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Original Research

Prevalence and risk factors of Diabetic Foot changes among Community-Dwelling Adults with diabetes mellitus in an Underprivileged Area of Bangalore: A Cross-Sectional Study

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Background

Diabetic foot changes are often neglected in diabetes management, especially in underprivileged communities. Foot changes such as dry skin, cracks, ulcers, and infections are common among individuals with diabetes. This study aims to assess the prevalence and risk factors diabetic foot changes among community-dwelling adults with diabetes in Tavarekere slum an underprivileged area of Bangalore city.

Methods

A community based cross-sectional study was conducted among 374 adults with diabetes in an underprivileged area of Bangalore city. A pretested questionnaire capturing socio-demographic details, morbidity profile and diabetic foot changes was used. Statistical analysis included chi-square tests and multivariable logistic regression.

Results

The prevalence of diabetic foot changes was 62.6% (95% CI: 57.7 to 67.5), with dry skin (48.1%, 95% CI: 43.0 to 53.2) and cracks (41.9%, 95% CI: 36.9 to 46.9) being the most common findings, while foot ulcers were observed in 7.4% (95% CI: 4.7 to 10.1) of participants. Older age (⩾45 years) was a significant risk factor of foot changes (AOR: 1.94, 95% CI: 1.11–3.38, p = 0.02)

Conclusion

The high prevalence of diabetic foot changes highlights the need for regular foot examinations, improved patient education and accessible preventive care. Integrating foot care into diabetes management programs can help reduce morbidity and prevent amputations, especially in resource-limited settings.

INTRODUCTION

Globally, 537 million adults (20-79 years) are living with diabetes. This translates to 1 in 10 adults. This number is predicted to rise to 643 million by 2030 and 783 million by 2045. Over 3 in 4 adults with diabetes live in low and middle-income countries. Diabetes was responsible for 6.7 million deaths in 2021.[1]

Patients with diabetes mellitus are at higher risk for developing foot changes due to microvascular and neuropathic changes to the foot. Diabetic foot is more vulnerable to mechanical or pressure injury wounds due to neuropathic changes in the body, which reduce sensation in the feet. Microvascular alterations may cause the lower extremities to receive less blood, which would delay the healing of wounds.[2]

Diabetic foot changes are one of the most severe and debilitating complications of diabetes. About 12% of people with diabetes develop diabetic foot changes or ulcers during their lifetime.[3] It is a primary contributor to low quality of life, increased socioeconomic burden, hospitalization, morbidity, and mortality. Foot ulcers are precursors to about 85% of lower limb amputations.[4] Pre-ulcerative changes such as dry skin, cracks, nail infections, toe deformities, and interdigital infections can further compromise foot integrity, increasing the risk of ulceration and subsequent complications if not managed appropriately.

One of the most neglected areas of diabetes care in India is foot care practices. People walk barefoot due to social, religious, and economic factors. Inappropriate footwear uses and delayed reporting of foot lesions are caused by poverty and illiteracy.[5] Delayed reporting of foot lesions is often attributed to the loss of protective sensation in the feet, a

common complication of diabetic neuropathy. This sensory impairment prevents individuals from recognizing early signs of injury or infection, leading to delays in seeking care and increasing the risk of severe complications. To prevent such complications, examination of the foot changes by physicians plays a vital role. There are very few physicians performing foot examinations. This lack of attention to foot health in patients with diabetes underscores the need for increased awareness and training among healthcare professionals.

There is a lack of studies on diabetic foot changes among community-dwelling adults in underprivileged urban areas, where socio-economic and cultural factors may uniquely influence outcomes. Regular foot examinations can lead to early detection and intervention, significantly reducing the risk of severe complications and improving overall patient outcomes. Thus, this study aims to assess diabetic foot changes among community-dwelling adults with diabetes in Tavarekere slum, an underprivileged area of Bangalore city.

MATERIAL AND METHODS

Study design- A community based cross section study

Study population- All adults diagnosed with diabetes residing in Tavarekere slum, an underprivileged area in Bangalore city, who are permanent residents of this area.

Inclusion criteria-

1. Adults aged 18 years and above and diagnosed with Diabetes.
2. Permanent residents of the study area.

Exclusion criteria-

1. Newly diagnosed cases of diabetes.
2. Individuals unavailable for follow-up visits after three attempts.

Study duration - Study was done for a duration of 7 months.

Sample size- We estimated a minimum sample size of 163 by taking a prevalence of 12% as the lifetime risk for foot ulcers, with an absolute precision rate of 5% and a confidence interval of 95%.[6] As it was a community-based study, only individuals who reported to have diabetes in our study area were included. Hence, universal sampling method was done and we had 374 participants total.

Study tools- A face validated, pretested, semi-structured questionnaire was used for data collection. The questionnaire included the following components:

1. Socio-Demographic details- Collected data on participants' age, gender, marital status, and occupation.
2. Morbidity Assessment - Identified participants with diabetes mellitus and categorized them as having controlled or uncontrolled diabetes. Diabetes is categorized as fasting blood sugar (FBS) (>126 mg/dl), postprandial blood sugar (PPBS) (>200 mg/dl) or random blood sugar (RBS) ⩾200 mg/dL. These were taken as cutoff values.(Association, 2021). We also documented the presence of comorbid conditions, including hypertension, dyslipidaemia, lung diseases, liver diseases, and cancer.
3. Observational checklist for foot examination - A comprehensive foot examination was conducted to assess the presence of cracks, dry skin, ulcers, sharp toenails, ingrown toenails, nail infections, interdigital infections, and any other observable foot changes.
4. Footwear and foot care practices - Participants were assessed for the type of footwear used, including open-toed, closed-toed, or diabetic footwear. Foot care practices such as regular foot inspection, proper nail trimming, moisturizing, hygiene maintenance, and seeking medical attention for foot issues were also evaluated.

Ethical considerations- The study had the approval of Institutional Ethics Committee 125/2022 SJMC. Informed written consent was obtained from the study participants.

DATA MANAGEMENT AND ANALYSIS

Data was collected in Epicollect5, extracted into MS Excel and analysed using Jamovi software version 2.4.11. In our study, we used descriptive statistics like mean, SD, and percentages to summarize the prevalence of diabetic foot changes, socio-demographic variables (e.g., age, gender, marital status), morbidity profiles, and specific foot complications. We employed Chi-square tests to explore associations between categorical variables, including age, marital status, diabetes control, and the presence of foot changes. We calculated odds ratios (ORs) with 95% confidence intervals (CIs) to estimate the strength of associations between risk factors (e.g., age, comorbidities) and diabetic foot changes. We performed multivariable logistic regression analysis to identify the predictors for diabetic foot changes, while adjusting for other factors. For the multivariable logistic regression, the presence of any diabetic foot changes was considered the outcome variable. All socio-demographic and morbidity-related variables with a p-value less than 0.2 (age, gender and presence of comorbidities) were included in the model as covariates. Statistical significance was assessed using p-values, with a threshold of $p < 0.05$.

RESULTS

We included 374 participants with diabetes mellitus. The mean age was 54.5 years (SD- 11.6). Most participants were female (67.9%). 74.1% of the participants were currently married. Occupationally, over half, 52.4%, were homemakers, reflecting a population with limited professional engagement. Salaried individuals comprised 13.9%, followed by retirees 12.8%, daily wage workers 8%, and unemployed individuals 6.7%. Of our study participants, 78.7% had appropriate foot wear and 69.8% had good foot care practices. Table 1 provides an overview of the socio-demographic characteristics of the study population.

The morbidity profile highlights that 65% of participants had controlled diabetes, while 35% had uncontrolled diabetes. Comorbidities were prevalent, with hypertension

Table 1. Socio demographic details of study participants

Variable	Categories	N(%)
Age	24- 44 45 and above	75 (20.1%) 299 (79.9%)
Gender	Male Female	120 (32.1%) 254 (67.9%)
Marital status	Currently Married Not currently Married	277 (74.1%) 97 (25.9%)
Occupational status	Home maker Salaried Unemployed Daily wager Retired Self-employed / Business Student	196 (52.4%) 52 (13.9%) 25 (6.7%) 30 (8.0%) 48 (12.8%) 22 (5.9%) 1 (0.3%)

Table 2. Morbidity Profile of study participants

Variable	Categories	N (%)
Diabetes Mellitus	Controlled Uncontrolled	243 (65%) 131 (35%)
Comorbidities	HTN Dyslipidaemia Lung diseases Liver disease Cancer	212 (56.7%) 29 (7.8%) 07 (1.9%) 02 (0.5%) 04 (1.1%)
Complications	Stroke CVD	10 (2.9%) 36 (9.36%)

Table 3. Diabetic Foot changes in study participants

Diabetic Foot changes	Percentage (95% CI)
Crack	41.9% (95% CI: 36.9 - 46.9)
Dry skin	48.1% (95% CI: 43.0 - 53.2)
Ulcer	7.4% (95% CI: 4.7 - 10.1)
Toe nail sharp	11.2% (95% CI: 8.0 - 14.4)
Toe nail Ingrowth	5.8% (95% CI: 3.4 - 8.2)
Nail infection	2.6% (95% CI: 1.0 - 4.2)
Infection between toe	2.1% (95% CI: 0.6 - 3.6)
Any changes	62.6% (95% CI: 57.7 - 67.5)

(56.7%) being the most common, dyslipidaemia 7.8%, and cardiovascular disease 9.36%. Table 2 explains the details of morbidity. Stroke occurred in 2.9% of the sample.

Table 3 shows that 62.6% of participants reported diabetic foot changes, with dry skin (48.1%, 95% CI: 43.0 to 53.2) and cracks (41.9%, 95% CI: 36.9 to 46.9) being the most common issues. 7.4% (95% CI: 4.7 to 10.1) of cases showed serious complications such as ulcers, while nail infections were 2.6%, and interdigital infections were 2.1%.

In Table 4, our study identified significant associations between diabetic foot changes and specific demographic and health factors. Older individuals (⩾45 years) had nearly twice the likelihood of developing diabetic foot changes compared to younger participants (AOR: 1.94, 95% CI: 1.11–3.38, p = 0.02). Marital status showed a notable trend, with individuals not currently married, having a higher risk of diabetic foot changes (AOR: 1.59, 95% CI: 0.95–2.67, p = 0.08), though this was not statistically significant. Gender, presence of co-morbidities and glycaemic control (controlled vs. uncontrolled diabetes) were not significantly associated with foot complications.

DISCUSSION

Underprivileged areas in Bangalore consist of densely populated urban slums and low-income settlements where residents face challenges such as poor sanitation, inadequate healthcare access and lower education levels. In our study,

Table 4. Association between diabetic foot changes and sociodemographic variables

	Total	Diabetic foot changes		Odds Ratio (95% CI)	P value	AOR	P Value
		Yes (%)	No (%)				
Age	24- 44	27 (33.7%)	48 (16.3%)	2.61 (1.50-4.56)	<0.001	1.94 (1.11-3.38)	0.02
	45 and above	53 (66.3%)	246 (83.7%)				
Gender	Male	95 (32.3%)	25 (20.8%)	0.952 (0.559-1.62)	0.857		
	Female	199 (67.6%)	95 (79.2%)				
Marital status	Currently Married	164 (70.1%)	113 (80.7%)	0.560 (0.338-0.927)	0.023	1.59 (0.95-2.67)	0.08
	Not currently Married	70 (29.9%)	27 (19.3%)				
Diabetes Mellitus	Uncontrolled	154 (65.8%)	89 (63.6%)	1.10 (0.712-1.71)	0.660		
	Controlled	80 (34.2%)	51 (36.4%)				
Comorbidities	No Comorbidities	83 (35.5%)	64 (45.7%)	0.653 (0.426-1.00)	0.050	1.03 (0.51-2.05)	0.94
		151 (64.5%)	76 (54.3%)				
	1 Comorbidities	121 (51.7%)	58 (41.4%)	1.54 (0.992-2.31)	0.054	0.817 (0.41-1.60)	0.55
		113 (49.3%)	82 (58.6%)				
	2 Comorbidities	20 (8.5%)	11 (7.9%)	1.10 (0.509-2.36)	0.815		
		214 (91.5%)	129 (92.1%)				
	3 Comorbidities	5 (2.1%)	6 (4.3%)	0.488 (0.146-1.63)	0.234		
		229 (97.9%)	134 (95.7%)				
	4 Comorbidities	4 (1.7%)	1 (0.7%)	2.42 (0.268-21.8)	0.417		
		230 (98.3%)	139 (99.3%)				

the prevalence of diabetic foot changes among adults in Tavarekere slum- an underprivileged area of Bangalore city was notable, with 62.6% of participants exhibiting at least one form of diabetic foot change. Many individuals in these areas work in informal sectors, have limited awareness of preventive healthcare, and may not have access to regular medical check-ups.

The most common issues were dry skin 48.1% (95% CI: 43.0 to 53.2), cracks 41.9% (95% CI: 36.9 to 46.9), and foot ulcers were present in 7.4% (95% CI: 4.7 to 10.1) of the population. 65% of participants had controlled diabetes, while 35% had uncontrolled diabetes. Pre-ulcerative changes, including dry skin, cracks, nail infections, toe deformities, and interdigital infections, can significantly weaken integrity of the foot. If left unaddressed, these conditions may progress to ulceration, increasing the risk of severe complications, including infection and amputation. A prior study reported that poor knowledge and inadequate foot care practices among diabetic patients exacerbate the progression of such pre-ulcerative conditions, aligning with our findings and highlighting the critical role of awareness in prevention.[7] A combination of efforts from healthcare personnel, improved patient education, multidisciplinary approach to prevention and early detection of foot changes and treatment and regular monitoring of wounds can lower amputation rates by 49–85%.[8]

Comparing our findings with similar studies, a study conducted in Kollam, Kerala, India, reported a prevalence of 9.9% of diabetic foot ulcers, where less than 12% of diabetic patients performed regular foot screenings, and systematic analysis reported a prevalence of 6.25%, which aligns with our study findings of 7.4%.[9,10] Foot ulcers in patients are largely due to poor glycaemic control, neuropathy, and peripheral arterial disease, which impair healing and sensation. Factors like dry skin (48.1%), cracks (41.9%), comorbidities (e.g., hypertension at 56.7%), and barefoot walking- a common practice in underprivileged areas due to cultural norms and lack of footwear- expose feet to trauma

and infections, increasing ulcer risk.[11] In this area, we found that many people were unaware of the consequences of foot ulcers in patients with diabetes. This lack of awareness can lead to serious health complications, ultimately increasing the risk of amputations and hospitalizations. Education and outreach efforts are crucial in helping individuals understand the importance of proper foot care and regular check-ups for those living with diabetes. In general, we felt there was a need for education on protective footwear, foot care examination and foot care practices.

Our findings revealed that three-fourths of the study participants were aged >45 years and were at risk for foot changes. Similarly, a study conducted in 2018 found that the people in higher age groups are at more risk of getting diabetic foot ulcers.[12] Aging leads to reduced elasticity of blood vessels, which in turn reduces the efficiency of circulation. Due to the effects of peripheral neuropathy, there is a decrease or loss of sensation in the feet. They did not feel minor injuries, pressure sores, or blisters, which had progressed to ulcers unnoticed. Aging causes the skin to lose collagen and elasticity, making it more vulnerable to cuts, abrasions, and pressure sores. Reduced mobility had prevented older adults from inspecting their feet regularly, delaying ulcer detection. Vision impairment makes it difficult to notice small wounds or pressure sores early. Ill-fitting shoes may increase the pressure and friction, leading to blisters, ulcers and difficulty in maintaining proper foot hygiene, increasing the risk of infections. These suggest that age is a significant factor in the development of diabetic foot ulcers, highlighting the importance of targeted prevention strategies for older individuals. It is crucial for healthcare providers to consider age as a key risk factor when assessing and managing diabetic foot complications.

Our study highlights the urgent need for a multidisciplinary approach to diabetic foot care, particularly in underprivileged settings. The high prevalence of diabetic foot changes underscores the importance of routine foot examinations and self-care practice for patients. Physicians must integrate foot assessments and patient education into routine diabetes management, and ensure better glycaemic control and adherence to treatment. Policy makers can leverage these findings to implement community-level interventions such as routine foot screenings, subsidized footwear and public health education. Strengthening medical curricula with modules on diabetic foot care and training community health workers for early detection and referral can significantly improve outcomes. Addressing these clinical, educational, and policy dimensions will help reduce the burden of diabetic foot complications and improve patient's quality of life.

Further research is essential to explore community-level risk factors, social determinants, and the effectiveness of interventions for diabetic foot complications in underprivileged areas. While hospital-based studies exist, there is limited data on how socio-economic and cultural factors, such as barefoot walking and limited healthcare access, influence foot health at the community level. Understanding these factors can help develop targeted prevention strategies.

LIMITATIONS AND FUTURE DIRECTIONS

This study's cross-sectional design limits causal inferences, and the reliance on observational checklist data may introduce recall and social desirability biases. Additionally, the exclusion of newly diagnosed diabetes cases and the lack of objective diagnostic tools, such as monofilament testing and Doppler studies, may have led to an underestimation of complications. Since the study was conducted in a single underprivileged urban area, its findings may not be generalised to other regions. Longitudinal studies are needed to track disease progression and assess the long-term impact of interventions. A significant association was found between age and the presence of foot changes, with older participants (45 years and above) found to be at a higher risk of developing disease. These findings underscore the magnitude of diabetic foot issues in this vulnerable population and highlight the need for targeted interventions.[13-15] Future research should focus on intervention-based trials to evaluate the effectiveness of community-based education, subsidized protective footwear, and improved screening practices. Expanding studies to multiple regions and integrating diabetic foot care into existing national health programs will be crucial in developing scalable and sustainable strategies to reduce diabetic foot complications and improve patient outcomes.

CONCLUSION

The study highlights a high prevalence (62.6%) of diabetic foot complications among community-dwelling individuals with diabetes, with dry skin, cracks, and ulcers being the most commonly observed conditions. These findings underscore a critical public health concern, as such pre-ulcerative and ulcerative changes not only impair mobility and quality of life but also increase the risk of infections, hospitalizations, and lower-limb amputations. The significant association between age and diabetic foot changes further emphasizes the vulnerability of older adults, particularly those aged 45 years and above, who were found to have nearly twice the odds of developing foot complications.

These insights reinforce the urgent need for early screening, regular foot examinations, and community-level health education focusing on foot care and proper footwear use. By integrating foot care awareness into routine diabetes management programs, especially in resource-limited settings, it is possible to prevent complications, reduce healthcare costs, and improve the overall well-being of people living with diabetes.

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CONFLICT OF INTEREST

None

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