

## FOOT COMPLICATIONS AND FOOTWEAR HABITS: A STUDY OF DIABETES MELLITUS PATIENTS IN BANGLADESH

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### ABSTRACT

*Foot complications among diabetic mellitus patients are a major cause of morbidity and death across the world. A large number of Bangladeshis are also affected by this type of diabetes. This study aimed to explore the common foot complications and footwear selection of diabetes mellitus patients in Bangladesh. This study used a questionnaire to conduct empirical research and analyzed the data using statistics. In a survey of 304 diabetes mellitus patients, 36.84% reported peripheral neuropathy, 27.30% foot swelling, and 11.50% foot ulcers. Approximately 58.33% of patients reported at least one of the above complications. Only 14.5% of participants were aware of therapeutic footwear, and half were satisfied with their requirements. The remaining 85.5% of patients were careless about footwear safety. The findings of this study suggested increasing awareness of ergonomically fit footwear to reduce foot complications. Additionally, future studies should explore proper guidance and features for selecting and using them.*

**Keywords:** *Diabetic foot; Foot complications; Footwear safety; Specialized footwear.*

### 1. INTRODUCTION

Diabetes is a widely recognized disease and one of the major health concerns of the 21<sup>st</sup> century across the world. It has a large impact on human health, with multiple complications, and also affects the economy (Papatheodorou *et al.*, 2018). In 2019, the International Diabetes Federation (IDF) released that globally, nearly 463 million people suffered from diabetes mellitus, and by 2045, it was expected to exceed 700 million (IDF, 2019). Southeast Asia contains about one-fifth of diabetes patients worldwide (IDF, 2021). As Bangladesh is a developing country in South Asia, it has high-risk factors for diabetes and was ranked 10th by the IDF in 2019. Around 8.5 million people in Bangladesh were affected by diabetes mellitus in 2019, and by 2045, it is expected to almost double (around 15 million) (IDF, 2019). Unfortunately, diabetes mellitus is responsible for more than 80% of deaths in low- and middle-income countries, and this figure is expected to double by 2030 (Mathers & Loncar, 2006). In 2016, the World Health Organization reported that diabetes is responsible for around 3% of total deaths of all ages in Bangladesh (WHO, 2016). In addition, diabetes treatment costs are high as huge complications are associated with this disease. In Bangladesh, the annual estimated cost of diabetic expenditure was more than 1.5 billion US dollars in 2016, and this expenditure will rise in the 21<sup>st</sup> century if no preventive action is adopted (Afroz *et al.*, 2019).

Foot complications are very common in diabetic patients. Approximately half of the affected populations are prone to diabetic foot complications due to a lack of adequate awareness and management (Adler *et al.*, 1999). Roughly 19–34% of diabetes patients around the world are affected by foot ulcers and other foot complications (Armstrong *et al.*, 2017). The number is much higher in low- and middle-income countries since people don't wear appropriate footwear often and have a tendency to walk barefoot (Jayasinghe *et al.*, 2007). Inappropriate or poorly fitted footwear is highly responsible for diabetic foot ulceration as well as other foot deformities addressed in several previous studies. Selection of suitable footwear with a sound educational background can reduce diabetic foot complications. Diabetic patients must wear footwear that provides adequate foot protection and is free of potential hazards (Uccioli & Giacomozzi, 2018). Furthermore, physicians must know the importance of footwear in order to make appropriate recommendations for their patients. In turn, patients should also be careful about lesions that develop from ill-fitting footwear. One recent study reported that awareness, proper foot-care practices, and the selection of suitable footwear are vital for patients with diabetes mellitus (Wimalarathna *et al.*, 2021). Moreover, previous studies revealed that specialized therapeutic footwear can be an effective intervention and could contribute to the prevention of diabetic foot complications. In contrast, inappropriate footwear has been identified as one of the main causes of diabetic foot deformations (Schaper *et al.*, 2016).

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Although specialized therapeutic footwear is widely recommended for diabetic feet, there are no data on its proper application in Bangladesh. Besides, studies on the foot status and footwear habits of patients with diabetes mellitus, are quite unknown here. Therefore, this study aimed to collect, analyze, and explore information on the current prevalence of foot problems among diabetic patients in Bangladesh. In addition, this study will cover participants' experiences with footwear selection and use.

## 2. MATERIALS AND METHODS

A qualitative survey of current foot ailments and footwear use was conducted among Bangladeshi populations with diabetes mellitus. A total of 304 data points from diabetes mellitus participants were investigated in the study. 150 (49.34%) male and 154 (50.66%) female subjects from urban to rural areas were included, considering their age limit of 18 years or older. All patients were invited to participate in this survey on three different platforms: government diabetic hospitals, private diabetic hospitals, and online submission systems. A set of standard questionnaires was constructed using Google form in the local language. These questionnaires included demographic information, patient characteristics, foot complications, prescribed medicine, current footwear use, and awareness about specialized footwear. The Google survey form also included a five-interval scale ranging from 1 for the worst to 5 for the excellent experience with their used footwear. The six common foot complications in the survey questionnaire were peripheral neuropathy, or lack of nervous system; foot swelling; foot ulcers; infectious foot; gangrene; and non-traumatic amputation. The physician's schemes of treatments are also noted under five separate categories, e.g., medicine, insulin, medicine + insulin, medicine + therapeutic footwear, and medicine + insulin + therapeutic footwear. This survey also investigated respondents' awareness of safety footwear and justified their satisfaction. The research students received written consent from all participants who completed and returned the response questionnaire. This study used Microsoft Excel (Microsoft Corporation) for analyzing and graphically presenting the data.

## 3. RESULTS AND DISCUSSIONS

Patient information, including demographics, foot condition, footwear habits, and consciousness, is presented in Table 1. A total of 45% of participants were between the ages of 30 and 45, while just 4.28% were under 30 years old. More than 58% of participants have suffered from diabetes mellitus for more than 5 years, including 37% who have had diabetes for 10 years. 36.84% of participants claimed peripheral neuropathy, or a lack of a nervous system in their foot, whereas 27.30% of participants suffered from foot swelling problems. In addition, 11.50% of participants reported foot ulcers. Besides, gangrene, infectious foot, and foot amputation were found at 8.55, 7.89, and 3.61%, respectively. Physicians treated diabetic patients in different ways. Among them, 71.38% of diabetes patients received only medicine, whereas 12.5% of participants claimed they received medicine with insulin. Unfortunately, only 6.5% of diabetes patients who used therapeutic footwear with medicine and 3.84% of those who used therapeutic footwear with medicine and insulin were found.

Among all participants, around 85% of patients are careless about footwear safety. In contrast, only 15% of diabetes mellitus patients cared about specialized footwear, and half of these populations were satisfied with their requirements. Those who are unaware of the importance of safety footwear can be split into three groups and shown in Table 3. The first category includes 12 % of all diabetic patients who walk barefoot for at least 2 hours. Another group of patients, accounting for 39 % of all patients, walk barefoot for less than two hours. The last group, which accounts for 41.8 % of all diabetic patients, never walks barefoot.

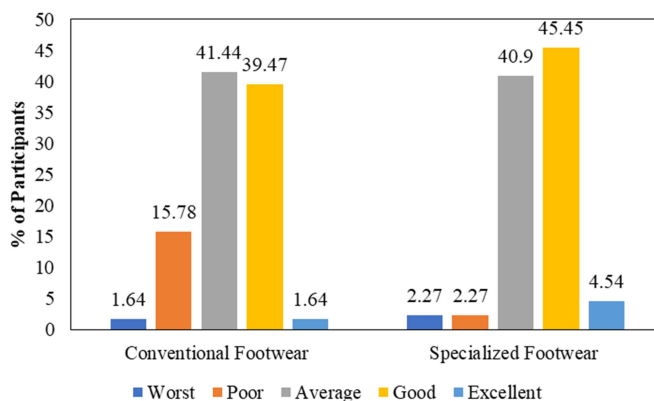
The level of satisfaction among the specialized and conventional footwear groups is also represented in Fig. 1. Participants responded to a comfort scale and rated satisfaction. About 40% of participants comment about their products for both conventional and specialized footwear. In comparison to 1.64 % of conventional users, 4.54 % of patients wearing specialist footwear gave positive feedback. Due to the lack of satisfaction with safety footwear, 2.27% of patients gave the worst response, whereas 1.64% of conventional users claimed the worst result. It may be due to the fact that their special footwear is not produced on the basis of necessity.

A total of 304 patients from various locations in Bangladesh responded to a survey on people with diabetes mellitus for this study. Both male and female participants with a near equal number of responses have responded to the survey. Among them, more than 58% of participants have suffered from diabetes mellitus for more than 5 years. Locality, employment status, and level of education are also noted in the questionnaire. A response to six common diabetic foot problems was received, and it was discovered that three complications popped up the most in the survey. The most prevalent are peripheral neuropathy (36.84%), foot swelling (27.30%), and foot ulcers (11.50%). In Table 2, a comparative assessment of the prevalence of common diabetic foot problems in different parts of the world is shown. When comparing this study to two prior studies on the prevalence of peripheral neuropathy in Bangladesh (35.0 and 20.9%), one data indicated substantially identical results (36.84%). Surprisingly, India (30.2%), the United Arab Emirates (35.6%), and Egypt (29.3%) all reported

roughly the same number of neuropathy cases. But, this study's prevalence is lower than that observed in China (57.1%) and Trinidad (49%). On the other hand, it was higher than Australia (22%), Canada (10%), and Malta (13.17%). In the case of foot ulcers, China and Ethiopia reported similar data to this study. But it was higher with comparisons against Australia (9.5%), Canada (6%), India (6.5%), Egypt (8.7%), Malta (4.1%), Kenya (4.6%), and Jordan (4.6%). Only Ethiopia (13.6%) has a higher prevalence of foot ulcers.

**Table 1:** Characteristics of diabetic patients with their demographic and other information.

Title	Parameters	Number, n	Percentage (%)
Sex	Male	150	49.34
	Female	154	50.66
Age groups	<30 years	13	04.28
	30-45 years	56	18.42
	46-60 years	137	45.07
	>60 years	98	32.24
	Rural	129	42.43
Locality	Urban	175	57.57
	Employed	120	39.47
Employment status	Unemployed	184	60.53
	<1 year	23	07.56
	1-5 years	104	34.21
Duration of Diabetes	5-10 years	63	20.72
	>10 years	114	37.50
	peripheral neuropathy or Lack of nervous system in foot	112	36.84
Foot complications	Foot swelling	83	27.30
	Foot ulcer	35	11.50
	Infectious foot	24	07.89
	Gangrene	26	08.55
	Partial or full foot amputation	9	02.63
	Medicine	217	71.38
Physicians prescribed	Insulin	16	05.26
	Medicine + Insulin	38	12.50
	Medicine + Therapeutic	21	06.90
	Footwear	12	03.94
Conscious about safety footwear	Satisfy their Requirements	22	07.50
	Don't Satisfy their Requirements	22	07.50
Not Conscious about safety footwear		260	85.50



**Figure 1:** Comparison of feedback from the participants who wore specialized footwear against conventional footwear.

**Table 2:** Comparison of diabetic foot complications with different countries data across the world.

Contributors	Subject counts, <b>n</b>	Peripheral neuropathy <b>%</b>	Foot ulcer <b>%</b>	Amputation <b>%</b>
This work	304	36.84	11.5	2.63
Sultana <i>et al.</i> , 2013	140	35.0	--	--
Morkrid <i>et al.</i> , 2010	294	20.9	--	--
Maiya <i>et al.</i> , 2018	2110	30.2	6.38	--
Wu <i>et al.</i> , 2015	296	57.1	12.7	1.35
Maskari and Sadig, 2007	513	35.60	--	--
Bakri <i>et al.</i> , 2012	1000	14.9	4.6	1.7
Gulliford and Mahabir, 2002	2106	49.0	12.0	4.0
Mariam <i>et al.</i> , 2017	279	21.7	13.6	--
Nyamu <i>et al.</i> , 2003	1788	--	4.6	--
Lazzarini <i>et al.</i> , 2017	733	22.0	9.5	4.1
Reid <i>et al.</i> , 2006	169	10	6	1.4
Khalil <i>et al.</i> , 2015	2000	29.3	8.7	4.4
Formosa <i>et al.</i> , 2012	243	13.17	4.1	--

Peripheral neuropathy, or lack of a nervous system, is the second most important risk factor for foot ulcers and the third most important risk factor for other infections, gangrene, and amputation (Rubeaan *et al.*, 2015). Patients with peripheral neuropathy have a huge deficit in the ability to perceive lower extremity proprioception. This affected nervous system cannot properly carry messages between the brain and other organs of the body. As a result, the sensation of heat, cold, or pain diminishes when it comes into contact with the feet, legs, or hands, increasing the likelihood of injuries such as cuts or sores in diabetic outpatients. This lack of sensory response also deteriorates the gait system and increases fall risk and impaired balance among diabetic patients (Grewal *et al.*, 2013). Thus, wearing inappropriate shoes could develop a foot ulcer without any notice. Besides, wearing ill-fitted footwear and walking barefoot can provoke higher mechanical stress and give access to foot complications like peripheral neuropathy, foot ulcers, gangrene and amputation. Therefore, prescribed therapeutic footwear may play an important role and might compensate for the lost sensation of the foot (Bus *et al.*, 2020). Some strong evidence supports the effectiveness of specialized therapeutic footwear with offloading techniques for healing plantar neuropathic forefoot and midfoot ulcers and preventing the risk of infection, gangrene, and foot amputation (Lazzarini *et al.*, 2020). Around 71% of diabetes patients in Bangladesh are currently receiving only medicine from their physician. 12.5% are taking insulin with medicine. Unfortunately, less than 7% of all participants claim to have used therapeutic footwear in conjunction with medication, despite the fact that the International Working Group on the Diabetic Foot (IWGDF) has published guidelines on wearing therapeutic footwear, insoles or custom orthoses that properly fit the shape of the foot, and other requirements (Netten *et al.*, 2020).

**Table 3:** Foot complications of diabetic patients against footwear status.

Activity	Walk Barefoot at least for 2 hrs.	Walk Barefoot for less than 2 hrs.	Never walk on Barefoot	Walk with Specialized Footwear
Counts	37(12%)	119 (39%)	104 (34.29%)	44 (14.5%)
Peripheral neuropathy	16 (42.8%)	34(28.9%)	43 (41.8%)	10 (22.7%)
Foot swelling	17 (47.6%)	34(28.9%)	38 (36.8%)	12 (27.2%)
foot ulcers	3 (9.5%)	13 (10.8%)	14 (13.1%)	5 (11.3%)
Infectious foot	3 (9.5%)	3 (2.8%)	14 (13.9%)	10 (15.9%)
Gangrene	4 (11.9%)	2 (1.4%)	15 (14.7%)	4 (9.0%)
Amputation	4 (11.9%)	4 (2.8%)	0 (0%)	2 (4.5%)

The five common foot complications that are shown in Table 3, have been analyzed against the four different schemes of footwear use to justify whether any logical relationships exist between these parameters. First group, whose participants (n = 37, 12%) were habituated to conventional footwear and walked barefoot for at least 2 hours. In this category, foot swelling and peripheral neuropathy appeared most, with 47.6% and 42.8%, respectively. Here, 9.5% of patients are found with foot ulcers. The second group, where participants (n = 119, 39%) walked barefoot for less than 2 hours and also became habituated to wearing normal footwear. The lack of nervous system and foot swelling was found to decrease by 28.9% in this category of patients. Although participants in the third category (n = 104, 34.29%) never walked barefoot, they were habituated to non-prescribed conventional footwear, and there was no remarkable improvement in foot performance found among them. Surprisingly, the foot ulcers of patients from the third group, where participants used conventional

footwear and never walked barefoot, increased to 13.1%. It is probably from the use of ill-fitting footwear with inappropriate shapes, sizes, toe capes and other features of footwear (Premkumar *et al.*, 2017). Only participants (n = 44, 14.5%) from the last category claimed they were conscious of safety footwear and used it for variable durations. Here, half of these populations report being satisfied with their choice. In contrast, 85.52% (n = 260) of diabetic patients were unconscious about the specialized footwear. This specialized safety footwear enhanced foot performance in cases of peripheral neuropathy and foot swelling more than conventional ones. In conventional to specialized footwear, the rate of complications was reduced from 42.8% to 22.7% for peripheral neuropathy and from 47.6% to 27.2% for foot swelling. But, in the rest of the cases, e.g., foot ulcers, gangrene, infectious foot, and amputation, it did not provide satisfactory results. Half of these category participants (50%) claim they were not satisfied with the specialized footwear. The causes behind this statement are probably the selection and choice of therapeutic footwear that was not on the basis of anthropometric measurements and the exact requirements of the foot. Patients in this group might adopt their products from stock footwear rather than customize them.

The level of this satisfaction from the specialized and conventional footwear groups is also represented in Fig. 1. Participants responded against a comfort scale and put their rating on the basis of satisfaction. About 40% of subject comment on average about their products for both conventional and specialized footwear. In comparison to 1.64 % of conventional users, 4.54 % of patients wearing specialist footwear gave great feedback. Due to the lack of satisfaction with safety footwear, 2.27% of patients gave the worst response, whereas 1.64% of conventional users claimed the worst result. It may be due to the fact that their special footwear is not produced on the basis of necessity.

Although the survey paints a picture of the current condition of the feet and the use of footwear by diabetic patients in Bangladesh, the study reveals some limitations which, if removed, would give a more accurate picture. The power of information could be enhanced through the participation of more patients. In addition, it would be nice to be able to attach similar information about the patient and whether to use shoes from a specialized doctor on the feet. Moreover, the presentation would be even more valuable if the patients who are wearing special types of footwear knew what kind of therapeutic shoes they were using. However, the results from the study indicate some issues to be taken into consideration by the respective authorities. First of all, awareness has to be raised among people in Bangladesh about the consequences of diabetic foot complications. Furthermore, the advantages of wearing therapeutic footwear should be emphasized more in terms of preventing and minimizing diabetic foot complications. The physicians also have to prescribe the therapeutic shoes with the required features. Therapeutic footwear should be introduced largely in the footwear market by various footwear manufacturers so that people can easily find their required footwear. Besides, the cost will have to be within everyone's affording limit.

#### 4. CONCLUSIONS

This study identified and explored the existing state of the feet and the status of footwear selection and use among participants with diabetes mellitus in Bangladesh. Diabetes patients suffered from various foot disorders. They are mainly characterized by peripheral neuropathy, foot swelling, and foot ulcers. In most cases, medicine is used as a treatment method. It has been found that most people are not particularly concerned about the type of footwear they wear. Most of them have no clear idea about therapeutic footwear and its effectiveness in reducing diabetic foot problems. Local medical professionals are also reluctant to recommend therapeutic footwear in routine cases. However, a few patients who used to wear therapeutic footwear reported better outcomes in most cases than while using their regular footwear.

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