DOI: https://doi.org/ 10.20372/mhsr.v2i2.1973
Medical and Health Sciences Research Journal
Med. Health Sci. Res. J., Jul- Dec.2025, 2(2), 14-24
Journal Homepage: https://journals.wgu.edu.et
ISSN: 2520 – 7695 (Print)
ISSN: 3005 – 7523 (Online)

Original research

Incidence and predictors of amputation among diabetic foot ulcer patients in south western Ethiopia: a retrospective follow-up study

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ABSTRACT

Background: *Diabetic foot ulcer amputation is a serious medical, social, and economic concern, and a primary cause of hospitalisation, increased morbidity, and mortality. There is scarce evidence on the extent and drivers of diabetic foot amputations in southern Ethiopia. This study assessed the incidence and predictors of amputation among patients admitted to Metu Karl Comprehensive Specialized Hospital with diabetic foot ulcer from 2015 to 2024.*

Methods: *This retrospective cohort study was conducted on 455 randomly selected diabetic foot ulcer patients. Data were collected using a structured abstraction tool, entered into EpiData v4.7, and analysed in Stata v14. Survival time was estimated using the Kaplan-Meier method, with differences assessed by the log-rank test. The significant predictors of amputation were identified considering 95% CI of AHR and p-value <0.05.*

Results: *The incidence rate of diabetic foot amputation was 11.6 per 100 persons-years (95% CI: 9.8–13.7). The 10-year incidence proportion was 31.2% (95% CI: 26.9-35.7). The cohort was followed for a median of 40 months (interquartile range of 37-42), and a median survival time was 36 months (95% CI: 33-38). Significant predictors of amputation were diabetes complications (AHR 2.8, 95% CI: 2.0-3.8), comorbidities (AHR 2.3, 95% CI: 1.7-3.1), and diabetic foot ulcer infection (AHR 5.9, 95% CI: 4.9-7.7).*

Conclusion: *The incidence of lower-limb amputation among diabetic patients was high, emphasizing the need for targeted prevention strategies and integrated care.*

Article Information

Article History
Received: 28-07-2025
Revised: 17-10-2025
Accepted: 19-12-2025

Keywords:
Incidence
Predictors;
Amputation
Mattu Karl
Comprehensive
Specialized Hospital

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INTRODUCTION

Amputation is the surgical removal of a limb or part of a limb when the affected tissue is irreversibly damaged or infected, making limb salvage impossible. Although often life-saving, amputation can have profound physical, psychological, and social consequences for patients (1). A diabetic foot ulcer (DFU) is defined as a full-thickness wound or break in the skin occurring below the ankle in individuals with diabetes. These ulcers commonly result from a combination of peripheral neuropathy, peripheral arterial disease, and minor trauma, and represent a major risk factor for lower limb amputation if not properly managed(2). DFUs may present as open sores, areas of necrosis, or loss of skin and underlying tissues, often complicated by infection, which accelerates tissue destruction and delays healing(3).

The number of diabetes-related amputations is a good measure of how much of the problem diabetes is and how well healthcare systems are doing at finding and helping people at high risk (4). It's essential to keep track of how often these lower limb amputations are happening so we can monitor changes and try to prevent this problem from getting worse, as more and more people are diagnosed with diabetes worldwide. The global impact of amputations caused by diabetic foot ulcers is serious and needs to be addressed (4-6).

Globally, about 20% of diabetic foot ulcer (DFU) patients have minor (below ankle) or major (above ankle) lower limb amputations(7). Locally, research at Nekemte Referral Hospital shows a higher prevalence, with lower extremity amputations (LEA) accounting for 30.43% of DFU cases. Patients with diabetic foot ulcers were found to have a rapid rate of amputation when their treatment involved inappropriate antibiotics and when the ulcers were classified as having a higher severity grade (8).

Targeted risk-reduction initiatives can prevent foot ulcers, while basic interventions have the potential to cut amputation rates by up to 70 percent (9). Despite the increasing burden of diabetic foot ulcer-related amputations, there was limited published data on amputation among diabetic foot ulcer patients in Ethiopia. This study assessed the incidence and predictors of amputation among patients admitted to Metu Karl Comprehensive Specialized Hospital with diabetic foot ulcer from 2015 to 2024.

METHODS

Study period and area

From January 1, 2015, to December 31, 2024, a retrospective cohort study was done at Mattu Karl Comprehensive Specialized

Hospital (MKCSH) on the medical records of patients admitted with diabetic foot ulcers. Located in Mattu, Oromia Regional State, MKCSH is found around 600 kilometres southwest of Addis Ababa, Ethiopia. It provides care for an estimated 2.5 million people across southwest Ethiopia. It offers specialized diabetic follow-up services, with approximately 1,683 diabetic patients registered annually and 105-140 patients seen monthly for chronic care and diabetes complication management.

Population, Sampling Procedure

The study comprised diabetic foot ulcer patients who were hospitalised to MKCSH between 2015 and 2024. Patients who had previous amputations, trauma-induced ulcers, or incomplete records (missing diagnostic or outcome dates) were excluded. Using Epi Info 7.2.3 and Wagner grade as a key predictor, a sample size of 455 was determined (95% CI, 80% power, HR=1.59(8); 10% non-retrieval for incomplete records, and 1:1 ratio). Participants were chosen from 838 eligible population using simple random sampling.

Operational definitions

Diabetic foot amputation: Surgical removal of part of the lower limb in a diabetic patient (10). In this study, the event of interest was diabetic foot amputation during the follow-up period, whereas cases where no amputation occurred but other outcomes, such as death, loss to follow-up, healing, or debridement, were censored.

Data Collection Procedure

Three trained nurses collected data from patient records and hospital records, with two public health professionals supervising the process. Before the actual study, the tool was pre-tested on 23 records using medical records available before 2015. All team members underwent extensive training, and the collected data was validated and safeguarded daily to ensure quality.

Data analysis

Data were cleaned and inspected for inconsistencies before being imported into EpiData V4.7 and analysed with Stata V14.0. Descriptive statistics used medians with IQR for continuous variables and frequencies for categorical data. Survival time was calculated using the Kaplan-Meier method and compared using log-rank testing. Study outcomes were dichotomized as event (code ‘1’) or censored (code ‘0’). The proportional hazards assumption was validated with Schoenfeld residuals. In bivariable analysis, variables having a p-value < 0.25 were included in the multivariable Cox proportional hazards model. Model fit was evaluated using Cox-Snell residuals. The significant predictors of amputation were identified considering 95% CI of AHR and p-value <0.05.

Ethics Approval

The Institutional Ethical Review Board (IERB) of Wollaga University provided formal ethical clearance with reference number IHS/REC/103/2025.

RESULTS

Socio-demographic characteristics

The study included 455 diabetic patients with foot ulcers. About 217(47.70%) were aged 55 or younger, with 254 (55.82%) being female. In addition, 265(58.24%) lived in urban areas (Table 1).

Table 1. participants' socio-demographic characteristics, January 2015-December 2024 (n = 455)

Variables	Category	Frequency	Percentage
Age	≤ 55 years	217	47.7
	>55years	238	52.3
Sex	Male	201	44.18
	Female	254	55.82
Resident	Urban	265	58.24
	Rural	190	41.76

Clinical characteristics

In this study, 53 participants (33.6%) had fasting blood sugar (FBS) levels <126 mg/dl, while 302 (66.4%) had levels ≥126 mg/dl. Total cholesterol <200 mg/dl was observed in 42.2% of participants, and favorable HDL levels (≥50 mg/dl) in 52.3%. Clinically confirmed diabetic foot ulcer infections were present in 59.6% of cases, with cellulitis (41.2%), gangrene (21.0%), and abscess (15.8%) being the most common types (Table 2).

Table 2. Participants' clinical characteristics, January 2015-December 2024 (n = 455)

Variables	Category	Frequency	Percentage
Recent FBS in mg/dl	< 126 mg/dl	153	33.6
	FBS ≥ 126 mg/dl	302	66.4
Total cholesterol in mg/dl	< 200 mg/dl	192	42.2
	≥ 200 mg/dl	263	57.8
Total HDL in mg/dl	≥ 50 mg/dl	238	52.3
	< 50 mg/dl	217	47.7
Total LDL in mg/dl	< 160 mg/dl	159	34.9
	≥ 160 mg/dl	296	65.1
BMI	<25kg/m2	320	70%
	≥25kg/m2	135	30%
Diabetic foot ulcer infection	Yes	271	59.56
	No	184	40.44
Types of infection	Cellulitis	112	41.18
	Abscess	43	15.81
	Osteomyelitis	37	13.60
	septic arthritis	14	5.15
	Fasciitis	9	3.31
	Gangrene	57	20.96
Grade of Ulcer	Grade 0	6	5.22
	Grade 1	60	52.17
	Grade 2	25	21.74
	Grade 3	1	0.87
	Grade 4	13	11.30
	Grade 5	10	8.70

PEDIS Size Grade	Grade	108	23.8%
	Grade 3	347	76.2%
Comorbidity	Yes	85	18.68
	No	370	81.32
Types of comorbidities	Hypertension	36	42.35
	Ischemic Heart Disease	6	7.06
	Dyslipidemia	26	30.59
	Peripheral Vascular Disease	14	16.47
	Stroke	3	3.53
DM complication	Yes	101	22.25
	No	353	77.75
Type of DM complication	Retinopathy	8	7.9
	Neuropathy	14	13.86
	Nephropathy	34	33.66
	Coronary Heart Disease	8	7.9
	Peripheral vascular disease	37	36.6

Incidence of diabetic amputation

In this study, 142 patients (31.2%) experienced diabetic foot amputation. The median follow-up time was 40 months (IQR: 37-42), with a total observation period of 1,224 person-years. This yielded an incidence rate of 11.6 amputations per 100 person-years (95% CI: 9.8-13.7), meaning approximately 12 new amputations occurred for every 100 patients followed for one year. The median survival time was 36 months (95% CI: 33-38) (Figure 1).

Predictors of diabetic foot amputation

In the bivariable Cox regression, ulcer infection, comorbidities, diabetes-related complications, and BMI were identified as candidates for the final model. In the multivariable analysis, after adjusting for potential confounders, three factors remained significantly associated with diabetic foot ulcer amputation: ulcer infection (AHR = 5.9, 95% CI: 4.9-7.7), comorbidities (AHR = 2.3, 95% CI: 1.7-3.1), and diabetes complications (AHR= 2.8, 95% CI: 1.7-3.1) (Table 3). Kaplan-Meier survival analysis showed that patients with ulcer infection experienced a marked decline in survival over time, with the log-rank test p-value <0.001 (Figure 1B). Kaplan-Meier survival analysis demonstrated that patients with comorbid conditions experienced a significantly faster decline in survival compared to those without, as confirmed by the log-rank test ($p < 0.001$) (Figure 1D). Kaplan-Meier survival analysis showed that patients with diabetic complications experienced a significantly faster decline in survival compared to those without, as confirmed by the log-rank test ($p < 0.001$) (Figure 1C). The Nelson-Aalen cumulative hazard curve closely matched the 45° reference line, according to Cox-Snell residual analysis, indicating that the residuals observed as predicted under a unit exponential distribution (Figure 2).

Table 3. Predictors of diabetic foot ulcer amputation among patients with diabetic foot ulcers, Mattu, Ethiopia (n = 455)

Variables	characteristics	Censored (%)	Event (%)	CHR (95%CI)	AHR (95%CI)
Diabetic foot ulcer infection	Yes	135(49.82%)	136(50.18%)	9.77(4.3-22.2)	5.9(4.9-7.7)*
	No	178(96.74%)	6(3.26%)	1	1
Comorbidities	Yes	0(0%)	85(100%)	3.64(2.58-.13)	2.3(1.69-3.12)*
	No	313(84.59%)	57(15.71%)	1	1
Diabetes complications	Yes	2(1.98%)	99(98.02%)	4.79(3.33-.88)	2.8(1.7-3.12)*
	No	310(87.82%)	43(12.18%)	1	1
Body mass index	<25kg/m2	260(81.25%)	60(18.75%)	1	1
	≥25kgm2	53(39.26%)	82(60.74%)	2.29(1.63-.21)	1.44(0.99-2.05)

*p-value< 0.05, 1= reference group, AHR: adjusted hazard ratio, CHR: crude hazard ratio

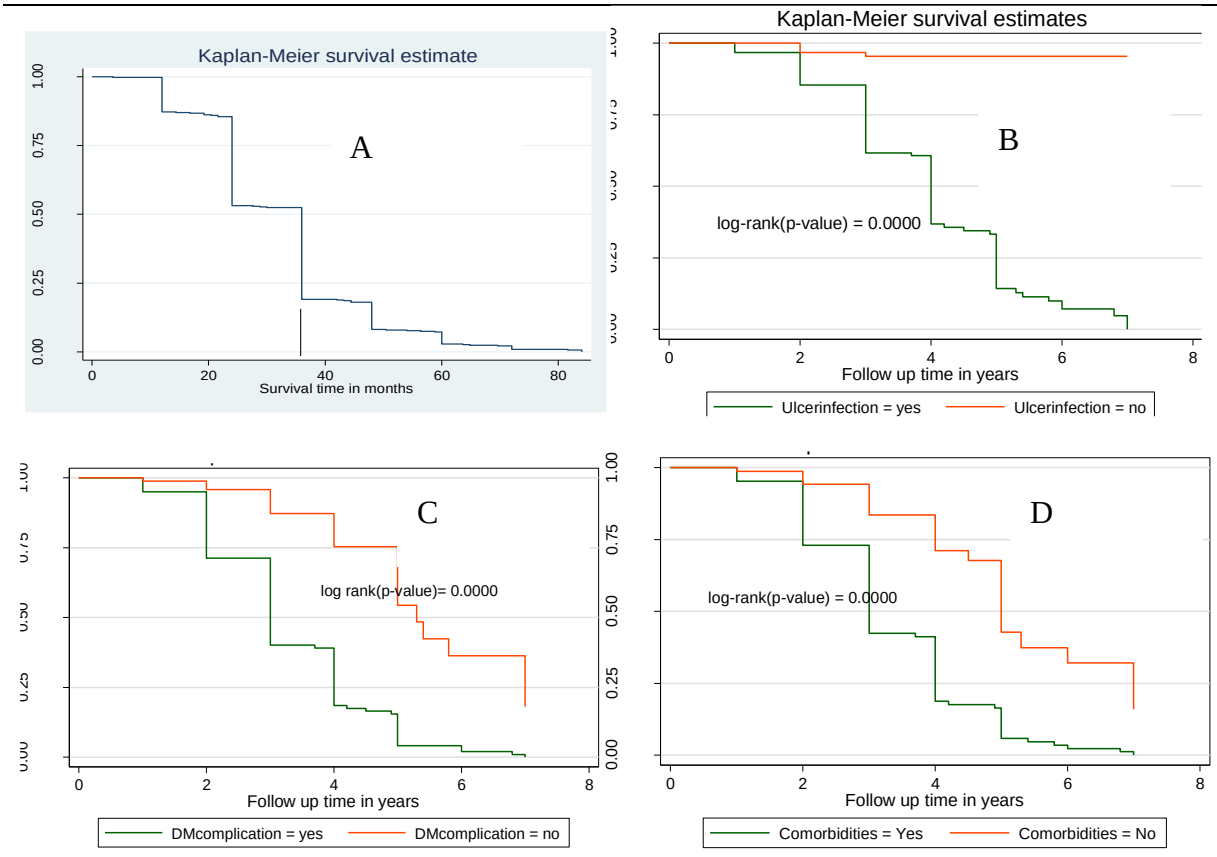

Figure 1: KM Median Survival time of study participants across categories of different predictors

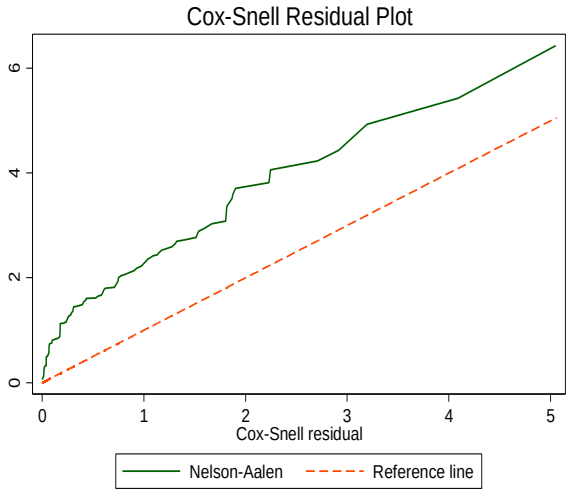

Figure 2. Cox-Snell Residual Plot with Nelson-Aalen Cumulative Hazard Function

DISCUSSION

This study found the cumulative incidence of diabetic foot ulcer amputation was 31.2%, which is higher than studies done in a 5-year European cohort study of 14 centers(11), Manchester (12), Pakistan(13), Singapore (14), and Jamaica (15). The difference can be explained by differences in healthcare infrastructure, delayed patient presentation, severity of ulcers at admission, and limited access to specialized foot care, low awareness, poor health-seeking behavior, and socioeconomic barriers contribute to worse outcomes.

However, this finding was lower than those reported in studies from a Mediterranean country (16) and Tanzania (17), which could be attributed to differences in study populations, methodologies, healthcare service coverage, and study durations. However, this result was fairly consistent with findings from Nekemt Comprehensive Specialized Hospital, where 30.43% of diabetic foot ulcer (DFU) patients underwent lower extremity amputations (LEA) (8).

The amputation incidence in this study was 11.6 per 100 person-years, which was higher than the rate reported in a similar Ghanaian study (18). This discrepancy could be attributed to variations in sample size, study design, duration of follow-up, and differences in healthcare infrastructure and service delivery between the two settings.

Diabetic foot ulcer patients with comorbidities had a higher hazard of developing diabetic foot amputation compared to those without comorbidities. It is consistent with a study conducted at King Abdullah University Hospital(19). The findings of this study reported that comorbidities like hypertension, cardiac disease, renal disease, and stroke, when coupled with diabetic foot ulcer, speed up

diabetic foot amputation compared to those without comorbidities (19).

According to a review of many studies by Rodrigues, comorbidities such as kidney difficulties considerably enhance the chance of lower limb amputation (LLA)(20). Additionally, a study done in Ghana concluded that hypertension was a significant predictor of diabetic foot amputation(21). Comorbidities such as hypertension, cardiac disease, renal disease, and stroke can compromise blood circulation, impair immune response, and delay wound healing, thereby increasing the risk of infection and tissue necrosis in patients with diabetic foot ulcers. These effects can accelerate the progression from ulceration to the need for amputation(22). The findings suggest that to lower the risk of amputation and enhance patient outcomes, diabetic foot care should incorporate the comprehensive management of comorbidities, particularly hypertension and renal illness.

This study found a statistically significant association between an increased risk of amputation and diabetic foot ulcer infection. This finding was in line with a study conducted in Australia, which said that diabetic foot ulcer infection was independently linked to diabetic foot ulcer amputation(19). Infected ulcers compromise local tissue integrity, impair healing, and increase systemic inflammatory response, which can lead to rapid deterioration of the affected limb (23). The significant association between diabetic foot ulcer infection and increased risk of amputation underscores the urgent need for early identification and aggressive management of infections in diabetic foot care.

Diabetic complications like diabetic neuropathy, nephropathy, retinopathy, and other macro complications like peripheral vascular disease significantly contributed to diabetic foot amputation. According to a study done in Jamaica, key factors contributing to diabetic foot amputation were diabetic neuropathy (24). A study conducted in Ghana identified diabetic neuropathy and peripheral vascular disease as significant predictors of amputation, a finding that aligns with the results of this study (18). These complications collectively create an environment to rapidly progress to severe ulcers requiring amputation (25). This finding implies that implementing routine screening and integrated management of diabetes-related complications such as neuropathy, nephropathy, retinopathy, and peripheral vascular disease can reduce the risk of foot ulcer progression to amputation.

Limitations of the Study

Although the study employed a robust statistical approach in presenting incidence and predictors of diabetic foot amputation, it

has some limitations. First, due to the retrospective nature of the study, a number of important clinical, behavioural, and sociodemographic characteristics that were either inconsistent or absent from the medical documents could not be included. Second, the findings will not be generalized for the community, as it is an institution-based study.

CONCLUSION

Incidence of diabetic foot amputation was 11.6 per 100 person-years and a 10-year cumulative incidence of 31.2%. Its predictors were Diabetic foot ulcer infection, comorbidities, and diabetes complications.

Declarations

Acknowledgements

The authors would like to thank Mattu Karl Comprehensive Specialized Hospital for facilitating access to patient records and supporting data collection.

Funding

No funding received for this study.

Consent to publish

Not applicable

Availability of data

The datasets used in the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors disclose that they have no competing interests.

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