

## Prevalence of Foot at Risk for Ulceration in Adult Patients Attending a Diabetic Clinic at a Tertiary Centre in Zimbabwe

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### Abstract

Diabetic foot ulcers pose medical, social and economic problems to diabetes patients especially in low income countries, were most are already living below the poverty datum line. The burden of DFU in low income countries is fuelled by poverty, poor sanitation and hygiene, and barefoot walking. Timely identification of foot at risk of ulceration allows for timeous intervention to prevent DFU in affected individuals. The purpose of this study was to determine the prevalence of foot at risk of ulceration in adults with diabetes mellitus. This descriptive cross-sectional study was carried out in the Diabetic Clinic at Parirenyatwa Group of Hospitals Outpatients Department in Zimbabwe. Consecutive sampling was used to select 76 adult patients aged 18 years and above with a confirmed diagnosis of diabetes mellitus. Approval for the study was granted by the Joint Research Ethics Board. All participants gave informed consent. Examinations and interviews were held in private rooms and code numbers were put on filled in forms. Data were collected by a demographic questionnaire. Neurological evaluation of the feet was done by monofilament testing and vibration sensation testing. Peripheral arterial occlusive disease was assessed by checking dorsalis pedis and posterior tibialis pulses. Data was analysed using Epi Info software. Descriptive statistics were used to analyse demographic data and prevalence of risk factors. Chi square test was used to compare proportions and the Fischer's exact test was used to analyse categorical variables. The student's t-test was used to compare means of continuous variables. Mean age of participants was 47.7 years (sd  $\pm$  14.3). Regarding foot at risk of ulceration, 25 (32.9%) had absent foot pulses in either foot, 16 (21.2%) had absent vibration sense at the first metatarsal head of either foot while 25 (31.6%) had monofilament defined neuropathy. Significantly more people who had had diabetes mellitus for longer ( $13.6 \pm 6.9$  vs  $8.2 \pm 7.1$ ,  $p = 0.002$ ) absent pedal pulses ( $66.7\%$  vs  $17.3\%$ ,  $p = 0.00021$ ) and absent vibration sense ( $50.0\%$  vs  $7.7\%$ ,  $p = 0.000026$ ) had neuropathy. There should be routine assessment of foot at risk of ulceration in diabetic clinics to enable early identification of DFU and timeous management.

**Keywords:** Diabetes Mellitus; Foot at Risk; Peripheral Neuropathy; Diabetic Foot Ulcers; Peripheral Vascular Disease

### Introduction

The global prevalence of diabetes mellitus is predicted to reach 642 million people by 2040 according to the international diabetes federation [1]. The estimated prevalence of diabetes mellitus in Zimbabwe is 9.7% [1]. A systematic review conducted in 2015 reported prevalence of diabetes mellitus of 5.4% in Zimbabwe [2]. However, neither prevalence of diabetic foot ulcers (DFU) nor foot at risk for ulceration are known in Zimbabwe. DFU pose medical, social and economic problems to diabetes patients especially in low income countries, were most are already living below the poverty datum line [3]. Patients with DFU are often infected with multidrug resistant organisms due to chronic course of the wound, inappropriate antibiotics treatment, frequent hospital admission, neuropathy, nephropathy, and peripheral vascular disease [4]. The burden of DFU in low income countries is fuelled by poverty, poor sanitation and hygiene, and

barefoot walking [1]. In addition limited access to adequate health care in low income countries worsens the impact of diabetic foot in diabetics [5].

DFU complicate up to 25% of diabetes mellitus cases and puts patients at high risk of amputation and increased mortality rate. However, screening can identify feet at risk thus preventing DFU. Risk factors include peripheral arterial disease, neuropathy, deformity, previous amputation, and infection. Management requires a multidisciplinary approach [6]. More than 10% of people with type 2 diabetes mellitus would already have one or two episodes of diabetic foot at time of diagnosis and have a further lifetime risk of 15% [7]. This is because 62% of cases are undiagnosed in Africa and are seen by a medical professional only once complications have manifested. It therefore brings social devastation to patients and their families [8].

Prevalence of DFU remains relatively unknown in Zimbabwe with no available published literature on prevalence of risk factors such as peripheral neuropathy and peripheral arterial disease.<sup>1</sup> The purpose of this study was to assess the prevalence of foot at risk of ulceration in adult patients attending a diabetic clinic at a tertiary centre in Harare, Zimbabwe.

## Materials and Methods

This descriptive cross-sectional study was carried out in the Diabetic Clinic at Parirenyatwa Group of Hospitals Outpatients Department in Zimbabwe. Consecutive sampling was used to select adult patients aged 18 years and above with a confirmed diagnosis of diabetes mellitus. Approval for the study was granted by the Joint Research Ethics Board. All participants gave informed consent. Examinations and interviews were held in private rooms and code numbers were put on filled in forms. Data were collected by a demographic questionnaire. Neurological evaluation of the feet was done by monofilament testing and vibration sensation testing. Peripheral arterial occlusive disease was assessed by checking dorsalis pedis and posterior tibialis pulses.

### Monofilament testing

Sensation was evaluated using 5.07/10g monofilament. Prior to testing, all participants had the monofilament applied to their hand to familiarise with the procedure. With their eyes closed, they were instructed to say “yes” as an indication that they felt the filament. Ten sites were tested as recommended and where callus was heavy, the closest area without callus was used. Sites were tested randomly without following a specific order and sensory peripheral neuropathy was defined as inability to feel the monofilament at 4 or more sites. This was indicative of high risk for ulceration.

### Vibration sensation

Vibration sense was tested using a 128Hz tuning fork. The forehead was used as a reference of normal vibratory sense to familiarise the patient with the sensation. This was evaluated by asking the participant what they felt and a response describing vibration was acceptable. Testing was done at the first metatarsal head and if absent the medial malleolus was used. Vibration was recorded as being absent or present.

### Peripheral pulses assessment

Diagnosis of peripheral vascular occlusive disease was based on the presence or absence of foot pulses. The dorsalis pedis and posterior tibialis arteries were palpated in turn and recorded as either present or absent.

Data was analysed using Epi Info software. Descriptive statistics were used to analyse demographic data and prevalence of risk factors. Chi square test was used to compare proportions and the Fischer’s exact test was used to analyse categorical variables. The student’s t-test was used to compare means of continuous variables.

## Results

These sections presents results of the study. Demographic characteristics, prevalence of neuropathy and prevalence of peripheral vascular disease will be presented.

### Demographic and clinical characteristics

Table 1 displays demographic variables. Mean age was 47.7 years (sd ± 14.3). The average duration of diabetes in years was 9.9 (sd ± 7.4). Mean body mass index was 26.2 (sd ± 5.0).

Variable	Frequency	Percentage
<b>Sex</b>		
Male	31	40.8
Female	45	59.2
<b>Type of diabetes</b>		
Type I	25	32.9
Type II	51	67.1
<b>Type of treatment</b>		
Insulin	33	43.4
Oral hypoglycaemics	40	52.3
Both	3	4.0
<b>Footwear habits</b>		
Outdoors only	33	43.4
Outdoors and indoors	40	52.3
Hardly wears	3	4.0
Smoking	7	9.2
Current alcohol use	9	11.8
Hypertension	40	52.3

**Table 1:** Demographic data and clinical characteristics (n = 76).

Table 2 shows comparison of demographic variables by sex. Only smoking and current alcohol use were significantly different.

Variable	Male (n = 31)	Female (n = 45)	P value
Smoking	6 (19.4%)	1 (2.2%)	0.033
Current alcohol use	8 (25.8%)	1 (2.2%)	0.006

**Table 2:** Comparison of demographic and clinical variables by sex (n = 76).

Table 3 shows comparison of demographic and clinical variables by type of diabetes. Only mean age, body mass index and being hypertensive were significantly different.

Variable	Type I diabetes	Type II diabetes	P value
Mean age (years)	34.6	54.1	0.001
Body mass index	23.6	27.4	0.007
Hypertension	6 (24.0%)	34 (66.7%)	< 0.001

**Table 3:** Comparison of demographic and clinical variables by type of diabetes.

**Peripheral neuropathy and peripheral vascular disease**

Table 4 presents foot abnormalities

Foot at risk characteristic	Frequency	Percentage
Absent foot pulses in either foot	25	32.9
Absent vibration sense at the first metatarsal head of either foot	16	21.2
Monofilament defined neuropathy	25	31.6

**Table 4:** Neurological examination and pulses (n = 76).

Table 5 presents comparison between participants with and without neuropathy.

Variable	Neuropathy	No neuropathy	P value
Age	53.6 ± 16.8	43.7 ± 11.7	0.077
Duration of diabetes	13.6 ± 6.9	8.2 ± 7.1	0.002
<b>Type of diabetes</b>			
Type I	18 (75.0%)	33 (63.5%)	0.319
Type II	6 (25.0%)	19 (36.5%)	
BMI	25.8 ± 6.5	26.3 ± 5.6	0.706
Smoking	3 (12.5%)	4 (7.7%)	0.805
Current alcohol use	4 (16.7%)	5 (9.6%)	0.615
Hypertension	16 (66.7%)	24 (46.2%)	0.096
Absent pedal pulses	16 (66.7%)	9 (17.3%)	0.000021
Absent vibration sense	12 (50.0%)	4 (7.7%)	0.000026

**Table 5:** Comparison between participants with and without neuropathy (n = 76).

## Discussion

Prevalence of DFU and its risk factors are not well documented in Zimbabwe. The study comprised 76 participants with a confirmed diagnosis of diabetes mellitus. There were more females than males in the study and this has been documented in literature. T2DM is more frequently diagnosed at lower age and body mass index in men; however, the most prominent risk factor, which is obesity, is more common in women [9]. Mean age was 47.7 years (sd ± 14.3) This generally falls within the economically active age groups and might explain why diabetes mellitus imposes a huge burden on the economy. More participants with type II diabetes were significantly overweight (BMI 27.4 vs 23.6, p = 0.007), were older (mean age 54.1 vs 34.6, p = 0.001) and had hypertension (66.7% vs 24.0%, p < 0.001). Hypertension and BMI are modifiable risk factors for type II diabetes and efforts should be made to maintain healthy body weight and to prevent or delay onset of hypertension [10]. This justifies the need for health education on lifestyle modification to prevent diabetes mellitus and to minimise complications in people with diabetes. Significantly more men smoked (25.8% vs 2.2%, p = 0.006) and drank alcohol (19.4% vs 2.2%, p = 0.033).

According to WHO age-standardized estimated prevalence of smoking among those aged 15 years or more in Zimbabwe for 2015, 30.8% of smokers are men while 1.7% are female [11]. Treatment for tobacco dependence in Zimbabwe is relatively unavailable [11]. This necessitates thorough psychosocial assessment of individuals to enhance mutual goal setting for lifestyle modification and glycaemic targets. Smoking and alcohol consumption are well documented risk factors for diabetic foot ulcers and other complications such as diabetic retinopathy [12].

## Foot care practices

Though 52.3% wore shoes both indoors and outdoors, 43.2% wore shoes outdoors only while 4% hardly wore shoes, people with diabetes should never walk barefoot, even indoors. This poses a risk of injury to the feet which is very undesirable in diabetes due to poor wound healing. It is common in low middle income countries [13]. A study to determine the knowledge and practice of foot care among diabetes patients attending three tertiary hospitals in Nigeria reported low knowledge and poor foot care practices. Poor foot practices included 89.2% not receiving advice when they bought footwear and 88.6% failing to get appropriate size footwear [14]. Illiteracy and low socioeconomic status were significantly associated with poor knowledge and practice of foot care. Another study conducted in Lahore reported satisfactory practices in 54% participants and poor practices in 32% participants. Education of the respondents had significant statistical association with knowledge and practices regarding foot care [15]. The degree to which a person is able to perform diabetes foot self-care is likely to be influenced by personal health, access to medical care and foot care education, and formal and informal support [16].

A study conducted in India reported 44.7% patients having not received previous foot care education and 45% walking barefoot while indoors [17]. Over 50% of participants in a prospective study to identify factors influencing diabetic patients' awareness of the risk of foot problems were not aware of the risks of diabetic foot [18]. Public health messages in countries with large rural populations such as Zimbabwe should be strengthened. These should be augmented with meticulous foot care that includes daily feet inspection by the patient, avoiding sitting close to extremes of temperature, wearing appropriate footwear, gentle cleansing with soap and water, followed by the application of topical moisturizers. There should be proper management of minor foot injuries, prevention of bathroom surgeries at home and early seeking of care at onset of a foot lesion [19]. Efforts to improve foot care practices in Zimbabwe are currently underway through a World Diabetes Foundation (WDF) programme. The programme has seen 124 health care professionals being trained in advanced diabetes management, 62 being trained in advanced foot care and 123 being trained in diabetic wound management [20]. This programme has seen 641 people with diabetes receiving foot examination and appropriate health education [20].

### Peripheral neuropathy

Regarding peripheral neuropathy 21.2% had absent vibration sense while 31.6% had monofilament defined neuropathy. More participants with absent pedal pulses in this study had peripheral neuropathy (66.7% vs 17.3%,  $p = 0.000021$ ) while more participants with absent vibration sense (50.0% vs 7.7%,  $p = 0.000026$ ) had peripheral neuropathy. Participants with neuropathy in this study had been on treatment for significantly longer (mean years  $13.6 \pm 6.9$  vs  $8.2 \pm 7.1$ ,  $p = 0.002$ ). Peripheral neuropathy is generally associated with age, duration of diabetes, male gender, alcohol intake, glycaemic control or smoking [3]. Inability to feel a 10 g monofilament (OR = 3.184; 95% CI: 2.654 - 3.82), at least one absent pedal pulse (OR = 1.968; 95% CI: 1.624 - 2.386), a longer duration of a diagnosis of diabetes (OR = 1.024; 95% CI: 1.011-1.036) were predictive of DFU in a systematic review by the international research collaboration for the prediction of diabetic foot ulcerations (PODUS) [21]. Diabetic foot ulcers are classified as neuro-ischemic if neuropathy and ischemia coexist [22]. According to severity they are classified using the Wagner system, grading foot ulcers from 1 to 5 based on extent, size and depth, location, presence of infection and ischemia [22]. Most DFU in low income countries are neuro-ischemic suggesting the interplay of both peripheral neuropathy and peripheral vascular disease.

Prevalence of peripheral neuropathy of 48.1%, 59.1% and 28.8% among all patients, patients with already established diabetes and newly diagnosed patients respectively was reported in Sri Lanka [23]. Neuropathic ulcers accounted for 47.5% of the ulcers while neuro-ischemic and ischemic ulcers accounted for 30.5% and 18% respectively in another study conducted in Kenya [24]. Prevalence of peripheral neuropathy in diabetes ranges from 10 - 26% in newly diagnosed adults with diabetes [25]. This reflects late diagnosis of diabetes in low income countries that in some instances is done when complications have already begun manifesting. Higher levels of physical activity have been associated with decreased risks of coronary heart disease, cerebrovascular disease, hypertension, diabetes mellitus, colon and, possibly, breast cancer as well as foot at risk for ulceration [26].

### Peripheral vascular disease

Regarding pedal pulses, 32.9% participants had absent foot pulses in both feet. There was no significant difference in absent foot pulses between males and females. A systematic review of studies done in 10 Sub-Saharan countries reported a lower prevalence of peripheral arterial disease that ranged from 3.1% to 24% of adults aged 50 years and older and 39% to 52% of individuals with known risk factors such as diabetes [27]. Earlier studies conducted in Africa show an increase in prevalence of PAD in Africa ranging 4% in 1960 from Zimbabwe, 1.1% in 1970' from Ethiopia, 2.9% in 1980' from Tanzania, 54% in 1990's from Nigeria and 78% in 2000 from Algeria [28]. This inconsistency in reported prevalence of PAD calls for objective and its uniform regional assessment in view of its negative impact on health in individuals with diabetes. Peripheral vascular disease (PVD) does slow the rate of healing of DFU especially in Africa due to lack of revascularization services [29]. In up to 50% of cases of DFU, PVD is a contributing factor [30]. Peripheral vascular disease prevalence varies across sites from 4% to 28% [31]. A study conducted in Nigeria reported prevalence of symptomatic PAD of 28.7% whilst that of asymptomatic PAD was 71.3% [32] PAD in that study was associated age ( $p < 0.05$ ), sex ( $p < 0.05$ ), and marital status ( $p < 0.05$ ). Another study conducted in Bahrain reported a prevalence of PAD of 20.2% [33].

Peripheral vascular disease causes considerable morbidity in diabetes mellitus patients and is defined clinically in patients with a history of intermittent claudication, rest pain, absence of the pedal pulses or abnormalities on non-invasive arterial assessment consistent

with impaired circulation or the presence of new collateral circulation [34]. Frequent measurement of Ankle Brachial Index in symptomatic subjects with absent foot pulses in Africa should be done in view of under-diagnosis and under-treatment of PAD in Africa [28].

Prevalence of PN in this study could have been affected by confounders such as HIV status and being on antiretroviral therapy (ART). Drugs such as nucleoside reverse transcriptase inhibitors (NRTI) and to a less extent, protease inhibitors (PI) may cause peripheral neuropathy. Neuropathy can also be age related though mean age in this study was low. Other confounders in this study are that other concurrent causes of peripheral neuropathy such as vitamin B12 deficiency were not excluded and may have led to over-estimation of the prevalence in this population. Nevertheless, overestimating PN in a resource limited setting might lead to enhanced screening and health education which can have a positive impact on prevention of DFU. More sensitive methods for evaluating PVD such as Doppler are more effective but in a resource limited setting, the advantages of using peripheral pulses far outweigh the disadvantages of no assessment at all. Evaluation of structural foot changes, though not affordable to the average person in a resource limited setting, is effective in screening for foot at risk of DFU. Structural foot changes are one of the most common risk factors for DFU. Evaluation of glycaemic control could also have identified more feet at risk for DFU. However, it was not feasible in the resource limited setting.

## Conclusion

The prevalence of foot at risk as reflected by peripheral neuropathy and peripheral arterial disease was high in the study. PN was significantly higher in participants who had a longer duration of diabetes, who had at least one absent pedal pulse and in those who had no vibration sensation. Diabetic foot disease outcomes can be improved with minimum financial resources including amongst them implementation of sustainable training programs for health care professionals and educational dissemination of information to patients [35]. Imparting knowledge to staff and patients about diabetic foot complications and increasing their awareness will reduce limb amputations [36]. Education must be supported with preventive measures for it to be effective [37]. A theory-based foot care education program (3STEPFUN) has shown effectiveness in improving foot self-care behaviours and foot risk factors for ulceration in people with type 2 diabetes [38]. Much of the standard clinical information obtained as part of the routine follow-up are also independent risk factors for development of first time diabetic foot ulcer and this may be used to create a basis for in which patient and when prevention should be started [39].

Screening includes testing for neuropathy using a 10g Semmes-Weinstein monofilament or 128Hz tuning fork and peripheral vascular disease, ideally by measuring Ankle Brachial Pressure Indices (ABPIs) if foot pulses cannot be felt. Foot deformity and lesions, including minor lesions such as callus and tinea pedis, should be actively looked for and documented [19]. The use of ABI is of great value in the detection of PAD as evidenced by a clearly more objective assessment of PAD compared to both intermittent claudication and absent pedal pulses [31]. Randomised controlled trials with longer follow-up time to examine the effects on decreasing foot ulcer incidence are recommended. Participants with DFU in another study frequently had swollen feet, limited ankle mobility, and peripheral sensory neuropathy [40]. It is also important to identify the biomechanical, neurological and clinical parameters, demographics and lifestyle risk factors that could explain the presence of foot ulcer in patients with diabetes in Africa [40], Zimbabwe included.

## Conflict of Interest

The authors declare no conflict of interest.

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