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Diabetes & its Complications

Foot Care Education and Self-Efficacy Practices Among Diabetic Patients in Developing Countries: A Cross-Country Survey

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ABSTRACT

Background: *Diabetic foot ulcers (DFUs) are a major complication among people with diabetes, particularly in developing countries, and are associated with high morbidity and mortality within the first five years of ulcer onset.*

Aim: This study aimed to assess foot care education, self-efficacy practices, and foot care behaviors among diabetic patients in Nigeria and Trinidad and Tobago.

Methods: *A cross-sectional questionnaire survey was conducted among 565 diabetic patients attending routine clinic appointments in Nigeria and Trinidad and Tobago. A validated questionnaire assessing foot care knowledge, self-efficacy, and behavior was adapted and administered. The Statistical Package for the Social Sciences (SPSS) software was employed for analysis of responses using binary and Likert-scale metrics while Student t-tests and Chi-square tests were used to compare groups.*

Results: *Diabetes duration exceeded five years in 85% of the participants, and the prevalence of DFUs was significantly higher among Nigerian patients ($p<0.001$). Overall, 38% of patients had never received foot care education, with a higher proportion in Trinidad (55.5% vs. 22.3%, $p<0.001$). Nearly half (46.3%) of respondents did not know their HbA1c levels. While 80% demonstrated average self-confidence scores, patients from Trinidad reported significantly higher scores (all $p<0.05$). Appropriate foot care practices were performed only occasionally by most participants, particularly in Trinidad (all $p<0.05$).*

Conclusion and Recommendation: *The high prevalence of DFUs, limited exposure to foot care education, and moderate self-efficacy levels observed in these populations align with previous findings in other developing countries. Strengthening foot care education as a central component of diabetes management could enhance self-efficacy and reduce the incidence of preventable lower-limb amputations in both settings.*

Keywords

Diabetic foot ulcer, Foot care education, Self-efficacy, Patient behavior, Developing countries.

Introduction

The 2024 International Diabetes Federation (IDF) report showed that the prevalence of diabetes and its complications were increasing more in the developing nations than the developed nations [1]. The report predicted that the prevalence of diabetes in Africa will

increase by 142%, that is, from the current 24.6 million people living with diabetes to 59.5 million by 2050 [1]. Thus, developing countries—especially those in the tropical regions of the world that were hitherto struggling with the scourge of infectious diseases—are further burdened with diabetes and its complications [2-4]. In developing countries, diabetic foot ulcers (DFUs), open sores on the feet, are common and serious complications of diabetes and usually result in high rates of health care costs, amputation, disability, and even deaths [5]. DFUs have the tendency to recur, and many patients report experiencing multiple episodes that may eventually lead to lower extremity amputation [6,7]. DFUs are major contributors to diabetic foot infections and gangrene, which commonly require prolonged hospital care with the associated high health care costs and burden on limited hospital resources [5,6]. Additionally, pain associated with DFUs, mobility issues, and psychological concerns negatively affect patients' quality of life [8,9]. Indeed, DFUs increase the risk of lower extremity amputation, and a recent report showed mortality rates of about 50% to 70% within 5 years of developing an ulcer [5]. Nigeria and Trinidad and Tobago are oil and gas economies but belong to different World Bank economic classifications [10]. However, both countries share high rates of DFUs associated with lower limb amputations [11-13]. Thus, DFUs are major public health problems in both countries and reflect the general trend in developing nations [5]. The strategy for stemming the rising burden of DFUs in developing countries requires a multifaceted approach, which must include, among others, optimal diabetes self-management and enhanced diabetic self-foot care education. Disease self-management education for patients with chronic noncommunicable diseases is very challenging in many developing countries [14-16]. A recent report from Nigeria showed that patients with chronic noncommunicable diseases have suboptimal self-efficacy scores [17]. Thus, given the importance of health care education in managing chronic diseases, this study aimed to assess diabetic foot care education, behaviors, and self-efficacy practices of patients in Nigeria and in Trinidad and Tobago. It is envisaged that this study will help provide insight into health care educational gaps in these 2 developing countries and assist in formulating recommendations that may strengthen foot care education.

Methodological Design

Study Sites and Patients' Recruitment

This 2-country study is part of a multinational international research collaboration involving Japan, Lithuania, China, Kazakhstan, Nigeria, and Trinidad and Tobago. The study is a cross-sectional questionnaire survey of 565 patients with diabetes attending routine clinic appointments in Nigeria and Trinidad and Tobago. The research study protocol was reviewed and approved by Nnamdi Azikiwe University Teaching Hospital, Nigeria (NAUTH/CS/66/VOL17/VER3/40/2024/90), and the Trinidad North Central Regional Health Authority (NCRHA-07-30-24), North-West Regional Health Authority (NWRHA-2024-0020), Eastern Regional Health Authority (ERHA: PHO:48/24:ERHA-REC.030/08/2024), and the University of the West Indies Research Ethics Committee (CRP.3.NOV.24.01).

Patients from Trinidad were recruited from primary health care settings. Trinidad and Tobago has 2 levels of health care—primary and secondary/tertiary. All patients attending primary care clinics receive similar treatment, care, and education from comparable health professionals (physicians, nurses, dietitians, and counselors) as per national health policies. Nigeria has 3 levels of health care—primary, secondary, and tertiary. Study participants from Nigeria were drawn from secondary health care facilities because primary care clinics in Nigeria do not have specialized clinics for chronic diseases. The secondary health care services in Nigeria are equivalent to primary health care in Trinidad and Tobago, particularly in terms of health care professional composition (specialist physicians, nurses, and dietitians).

Because patients with chronic noncommunicable diseases typically have appointments every 3 months, the survey in each country (Nigeria and Trinidad) was terminated after 4 months to avoid administering the same questionnaire twice to a single patient. Additionally, patients were counseled not to consent to participate again after completing the questionnaire. Research assistants assisted patients in completing questionnaires in each country.

Questionnaire Tool and Study Protocol

The questionnaire tool used in this study was adapted from Biçer and Enç.[18] Questions on foot care knowledge, self-efficacy, and actual foot care behaviors were adapted from the validated work of García-Inzunza et al. [19] Additionally, 5 Likert-scale items (1–5 points) were used to assess patient responses on foot care self-efficacy ([1] strongly not confident, [2] moderately not confident, [3] confident, [4] moderately confident, [5] strongly confident), and 4-point behavioral items ([1] always, [2] most of the time, [3] occasionally, [4] never) [18,19].

Because of the large number of questionnaire variables (49 variables), a patient-interviewer approach was used. The questionnaire was administered in English in Trinidad, and in a mixture of local Igbo and English in Nigeria. A previous study in Nigeria showed that the patient-interviewer approach using both Igbo and English languages improved response quality [17]. On each study day, patients were privately approached to obtain informed consent. The study's purpose and objectives were explained using an explanatory letter and consent form. Participation was voluntary, and only patients who provided informed consent were recruited. All participants met inclusion criteria: age > 18 years, prior diabetes diagnosis, ability to understand questions, and clinic registration. Patients were informed that data might be published in aggregate form to help improve medical services and that their identities would remain confidential. Completed questionnaires were coded and securely stored. The survey was conducted confidentially in private clinic spaces. No comprehension difficulties were reported, though patients were free to skip any question they found uncomfortable. The number of responses to each question is presented in the results tables.

Data analysis

The Statistical Package for the Social Sciences (SPSS, version 27) was used to analyze the data. The student's t-test was employed to analyze all quantitative data for differences between Nigeria and Trinidad while Chi-square test (2-sided) was utilized (where needed) to analyze all categorical variables. All quantitative data are presented as mean ± SD while numbers and percentages (%) are used to present all categorical data. A p-value of less than 0.05 was considered as statistically significant at 2-tailed testing.

Results

Table 1 shows that patients from Trinidad were significantly older than patients from Nigerian ($p < 0.001$). However, there was no difference in gender distribution between the two groups of patients. The majority of all the patients (85%) have had diabetes for more than 5 years. Although more patients from Trinidad had significantly longer diabetes duration ($p < 0.001$), the prevalence rate of DFU is higher in patients from Nigerian (47.0 vs. 29.5%, $p < 0.001$). Table 2 shows that about 38% of all the patients studied claimed that they have not received any specialized education on diabetic foot care, and more patients from Trinidad made this claim (55.5 vs. 22.3%, $p < 0.001$). Again about 15% of all the patients studied have never or rarely tested their blood glucose, and more patients from Trinidad than from Nigeria never/rarely tested their blood glucose (18.3 vs. 12.0%, $p < 0.05$). Similarly, more patients from Trinidad than Nigerian did not know their HbA1c levels (65.7 vs. 30.7%, $p < 0.001$). However, more patients from Trinidad were more likely to visit the hospital within a week of finding a wound on their feet (51.9 vs. 46.3%, $p < 0.001$). Table 3 shows the self-confidence assessment scores in key elements of DFU care in the patients studied. Generally, about 80% of all the mean self-confidence scores in all the assessment indicators were below 4.0 (average confident).

Thus, regardless of the mean self-confidence scores of all the patients studied, patients from Trinidad had higher self-confidence scores on most (60%) of the key elements of DFU care (Table 3, all, $p < 0.05$). However, patients from Nigerian were more likely to call their doctors about problems with their feet (4.01 ± 1.25 vs. 3.51 ± 1.50, $p < 0.001$). Table 4 shows that most of the patients cut their toenails straight across only occasionally and this is more prevalent in patients from Nigeria (60.0 vs. 45.5%, $p < 0.001$). Similarly, a relatively higher proportion of all the patients occasionally measured their feet when buying a new pair of shoes or wear trainers/sneakers/lace-up shoes, and the prevalence of these occasional practices were higher in patients from Trinidad (Table 4, $p < 0.001$). The majority of all the patients indicated that they never used chemical agents or plasters to remove corns and calluses, never treated corns or calluses with a blade and never used hot water bottles/heating pads to warm their cold feet at night. Interestingly, significantly higher percentages of patients from Trinidad never practiced these attributes compared with patients from Nigeria (Table 4, all, $p < 0.001$).

Summary of Findings and Discussion

Diabetic foot ulcer (DFU) is a common complication of diabetes in developing countries and contributes to mortality rates of approximately 50% to 70% within 5 years of onset [5]. To identify gaps in diabetic foot care education in developing countries, we conducted a cross-sectional survey of 565 patients with diabetes attending routine clinic visits in Nigeria and Trinidad and Tobago. The findings showed that most participants (85%) had diabetes for more than 5 years, and the prevalence of DFU was high in both populations, particularly among Nigerian patients. Approximately 38% of all participants had never received specialized education on diabetic foot care, especially those from Trinidad. Nearly half (46.3%) of all respondents did not know their HbA1c levels. Although 80% demonstrated average self-confidence scores, patients from Trinidad reported higher self-confidence overall. Most participants practiced appropriate foot care only occasionally. These findings are discussed in relation to diabetic foot care and education in developing countries.

Diabetes Duration and Prevalence of DFU

In both countries, most patients had been living with diabetes for more than 5 years. Although patients from Trinidad generally had a longer duration of diabetes, those from Nigeria exhibited a higher prevalence of DFU. This finding aligns with previous reports from both Nigeria and Trinidad and Tobago showing that DFUs were more prevalent in Nigeria [11-13]. Differences in DFU prevalence between the 2 populations may relate to variations in the standard of health care services or in the duration of diabetes. Trinidad's health care services are generally better developed than those in Nigeria (personal observation).

Nonetheless, studies from both countries indicate that DFUs substantially increase the risk of lower extremity amputation [11-13]. Mortality rates of 50% to 70% within 5 years of DFU onset have also been reported [5]. A study from Tanzania reported that 15% of hospitalized patients with DFU underwent amputation, with a high mortality rate [20]. Similarly, a Nigerian cohort demonstrated mortality rates as high as 40.5% due to DFU [21,22], consistent with reports from other African nations [23,24]. In Nigeria, predictors of in-hospital mortality among patients with DFU, aside from amputation, include advanced ulcers, bacteremia, cardiac failure, and renal impairment [25]. Therefore, intensified educational interventions to reduce DFU prevalence are warranted particularly in Nigeria, where DFU-related mortality remains high [21,22].

Diabetic Foot Care Education

The finding that 38% of participants had never received specialized diabetic foot care education is consistent with previous reports highlighting poor DFU-related education in developing countries [26,27]. Although the proportion lacking specialized education was higher among Trinidadian patients, they exhibited better general diabetes knowledge than Nigerian patients. However, both groups showed a high prevalence of poor foot care education. Despite Trinidad's relatively stronger health care infrastructure (personal

Table 1: Clinical characteristics and prevalence of diabetic foot ulcer amongst the diabetes patients surveyed.

Characteristics	All patients (n = 565)	Nigeria (n=300)	Trinidad (n=265)
Mean age ± *SD* (yr) **(n = 563)****	60.8 ± 13.5	57.2 ± 14.1	65.0 ± 11.4
Gender distribution (n = 558)			
• Male patients (%)	222 *(39.8)*	130 (43.3)	92 (35.7)
• Female patients (%)	336 *(60.2)*	170 (56.7)	166 (64.3)
Educational status (n = 561)**			
• No formal education (%)	40 (7.1)	29 (9.7)	11 *(4.2)*
• Primary education (%)	139 (24.8)	52 (17.3)	87 *(33.3)*
• Secondary education (%)	258 (46.0)	134 (44.7)	124 *(47.5)*
• Tertiary education (%)	124 (22.1)	85 (28.3)	39 *(14.9)*
Diabetes duration (n = 562)**			
• Less than 5 years (%)	86 (15.3)	61 (20.3)	25 *(9.5)*
• More than 5 years (%)	476 (84.7)	239 (79.7)	237 *(90.5)*
Prevalence of DFU (n =565)**			
• No DFU (%)	347 (61.4)	159 (53.0)	182 *(70.5)*
• Had DFU (%)	218 (38.6)	141 (47.0)	76 *(29.5)*

**p < 0.05, **P < 0.001 for Chi-Square comparisons between Nigeria and Trinidad patients. DFU – diabetic foot ulcer*

Table 2: Evaluation of key elements of DFU education amongst the patients surveyed.

Questionnaire assessment questions	All patients (n = 565)	Nigeria (n=300)	Trinidad (n=265)
Have you ever received specialized education on diabetes foot care? (n=565) **			
• Yes (%)	239 (58.2)	221 (73.7)	108 *(40.8)*
• No (%)	214 (37.9)	67 (22.3)	147 *(55.5)*
• Can't remember (%)	19 (3.4)	10 (3.3)	9 *(3.4)*
How often do you test your blood glucose? (n=563) *			
• Many times (%)	479 (85.1)	264 (88.0)	215 *(81.7)*
• Rarely or never (%)	84 (14.9)	36 (12.0)	48 *(18.3)*
What has been your HbA1c level within the last 2 months? (n=542) **			
• Don't know (%)	251 (46.3)	92 (30.7)	159 *(65.7)*
• Knows (%)	291 (53.7)	208 (69.3)	83 *(34.3)*
When you find a wound on your foot, do you go to the hospital? (n=531) **			
• Within a week (%)	259 (48.8)	139 (46.3)	120 *(51.9)*
• Wait until the next doctor's appointment (%)	102 (19.2)	81 (27.0)	21 *(9.1)*
• Wait for a while (%)	75 (14.1)	39 (13.0)	36 *(15.6)*
• I don't go to hospital (%)	95 (17.9)	41 (13.7)	54 *(23.4)*
Diabetes often causes poor blood circulation. (n=557) **			
• Yes (%)	330 (59.2)	137 (45.7)	193 *(75.1)*
• No (%)	77 (13.8)	52 (17.3)	25 *(9.7)*
• I don't know (%)	149 (26.8)	111 (37.0)	38 *(14.8)*
Cuts and abrasions on diabetes patients heal more slowly. (n=558) **			
• Yes (%)	401 (71.9)	175 (58.3)	226 *(87.6)*
• No (%)	65 (11.6)	48 (16.0)	17 *(6.6)*
• I don't know (%)	92 (16.5)	77 (25.7)	15 *(5.8)*
Diabetes patients should take extra care when cutting their toenails? (n=561) **			
• Yes (%)	493 (87.9)	250 (83.3)	243 *(93.1)*
• No (%)	34 (6.1)	24 (8.0)	10 *(3.8)*
• I don't know (%)	34 (6.1)	26 (8.7)	8 *(3.1)*
Diabetes can cause loss of feeling in my hands, finger and feet? (n=557)			
• Yes (%)	370 (66.4)	156 (52.0)	214 *(83.3)*
• No (%)	86 (15.4)	69 (23.0)	17 *(6.6)*
• I don't know (%)	100 (18.0)	75 (25.0)	25 *(9.7)*

**p < 0.05, **p < 0.001 on 2-sided Pearson Chi-squared comparisons between Nigeria and Trinidad patients. DFU – diabetes foot ulcer.*

Table 3: Self-confidence assessment in key elements of DFU care in Nigeria and Trinidad patients.

Assessment of foot care self-efficacy: *[1] strongly not confident, [2] moderately not confident, [3] confident, [4] moderately confident, [5] strongly confident*	**Patients' mean self-confidence score (minimum = 1.0, maximum = 5.0)**		
	All patients Mean ± SD	**Nigeria Mean ± SD**	**Trinidad Mean ± SD**
I can protect my feet. (n=555)	4.04 ± 1.16	3.95 ± 1.23	4.19 ± 1.26*
Even without pain/discomfort, I can look at my feet daily to check for cuts, scratches, blisters, redness or dryness. (n=555)	3.89 ± 1.20	3.71 ± 1.23	4.10 ± 1.14**
After washing my feet, I can dry between my toes. (n=555)	3.93 ± 1.24	3.67 ± 1.26	4.25 ± 1.15**
I can judge when my toenails need to be trimmed by a podiatrist. (n=555)	3.50 ± 1.41	3.18 ± 1.42	3.87 ± 1.31**
I can trim my toenails straight across. (n=555)	3.60 ± 1.37	3.58 ± 1.28	3.62 ± 1.46
I can figure out when to use a pumice stone to smooth corns and/or calluses on my feet. (n=547)	2.95 ± 1.46	2.79 ± 1.47	3.14 ± 1.43*
I can test the temperature of the water before putting my feet into it. (n=552)	3.89 ± 1.26	3.82 ± 1.26	3.98 ± 1.25
When I go shopping for new shoes, I choose shoes that are good for my feet. (n=551)	3.99 ± 1.26	3.84 ± 1.35	4.18 ± 1.13*
I can call my doctor about problems with my feet. (n=550)	3.78 ± 1.39	4.01 ± 1.25	3.51 ± 1.50**
Before putting on my shoes, I check the insides for problems that could harm my feet. (n=553)	4.05 ± 1.19	3.86 ± 1.25	4.26 ± 1.08**

**p < 0.05, **p < 0.001 for mean confidence comparisons between Nigeria and Trinidad patients*

Table 4: Evaluation of key elements in diabetes foot care between Nigeria and Trinidad patients.

Questionnaire assessment questions	**All patients**	**Nigeria**	**Trinidad**
How often do you use chemical agents or plasters to remove corns and calluses? (n=555) **			
• Always (%)	26 (4.7)	24 (8.0)	2 *(0.8)*
• Most of the time (%)	40 (7.2)	26 (8.7)	14 *(5.5)*
• Occasionally (%)	106 (19.1)	78 (26.0)	28 *(11.0)*
• Never (%)	383 (69.0)	172 (57.3)	211 *(82.7)*
How often do you yourself treat corns or calluses with a blade? (n=554) **			
• Always (%)	5 (0.9)	4 (1.3)	1 *(0.4)*
• Most of the time (%)	47 (8.5)	43 (14.3)	4 *(1.6)*
• Occasionally (%)	136 (24.5)	123 (41.0)	13 *(5.1)*
• Never (%)	366 (66.1)	130 (43.3)	236 *(92.9)*
How often do you cut your toenails straight across? (n=551) **			
• Always (%)	87 (15.8)	22 (7.3)	65 *(25.9)*
• Most of the time (%)	106 (19.2)	73 (24.3)	33 *(13.1)*
• Occasionally (%)	294 (53,4)	180 (60.0)	114 *(45.4)*
• Never (%)	64 (11.6)	25 (8.3)	39 *(15.5)*
How often do you have your feet measured when buying a new pair of shoes? (n=553) **			
• Always (%)	76 (13.7)	33 (11.0)	43 *(17.0)*
• Most of the time (%)	87 (15.7)	54 (18.0)	33 *(13.0)*
• Occasionally (%)	185 (33.5)	118 (39.3)	67 *(26.5)*
• Never (%)	205 (37.1)	95 (31.7)	110 *(43.5)*
How often do you wear trainers/sneakers or lace-up shoes? (n=552) *			
• Always (%)	64 (11.6)	24 (8.0)	40 *(15.9)*
• Most of the time (%)	125 (22.6)	65 (21.7)	60 *(23.8)*
• Occasionally (%)	216 (39.1)	117 (39.0)	99 *(39.3)*
• Never (%)	147 (26.6)	94 (31.3)	53 *(21.0)*
How often do you rely on feeling the fit of the shoes when buying a new pair? (n=553) **			
• Always (%)	212 (38.3)	85 (28.3)	127 *(50.2)*
• Most of the time (%)	135 (24.4)	85 (28.3)	50 *(19.8)*
• Occasionally (%)	130 (23.5)	82 (27.3)	48 *(19.0)*
• Never (%)	76 (13.7)	48 (16.0)	28 *(11.1)*
How often do you wear sandals or slip-ons? (n=553) *			
• Always (%)	213 (38.5)	133 (44.3)	80 *(31.6)*
• Most of the time (%)	170 (30.7)	78 (26.0)	92 *(36.4)*
• Occasionally (%)	134 (24.2)	70 (23.3)	64 *(25.3)*
• Never (%)	36 (6.5)	19 (6.3)	17 *(6.7)*
When your feet feel cold at night, how often do you use hot water bottles/heating pads to warm them? (n=554) **			
• Always *(%)*	41 (7.4)	31 (10.3)	10 *(3.9)*
• Most of the time *(%)*	83 (15.0)	73 (24.3)	10 *(3.9)*
• Occasionally *(%)*	110 (19.9)	83 (27.7)	27 *(10.6)*
• Never *(%)*	320 (57.8)	113 (37.7)	207 *(81.5)*

**p < 0.05 on 2-sided Pearson Chi-squared comparisons between Nigeria and Trinidad patients*

communication), diabetes education focusing on foot care appears inadequate in both settings, contributing to the observed high DFU and lower-limb amputation rates [11-13]. Another concern is that nearly half (46%) of respondents were unaware of their HbA1c levels. HbA1c reflects average blood glucose levels over approximately 12 weeks and is central to diabetes education. Poor glycemic control contributes to both macrovascular and microvascular complications [28]. These complications are strongly associated with DFU, infection, gangrene, and eventual amputation—conditions that are difficult to manage in resource-limited environments [26].

Glycemic control is crucial, as HbA1c levels greater than 8% and fasting blood glucose exceeding 126 mg/dL are associated with increased risk of lower extremity amputation [29]. The benefits of structured diabetic foot care education are well documented [26,30], and strengthening diabetes self-management education with a focus on foot care is essential in developing countries.

Diabetes Self-Efficacy Practices

This study found that patients' self-confidence scores regarding foot care were mostly average, and proper practices were often performed only occasionally. A prior study demonstrated that male gender, low family support, limited education, and rural residence were associated with poor self-care practices among patients with diabetes [31]. Although residential status was not recorded in this study, most individuals in developing countries reside in rural areas. Approximately 40% of participants were male, and 93% had at least primary education. The observed moderate self-confidence and occasional self-care behaviors may be linked to limited or suboptimal exposure to specialized foot care education.

Previous research has also shown that some health care professionals lack adequate knowledge of best practices in diabetic foot care [32]. For patients to achieve optimal self-efficacy, they must possess sufficient knowledge and practical skills to perform recommended foot care [33]. This study revealed that most participants demonstrated only average confidence in performing self-care behaviors, a level likely insufficient for effective and consistent foot care practices [26,30].

Limitations, Conclusion, Further Studies, and Recommendations

This study had several limitations. First, it was a consecutive cross-sectional survey capturing only patients whose appointments fell within the study period. Second, the questionnaire tool was validated among other populations [18,19]. Third, although Nigeria and Trinidad and Tobago are both developing countries, they differ in health care infrastructure and economic classification [10]. Nonetheless, these limitations do not undermine the overall significance of the study's findings. Future analyses will combine data from all collaborating countries (Japan, Lithuania, China, Kazakhstan, Nigeria, and Trinidad and Tobago) to explore global disparities in diabetic foot care between developed and developing nations.

In conclusion, the high prevalence of DFU, limited exposure to foot care education, and average self-efficacy levels observed in these two populations mirror trends in other developing regions. Enhancing foot care education as a central component of diabetes management may strengthen patients' self-efficacy, improve preventive behaviors, and reduce the burden of preventable lower-limb amputations.

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