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DIABETIC FOOT COMPLICATIONS AND ASSOCIATED MORTALITY AMONG ADULTS AT A TERTIARY CARE HOSPITAL IN KERALA: A RETROSPECTIVE STUDY

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ABSTRACT

Background: India carries one of the world's largest diabetes burdens, and Kerala reports the highest state-level prevalence in the country. Foot complications are a major, often underestimated source of morbidity, disability and death in this population, yet prevalence data from Kerala outside specialised podiatry settings remain scarce. The objective is to determine the prevalence and clinical spectrum of diabetic foot complications and the associated mortality among adult diabetic patients at a tertiary care hospital in Kerala.

Materials and Methods: We conducted a hospital record-based retrospective descriptive study in the Departments of General Medicine and General Surgery of Amala Institute of Medical Sciences, Thrissur, Central Kerala, over one year (January 2024 to January 2025). Records of 135 adult patients with type 1 or type 2 diabetes were reviewed using a predesigned proforma capturing demographics, anthropometry, glycaemic indices, comorbidities, foot findings, complications, amputation and mortality. Data were analysed in IBM SPSS v27.0; categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± standard deviation.

Results: Patients had a mean age of 60.9 ± 10.5 years, and 68.9% were male. Glycaemic control was poor (mean HbA1c 9.4 ± 2.7%), with a mean diabetes duration of 14.0 ± 9.4 years. Comorbidity was present in 80.7%, led by hypertension (58.5%), coronary artery disease (33.3%) and chronic kidney disease (29.6%). Foot ulcers were the commonest lesion (48.9%), followed by cellulitis (38.5%), gangrene (22.2%; predominantly wet), abscess (17.0%), osteomyelitis (2.2%) and necrotising fasciitis (1.5%). Amputation had been performed in 20.7% of patients, mostly at toe level. Mortality was 2.2%.

Conclusion: Adult diabetic patients at this tertiary centre carried a heavy burden of foot complications and a substantial amputation rate, concentrated in older individuals with poor glycaemic control, long disease duration and multiple comorbidities. Mortality was low in this cross-section, but the underlying cardiovascular and renal risk profile was pronounced. The findings support routine foot screening, tighter metabolic control and structured patient education.

Keywords: Diabetic foot; foot ulcer; amputation; diabetes mellitus; peripheral neuropathy; Kerala; tertiary care.

INTRODUCTION

Diabetes mellitus has become one of the defining public health problems of this century, and its prevalence continues to climb across every world region. India carries a disproportionate share of that burden, now ranking first globally with an estimated 212 million adults living with the disease.[1] Within

India, Kerala reports the highest state-level prevalence, which makes it a natural setting for the study of diabetes-related complications and their prevention.[2]

Foot complications rank among the most disabling long-term consequences of diabetes. Peripheral neuropathy, Charcot arthropathy, foot ulcers, soft-tissue infection and lower-extremity amputation are common, and each erodes quality of life, prolongs hospital stay and can leave permanent disability.[3]

The diabetic foot ulcer is the most feared of these lesions, affecting up to a quarter of people with diabetes at some point in their lifetime.4 Reported ulcer prevalence in India sits near 3%, yet that figure almost certainly understates the true load in high-risk settings such as tertiary clinics. Ulcer-associated infection spans a wide range—from paronychia and cellulitis to necrotising fasciitis and osteomyelitis—and can escalate quickly. When management lags, these infections turn limb-threatening and force amputation.[3]

Diabetic peripheral neuropathy compounds the risk. Loss of protective sensation, most marked over the plantar forefoot and toes, leaves patients unable to detect minor trauma, so injuries go unnoticed and ulcers develop unchecked.5 Changes in dermal foot temperature, an early marker of inflammation, can flag impending complications such as Charcot neuroarthropathy and cellulitis before they become clinically obvious.[6]

The downstream toll is heavy. Diabetes accounts for more than half of all non-traumatic lower-limb amputations, and a foot ulcer precedes amputation in roughly 85% of cases.3 Risk concentrates in patients with long-standing disease, peripheral arterial disease, non-healing ulcers, oedema and interdigital fungal infection—a profile that warrants early identification and intervention.[7]

Mortality in this group is driven largely by systemic sequelae, including chronic kidney disease, cardiovascular events, sepsis and respiratory failure.8 Despite the scale of the problem in Kerala, routine foot screening and preventive care remain limited, and most published local data come from specialised podiatry or foot clinics rather than general tertiary practice. Against this background, the present study set out to assess the prevalence and clinical spectrum of foot complications, and the associated mortality, among adult diabetic patients at a tertiary care hospital in South India.

MATERIALS AND METHODS

Study design and setting: This was a hospital record-based retrospective descriptive study conducted in the Departments of General Medicine and General Surgery of Amala Institute of Medical Sciences, a tertiary care teaching hospital in Central Kerala, India. The study is reported in line with the STROBE guidance for observational research.

Study period and population: Medical records of adult diabetic patients who attended the two departments over one year, from 1 January 2024 to 1 January 2025, formed the study population. Records were screened against the eligibility criteria and reviewed for demographic, clinical, biochemical, radiological and outcome data.

Eligibility criteria: We included adults aged 18 years and above with type 1 or type 2 diabetes mellitus who attended the General Medicine or General Surgery departments during the study period. We excluded patients with non-diabetic foot disease and those whose records were incomplete.

Sample size: The sample size was calculated from an anticipated prevalence of non-healing ulcer of 41.51% reported by Jyothylekshmy et al.,3 taking a 5% level of significance and 20% relative precision, which yielded a required sample of 135. A simple random sampling technique was used to select eligible records.

Data collection: All relevant information was abstracted from case records onto a predesigned proforma and entered into a spreadsheet. Variables captured included age, sex, height, weight and body mass index; glycaemic indices (glycated haemoglobin, fasting, postprandial and random blood glucose); duration of diabetes; pharmacological management; comorbidities; peripheral vascular status and dorsalis pedis pulsation; and the full spectrum of foot pathology—ulcer, cellulitis, abscess, gangrene, pre-gangrenous change, osteomyelitis, necrotising fasciitis and Charcot neuroarthropathy—together with amputation and in-hospital mortality.

Statistical analysis: Analyses were performed in IBM SPSS Statistics version 27.0. Categorical variables were summarised as frequencies and percentages, and continuous variables as mean ± standard deviation. Where a variable was not recorded for the whole cohort, the denominator is stated alongside the estimate.

Ethical considerations: The study was approved by the Institutional Ethics Committee of Amala Institute of Medical Sciences [approval number and date to be inserted]. Given the retrospective record-based design, the requirement for individual informed consent was waived by the committee. Patient anonymity and data confidentiality were maintained throughout.

RESULTS

Cohort characteristics: The study included 135 adult patients with diabetes mellitus. Age spanned 34 to 89 years, with a mean of 60.9 ± 10.5 years. The cohort skewed older. Roughly three in five patients fell between 55 and 74 years, and the 55–64-year band alone held 47 patients (34.8%), trailed by the 65–74-year band with 35 (25.9%) and the 45–54-year band with 31 (23.0%). Patients beyond 84 years were scarce, numbering just 2 (1.5%). Men predominated: 93 patients were male (68.9%) and 42 female (31.1%), a male-to-female ratio near 2.2:1 [Table 1].

Anthropometric data were available for most of the group. Mean height was 1.6 ± 0.1 m (n = 112), mean weight 65.0 ± 12.4 kg (n = 118), and mean body mass index 24.5 ± 3.7 kg/m² (n = 112; range 17.7–34.1). Judged against Asian BMI thresholds, that average sits at the overweight margin.

Glycaemic and biochemical profile: Glycaemic control was poor across the cohort. Mean glycated haemoglobin reached 9.4 ± 2.7% (n = 57), with individual values stretching from 5.6% to 16.1%. Fasting blood glucose averaged 176.2 ± 76.7 mg/dL (n = 89) and random blood glucose 227.9 ± 99.3 mg/dL (n = 130); postprandial readings, captured in only 11 patients, averaged 195.8 ± 102.7 mg/dL [Table 1]. Disease was long-standing, the mean recorded duration reaching 14.0 ± 9.4 years and extending in some patients to four decades.

Table 1: Sociodemographic, anthropometric and metabolic characteristics of the study cohort (N = 135)

Variable / category	Value [n (%) or mean ± SD]
Age	
Mean ± SD (range), years	60.9 ± 10.5 (34–89)
34–44 years	8 (5.9)
45–54 years	31 (23.0)
55–64 years	47 (34.8)
65–74 years	35 (25.9)
75–84 years	12 (8.9)
>84 years	2 (1.5)
Sex	
Male	93 (68.9)
Female	42 (31.1)
Anthropometry	
Height, m (n = 112)	1.6 ± 0.1
Weight, kg (n = 118)	65.0 ± 12.4
Body mass index, kg/m² (n = 112)	24.5 ± 3.7
Glycaemic indices	
HbA1c, % (n = 57)	9.4 ± 2.7
Fasting blood glucose, mg/dL (n = 89)	176.2 ± 76.7
Postprandial blood glucose, mg/dL (n = 11)	195.8 ± 102.7
Random blood glucose, mg/dL (n = 130)	227.9 ± 99.3
Duration of diabetes, years (n = 102)	14.0 ± 9.4
Treatment	
Oral hypoglycaemic agents	89 (65.9)
Insulin	37 (27.4)
Oral agents + insulin	8 (5.9)
Diet alone	1 (0.7)

SD, standard deviation; HbA1c, glycated haemoglobin. Denominators differ where a variable was not recorded for the whole cohort.

Treatment and comorbidity burden: Oral hypoglycaemic agents anchored management in most patients, prescribed to 89 (65.9%). Insulin alone covered 37 patients (27.4%), a combination of oral agents and insulin 8 (5.9%), and diet alone a single patient (0.7%) [Table 1]. Comorbidity was the rule rather than the exception, documented in 109 patients (80.7%). Hypertension headed the profile at 79 patients (58.5%), followed by coronary artery disease in 45 (33.3%) and chronic kidney disease in 40 (29.6%). Dyslipidaemia affected 18 (13.3%) and peripheral neuropathy 13 (9.6%). Rarer associations included chronic liver disease and hypothyroidism (8 each, 5.9%), peripheral vascular disease (7, 5.2%), diabetic retinopathy and nephropathy (6 each, 4.4%), and cerebrovascular accident (2, 1.5%) [Table 2].

Table 2: Comorbidity profile of the study cohort (N = 135)

Comorbidity	Frequency	Percent
Any comorbidity	109	80.7
Hypertension	79	58.5
Coronary artery disease	45	33.3
Chronic kidney disease	40	29.6
Dyslipidaemia	18	13.3
Peripheral neuropathy	13	9.6
Chronic liver disease	8	5.9
Hypothyroidism	8	5.9
Peripheral vascular disease	7	5.2
Diabetic retinopathy	6	4.4
Diabetic nephropathy	6	4.4
Cerebrovascular accident	2	1.5

Categories are not mutually exclusive; a patient could have more than one comorbidity.

Peripheral vascular status: Dorsalis pedis pulsation was recorded as unremarkable in 124 patients (91.9%). A documented pedal pulse deficit—feeble or absent—affected the remaining 10, most often as

an absent right dorsalis pedis pulse in 5 (3.7%). Frank peripheral vascular disease was absent in 114 patients (84.4%). Where it occurred, it favoured the right leg in 10 patients (7.4%), with the left leg (4, 3.0%), left foot (3, 2.2%) and right foot (2, 1.5%) involved less often.

Spectrum of foot complications: Foot ulceration was the single commonest lesion. Sixty-six patients (48.9%) presented with one or more ulcers, and 69 (51.1%) had none [Table 3]. The left foot carried the heaviest ulcer burden at 17 patients (25.8%), ahead of the right foot at 11 (16.7%); toe ulcers, right and left, each accounted for 5 (7.6%), and multisite involvement surfaced in a handful of cases (Table IV). Severity, characterised in 42 ulcers, tilted toward chronicity. Non-healing ulcers dominated at 17 (40.5%), diabetic ulcers followed at 13 (31.0%), and healing ulcers made up 5 (11.9%), with necrotic (3, 7.1%) and isolated chronic, bone-deep, trophic, and trophic-plus-non-healing lesions rounding out the range [Table 4]. Wagner grading, applied to 19 ulcers, concentrated at the middle grades—grade 3 in 7 (36.8%) and grade 2 in 6 (31.6%)—alongside grade 4 in 4 (21.1%) and grade 1 in just 2 (10.5%) [Table 4].

Soft-tissue infection ran high. Cellulitis affected 52 patients (38.5%), clustering on the left leg in 23 (44.2%) and the right leg in 14 (26.9%) [Tables 3 and 6]. Deep abscesses formed in 23 patients (17.0%), distributed across the plantar surfaces, mid-foot and toes. Necrotising fasciitis, though rare, struck 2 patients (1.5%)—one at the left foot, one at the right leg.

Ischaemic tissue loss was substantial. Gangrene developed in 30 patients (22.2%), overwhelmingly at the toes, with the right and left toe each affected in 12 patients (40.0%) [Table 3 and 6]. Where the type was recorded, wet gangrene outnumbered dry threefold (6, 75.0% versus 2, 25.0%). Pre-gangrenous lesions preceded overt necrosis in only 4 patients (3.0%), chiefly at the right toe.

Bone and joint involvement stayed uncommon. Osteomyelitis affected 3 patients (2.2%), each at a distinct site—left great toe, left great-toe distal phalanx, and the right fourth and fifth metatarsals. Charcot neuroarthropathy appeared in a single patient (0.7%). Structural toe deformities were equally scarce, recorded in 4 patients, and no patient carried an ingrown nail, callus or fissure.

Table 3: Prevalence of diabetic foot complications and mortality (N = 135)

Complication / outcome	Frequency	Percent
Foot ulcer	66	48.9
Cellulitis	52	38.5
Gangrene	30	22.2
Amputation (any level)	28	20.7
Abscess	23	17.0
Pedal pulse deficit (feeble/absent)	10	7.4
Pre-gangrenous lesion	4	3.0
Osteomyelitis	3	2.2
Necrotising fasciitis	2	1.5
Charcot neuroarthropathy	1	0.7
Mortality	3	2.2

Peripheral vascular disease was documented in 21 patients (15.6%); anatomical site data are given in the text.

Table 4: Characteristics of diabetic foot ulcers

Ulcer characteristic	Frequency	Percent
Anatomical site (n = 66)		
Left foot	17	25.8
Right foot	11	16.7
Left toe	5	7.6
Right toe	5	7.6
Right sole	4	6.1
Left forefoot	3	4.5
Other single sites (≤1 each)	21	31.8
Clinical type (n = 42)		
Non-healing	17	40.5
Diabetic	13	31.0
Healing	5	11.9
Necrotic	3	7.1
Chronic	1	2.4
Extensive / bone-deep	1	2.4
Trophic	1	2.4
Trophic + non-healing	1	2.4
Wagner grade (n = 19)		
Grade 1	2	10.5
Grade 2	6	31.6
Grade 3	7	36.8
Grade 4	4	21.1

Percentages are calculated on the number of ulcers for which each characteristic was recorded.

Amputation: Amputation had been performed in 28 patients (20.7%); the remaining 107 (79.3%) retained intact limbs (Table III). Minor amputation prevailed. Single-toe amputation was the commonest procedure at 9 patients (32.1%), followed by two-toe (6, 21.4%) and three-toe (3, 10.7%) amputations; transmetatarsal amputation accounted for 2 (7.1%) and below-knee amputation for 1 (3.6%). The left toe was the most frequently amputated site (12, 42.9%), ahead of the right toe (8, 28.6%) and bilateral toe loss (3, 10.7%) [Table 5].

Mortality: Death was infrequent. Three patients (2.2%) died over the study period, while 132 (97.8%) survived [Table 3].

Table 5: Amputation profile (n = 28)

Amputation characteristic	Frequency	Percent
Level / type		
Single toe	9	32.1
Two toes	6	21.4
Three toes	3	10.7
Four toes	2	7.1
Transmetatarsal	2	7.1
Ray amputation	1	3.6
Two toes + metatarsal	1	3.6
Three toes + split-skin grafting	1	3.6
Five toes	1	3.6
Below-knee amputation	1	3.6
Total knee replacement	1	3.6
Laterality		
Left toe	12	42.9
Right toe	8	28.6
Bilateral toe	3	10.7
Other combinations	5	17.9

Table 6: Anatomical distribution and type of cellulitis and gangrene

Site / type	Frequency	Percent
Cellulitis — site (n = 52)		
Left leg	23	44.2
Right leg	14	26.9
Left foot	8	15.4
Right foot	5	9.6
Right 4th webspace + leg	1	1.9
Right ankle + foot	1	1.9
Gangrene — site (n = 30)		
Left toe	12	40.0
Right toe	12	40.0
Left foot	3	10.0
Left leg	1	3.3
Right foot	1	3.3
Right lateral aspect of foot	1	3.3
Gangrene — type (n = 8)		
Wet	6	75.0
Dry	2	25.0

DISCUSSION

This study profiled the clinical spectrum of diabetic foot disease in a cohort with predominantly long-standing diabetes. Foot complications sit among the most disabling sequelae of the disease, yet they often attract less clinical urgency than retinopathy, nephropathy or coronary disease—despite comparable prognostic weight. Uncontrolled foot pathology ends in perfusion failure and tissue necrosis. We analysed 135 adults and set the findings against published Indian and international series.

The cohort was older, with a mean age of 60.9 years and a clear peak in the 55–64-year band. That pattern matches the wider literature, in which foot complications concentrate among middle-aged and elderly patients. Jyothylekshmy et al. identified advancing age as a critical risk factor at a South Indian podiatry clinic,3 and Maiya et al. documented the same trend in a community survey in rural Udupi.9 The signal likely reflects the cumulative burden of ageing and chronic hyperglycaemia, layered on peripheral neuropathy, vascular insufficiency and impaired wound healing. Akkus and Sert make the same point, noting that the diabetic foot ulcer remains devastating in elderly patients with long-standing disease despite modern therapy.[4]

Metabolic indices told a consistent story of poor long-term control. Mean HbA1c stood at 9.4%, well above target, and mean disease duration reached 14 years—a predominantly long-standing diabetic population. Mean BMI of 24.5 kg/m² placed most patients at the overweight margin by Asian criteria. These figures echo Jyothylekshmy et al.[3] and Satheesh and Philip,10 both of whom linked inadequate glycaemic control and prolonged duration to foot complications in South India. The relatively modest BMI fits the "Asian Indian phenotype," in

which higher visceral adiposity and metabolic susceptibility drive complications at lower body weight,1 against a backdrop of the rising diabetes and prediabetes burden documented in Kerala.[2]

Oral hypoglycaemic agents dominated management, consistent with Indian practice, where oral therapy remains the mainstay of long-term outpatient care.[1] The sizeable proportion on insulin points to advanced disease and poor control, reinforced by the elevated HbA1c and long duration; the near-absence of diet-only management shows that lifestyle measures rarely suffice once complications appear.[4]

Comorbidity was heavy. Hypertension led at 58.5%, followed by coronary artery disease and chronic kidney disease, a triad that signals substantial cardiovascular and renal risk. Hypertension aggravates the diabetic foot through endothelial dysfunction, reduced perfusion and slowed healing,[3] while renal impairment compromises immunity and tissue repair and raises infection risk.[5] The overlap of nephropathy with vascular insufficiency and neuropathy amplifies ulceration risk and stalls recovery,[11] and coexisting dyslipidaemia points to underlying metabolic syndrome and accelerated atherosclerosis.1 Shahi et al. similarly observed clustering of microvascular disease in patients with foot ulcers.[12]

Amputation had been performed in one in five patients, mostly at toe level. Shahi et al. identified the diabetic foot ulcer as a primary driver of lower-limb loss in North India,[12] and Jeyaraman et al. linked ischaemia, severe infection and multiple comorbidities to both amputation and death.[8] The comparatively low, predominantly minor amputation rate here may reflect earlier wound care and multidisciplinary management; Viswanathan et al. showed that proactive screening and patient education cut progression to surgery in South India.[13] Even so, the diabetic foot ulcer remains a leading global cause of non-traumatic lower-limb amputation.[4]

Non-healing ulcers made up the largest severity category, in keeping with the impaired wound repair characteristic of diabetes—persistent hyperglycaemia, infection, poor angiogenesis, chronic inflammation and ischaemia together convert acute lesions into chronic wounds.[4] Nair et al. reported severe infection and delayed healing, often with resistant organisms, in diabetic foot ulcers from South Kerala.[11] The bone-deep ulcers seen here imply osteomyelitis and a poorer prognosis, echoing the association between deep-tissue ulceration and adverse outcomes described by Jeyaraman et al.[8]

The high cellulitis rate tracks closely with ulceration: chronic ulcers act as portals of entry for pathogens, and impaired host defence and sustained hyperglycaemia let localised infection spread into deeper tissue.4 Neuropathy and inadequate foot care compound the problem by masking early injury, as Maiya et al. observed in their community survey.[9]

Wet gangrene predominated over dry, which carries clinical weight: wet gangrene reflects acute infection, rapid necrosis and a heightened risk of sepsis and amputation, and it typically demands emergency intervention.[4] Kilic et al. linked elevated foot risk and peripheral vascular disease to gangrene and severe ulceration.[7] The low count of pre-gangrenous lesions suggests that many patients presented only after overt necrosis had set in—an argument for earlier detection.

Documented peripheral vascular disease was relatively uncommon, which may reflect regional differences in care access, a neuropathy-dominant mechanism of foot injury, or effective early vascular screening.[6] Yavuz et al. highlighted repetitive trauma, neuropathy and disturbed biomechanics as ulcer drivers even without significant vascular disease,[6] and Viswanathan et al. showed that structured screening and education reduce progression to amputation and severe ischaemia.[13] Regardless of its prevalence, peripheral vascular disease remains an important prognostic marker, since Jeyaraman et al. tied it to higher mortality and worse outcomes.[8]

Mortality was low at 2.2%, but the finding should be read against the cohort's risk profile rather than in isolation. Jeyaraman et al. reported elevated mortality when foot disease coexisted with chronic kidney disease, cardiovascular events and severe ulceration,[8] and Akkus and Sert noted that fatal outcomes are frequently precipitated by sepsis and respiratory failure.[4] The modest death rate here may owe to the lower frequency of advanced ischaemic lesions, yet the high prevalence of hypertension, coronary artery disease and chronic kidney disease keeps the risk of systemic deterioration real.[8] Nair et al. likewise warned that severe infections such as necrotising fasciitis and gangrene can escalate rapidly where host defences and vascular health are compromised.[11]

Limitations: Several limitations temper these findings. The study was conducted at a single tertiary centre, so referral patterns may have concentrated more severe disease and limit generalisability to community settings. The retrospective, record-based design left several variables incompletely documented—glycated haemoglobin was available for 57 of 135 patients, and ulcers were formally Wagner-graded in only 19—which constrains the precision of some estimates. The analysis was descriptive, without testing associations between exposures and outcomes; in particular, the small number of deaths precluded any risk-factor analysis for mortality. Long-term follow-up was not available, so outcomes beyond the index period remain unknown. Prospective, multicentre studies with complete data capture would allow firmer estimates and formal risk modelling.

CONCLUSION

Adult diabetic patients at this tertiary care hospital in Kerala carried a high burden of foot complications, with ulceration, cellulitis and gangrene common and

amputation performed in one in five. The affected population was older, poorly controlled and long-diagnosed, with a dense comorbidity load dominated by hypertension, coronary artery disease and chronic kidney disease. Mortality was low in this cross-section, but the cardiovascular and renal risk profile was pronounced. These findings argue for routine foot screening—particularly for peripheral neuropathy—alongside tighter glycaemic control, structured patient education on foot hygiene, and dedicated training of clinical staff in diabetic foot care, as practical steps toward reducing the morbidity and mortality of this preventable condition.

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