97 (80.83%)	
Present	1 (100%)	0 (0%)	
Hammer toe			**0.010**[b]
Absent	11 (13.41%)	71 (86.59%)	
Present	13 (33.33%)	26 (66.67%)	
Claw toe			0.167[b]
Absent	13 (16.25%)	67 (83.75%)	
Present	11 (26.83%)	30 (73.17%)	
Skin problems			
Dirty skin			0.760[b]
Absent	14 (19.72%)	57 (80.28%)	
Present	11 (22.00%)	39 (78.00%)	
Dry skin			0.330[b]
Absent	9 (16.67%)	45 (83.33%)	
Present	16 (23.88%)	51 (76.12%)	
Callus			**0.026**[d]
Absent	17 (16.67%)	85 (83.33%)	
Present	8 (42.11%)	11 (57.89%)	
Corn			**0.041**[d]
Absent	23 (19.33%)	96 (80.67%)	
Present	2 (100%)	0 (0%)	
Fissure			0.567[d]
Absent	19 (19.39%)	79 (80.61%)	
Present	6 (26.09%)	17 (73.91%)	

Note. All associations were based on 121 participants with complete neuropathy and clinical foot-problem data. [b] Pearson chi-square test; [d] Fisher's exact test. Statistical significance was set at $p < 0.05$.

addition, recruitment from primary healthcare facilities may have introduced selection bias if individuals attending routine diabetes care differed systematically from those who did not seek regular healthcare services. Consequently, the prevalence reported in this study may not be directly comparable with population-based estimates from other settings. Nevertheless, the high prevalence of peripheral neuropathy underscores the substantial burden of diabetic foot risk within community healthcare settings. Peripheral neuropathy is a well-recognized microvascular complication of diabetes and an important risk factor for diabetic foot ulceration (Tavakoli *et al.,* 2023). From a community nursing and primary care perspective, these findings support the integration of routine neuropathy screening using simple, low-cost tools such as the 10-g monofilament test into regular diabetes management programs. Early identification of individuals at risk would enable timely foot care education, preventive interventions, risk stratification, and referral to specialized services, thereby potentially reducing the incidence of diabetic foot ulcers and lower-extremity amputations.

Relationship between Medical History and Diabetes Status on the Incidence of Neuropathy

This study identified significant associations between diabetes duration, insulin use, and peripheral neuropathy. Unexpectedly, patients with shorten reported duration of diabetes had a higher prevalence of peripheral neuropathy than those with a longer duration of disease. This finding differs from the established evidence that longer diabetes duration is generally associated with an increased risk of neuropathy (Brannick, Wynn, & Dagogo-Jack, 2016; Javed *et al.,* 2020). Several explanations should therefore be considered. First, the reported duration of diabetes reflects the time since clinical diagnosis rather than the true onset of hyperglycemia; consequently, delayed diagnosis may have resulted in prolonged exposure to hyperglycemia before diabetes was recognized. Second, self-reported diabetes duration may be subject to recall error or misclassification, particularly among older adults. Third, survival bias may have influenced the observed association if individuals with longer disease duration and more severe complications were underrepresented in the study population. With respect to insulin therapy, the observed association should also be interpreted cautiously. Insulin use may reflect greater disease severity or longer-standing metabolic dysregulation rather than an independent effect of insulin itself. Previous studies have suggested that achieving adequate glycemic control, regardless of treatment modality, is associated with a lower risk of diabetic neuropathy (Musa, Azrag, & Ahmed, 2023). Therefore, the associations observed in the present study should not be interpreted as causal. Future longitudinal studies with detailed characterization of diabetes duration, glycemic exposure, and treatment history are needed to clarify these relationships.

The present study also found that insulin use was significantly associated with neuropathy status, insulin had a lower prevalence of peripheral neuropathy than those not receiving insulin therapy. This finding is consistent with previous evidence suggesting that optimal glycemic management, including insulin therapy when clinically indicated, may be associated with a lower risk of diabetic neuropathy (ElSayed *et al.,* 2025). However, the observed association should be interpreted cautiously. Because of the cross-sectional design, the present study cannot determine whether insulin therapy contributed to the lower prevalence of neuropathy or whether other clinical characteristics influenced this relationship. In addition, the association may have been affected by unmeasured or uncontrolled confounding factors, such as long-term glycemic control, diabetes severity, treatment adherence, duration of insulin therapy, comorbidities, lifestyle factors, or access to healthcare. Furthermore, if multivariable adjustment was not performed, the observed association may reflect residual confounding rather than an independent association between insulin use and peripheral neuropathy. Future prospective studies with comprehensive adjustment for potential confounders are needed to clarify the relationship between insulin therapy and peripheral neuropathy.

This study also found a relationship between diabetic foot ulcer status and neuropathy, where patients who have had or are currently experiencing diabetic foot ulcers have a higher proportion of neuropathy than patients who have never had diabetic foot ulcers. This finding supports the concept that diabetic neuropathy is a major factor in the occurrence of DFU due to the loss of protective sensation in the lower extremities, making patients more susceptible to repeated trauma without realizing it (Dawi *et al.,* 2025; Spinelli *et al.,* 2026). Neuropathy not only acts as a predisposing factor, but also as a central component in the cycle of occurrence and recurrence of DFU (Qin *et al.,* 2022). Thus, routine neuropathy screening is important in efforts to prevent diabetic foot ulcers in patients with DM.

Prevalence of clinical diabetic foot problems in the community

Our study also identified a high prevalence of clinical diabetic foot problems, including nail disorders, deformities, and skin problems. Among nail disorders, onychomycosis is the most common. This finding is consistent with previous studies reporting that onychomycosis is one of the most frequently encountered nail problems in patients with diabetes (Agrawal *et al.,* 2023; Akkus *et al.,* 2016; Gupta *et al.*, 2025). The issue of onychomycosis is important to note because nails become thick, sharp, and brittle, potentially causing foot injuries and increasing the risk of diabetic foot ulcers (Watjer *et al.,* 2024). Our participants mainly over 50 years old. Aging reported has correlation with occurrence of onychomycosis (Gupta *et al*., 2025), foot deformity (Al-Rubeaan *et al.,* 2015), particularly hallux valgus and claw and hammer toe (Ababneh *et al.,* 2019). Aging also correlate with diabetic foot changes (Sridhar *et al*., 2025). Although the present study did not investigate this association directly, our findings highlight the high prevalence of clinically relevant diabetic foot problems among older adults with DM. We also found high number of foot deformities. One systematic review confirmed incidence of DFU lower in exercise and activity group (Matos *et al.,* 2018), participant with insufficient activity report tend to have clinical foot related problems (Perrin *et al.,* 2023). Furthermore, a low level of education has been associated with an increased risk of diabetic foot skin problems (de Lima *et al.,* 2015). Our findings indicate that clinical diabetic foot problems, including nail disorders, foot deformities, and skin abnormalities, are prevalent among older adults with diabetes regardless of educational background. Therefore, DFU prevention programs should not only focus on early detection and routine foot examinations but also integrate culturally appropriate health promotion and patient education strategies that are adapted to the demographic and sociocultural characteristics of the communities served by primary healthcare centers.

The relationship between the incidence of neuropathy and clinical problems of the diabetic foot

Our findings indicate an association between the incidence of onychomycosis and ingrown nails in patients with neuropathy. This suggests that patients with peripheral neuropathy are more susceptible to nail disorders owing to decreased protective sensation, changes in peripheral circulation, and repeated trauma to the feet (ElSayed *et al.,* 2025; Swain *et al.,* 2023). One possible explanation is that reduced protective sensation, alterations in peripheral circulation, and repeated minor trauma may increase the likelihood of nail abnormalities and fungal infections (Gupta *et al.,* 2025). Furthermore, previous studies have identified nail disorders as common manifestations in individuals with diabetic neuropathy and as important components of diabetic foot assessment (Yesudian, Nwabudike, & de Berker, 2022). However, because of the cross-sectional design, the present study cannot establish whether peripheral neuropathy preceded the development of nail disorders. Neuropathy was associated with a higher prevalence of nail disorders in this study, whereas prospective longitudinal studies are needed to clarify the temporal relationship between these conditions.

As for foot deformities, hammer toe showed a significant pattern in the neuropathy group. This finding is consistent with the theory that motor neuropathy in patients with diabetes can cause intrinsic foot muscle weakness, leading to muscle imbalance and changes in toe shape (Francis *et al.,* 2024). Hammer toe deformity increases pressure on certain areas during walking and contributes to the risk of recurrent trauma and the formation of DFU (Andersen *et al.,* 2024), consistent with previous studies showing that foot deformities are more frequently found in patients with diabetic neuropathy than in patients without neuropathy (Esther *et al.,* 2021). Although these findings support a relationship between peripheral neuropathy and foot deformities, the cross-sectional design of the present study does not allow the temporal or causal relationship to be established. Neuropathy may contribute to structural changes in the foot, but prospective longitudinal studies are required to clarify this relationship.

In addition, we found that the incidence of calluses and corns was more significant in patients with neuropathy than in those without neuropathy. This condition is likely to occur because neuropathy causes changes in the pressure distribution on the soles of the feet due to biomechanical disturbances and foot deformities (Jorgetto *et al.,* 2022). Repeated pressure on a specific point triggers skin thickening in the form of calluses and corns as the body's protective response (Isei *et al.,* 2025). However, in patients with neuropathy, it is often unnoticed due to the loss of pain sensation, which can develop into diabetic foot ulcers if not managed properly (Lee & Won, 2025). These findings underscore the importance of routine foot examinations and early detection of skin changes in patients with DM and peripheral neuropathy.

Clinical implications

This epidemiological study revealed a high prevalence of neuropathy among patients with DM participating in the Prolanis program at Community Health Centers. Therefore, it is necessary to implement a DFU prevention program at the Community Health Center level, integrated with the Prolanis program in the form of a Diabetes Foot Check, whose validity and reliability have been confirmed. Although the prevalence of DFU remains low, clinical issues related to the diabetic foot, such as onychomycosis, ingrown nails, hammer toe, calluses, and corn, must be the focus of attention for nurses and other health professionals, as these are gateways to the occurrence of DFU. The predominance of female participants and individuals with lower educational attainment highlights the importance of tailoring diabetic foot screening and prevention strategies to community populations that may have limited access to health information and specialized foot care services.

Research limitations

This study has several limitations that should be considered when interpreting the findings. First, the cross-sectional design precludes any inference of causal relationships between participant characteristics and diabetic foot problems. Second, the study was conducted in four Community Health Centers across two districts in South Sulawesi, which may limit the generalizability of the findings to other regions or healthcare settings. In addition, participants were recruited from Community Health Centers, introducing the possibility of selection bias, as individuals who regularly attend primary healthcare services may differ from those who do not seek routine care. Furthermore, the absence of longitudinal follow-up prevented evaluation of the progression of foot problems or the development of DFU over time. Future multicenter prospective studies involving more diverse populations, and comprehensive adjustment for potential confounders are warranted to strengthen the external validity and clinical applicability of these findings.

Conclusion

This community-based study found a high prevalence of diabetic foot neuropathy, affecting four out of five participants with DM. Clinical diabetic foot problems were also highly prevalent, with onychomycosis and dry skin being the most common nail and skin conditions, respectively, while claw toe and hammer toe were the most frequent foot deformities. Significant associations were identified between neuropathy status and several clinical foot problems, including onychomycosis, ingrown nail, hammer toe, callus, and corn. These findings highlight the substantial burden of diabetic foot problems among community-dwelling adults with diabetes and emphasize the importance of routine foot screening, early identification of neuropathy and clinical foot abnormalities, and culturally appropriate preventive foot care and health education within primary healthcare settings to reduce the risk of diabetic foot ulceration.

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