



# An Overview on the Risk Factors and Prevention of Diabetic Foot Ulcer: Simple Literature Review

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## ABSTRACT

**Background :** Diabetes is an ever-growing problem since the advent of imperial fast-food chains. Many people in developed and developing countries are facing obesity and diabetes co-pandemic. An important complication of diabetes is diabetic foot ulceration, an injury resulting from neural and vascular damage after years of poor glycemic control. **Objectives :** The purpose of this study is to review the literature and discuss the risk factors and prevention of diabetic foot ulceration. **Methodology:** PubMed database was used for articles selection, from where the papers were obtained and reviewed. PubMed database was used for articles selection and the following key terms: Diabetic foot ulcer, Risk factors, and Prevention. **Conclusion :** The best treatment is prevention of risk factors and recurrence of diabetic foot ulceration. This is best achieved by a multidisciplinary approach. Education of the population results in adherent and compliant patients and in-turn promptly reduces infections and ulcerations.

**Key Words:** Diabetic foot ulcer, Prevention, Risk factors

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## INTRODUCTION

Diabetic mellitus is a growing public issue around the world whose major complication is foot ulceration or the 'diabetic foot'. In Saudi Arabia, diabetes is rising at an alarming rate, with the global country ranking of seven in the prevalence of diabetes [1]. Unfortunately, diabetes is not well controlled in many patients in Saudi Arabia [2]. Many patients are reported subpar foot care, and therefore diabetic foot awareness and education is required for them [3]. The prevalence of diabetic foot in Saudi Arabia is reported between 26 - 62% [4, 5]. The global prevalence is similar at (6%), with males having a prevalence of 4.5% [6].

Diabetic foot is an end-result of neurovascular compromise in the presence of injury and uncontrolled blood glucose.

In Saudi Arabia, the occurrence of diabetic microvascular complication is not clearly documented [7]. Vascular complications evidently increase mortality risk in diabetic patients through micro- or macrovascular damage to organs. The estimated 5-year mortality reaches up to 30.5%; cost burdens of diabetic extremity care are as high as cancer [8]. Therefore, in this paper, we will review the proper literature discussing the mechanism of diabetic foot ulceration, the pathophysiology behind it, risk factors, diagnosis, management options, and prognosis for such cases.

## METHODOLOGY

PubMed database was used for articles selection, and the following key terms were used in the search: Diabetic foot,

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Risk factors, and Prevention. In regards to the inclusion criteria, the articles were selected based on inclusion of one of the following topics: diabetic foot ulcer risk factors and prevention. Exclusion criteria were all other articles, which did not have any of these topics as their primary endpoint.

**Review**

**Pathophysiology**

Diabetes is a medical condition where the pancreas is unable to provide adequate insulin hormone or there is increased cellular resistance to insulin's action, resulting in hyperglycaemic status that damages the body tissues on a systemic level [9-12]. Diabetic foot ulceration results from uncontrolled hyperglycemia and is a co-morbid complication of diabetes mellitus. In diabetic patients, evidence of complications should alert the surgeon to the plethora of potential micro and macrovascular complications. The patient will display complications of chronic diabetes including ulceration [3].

**Risk Scoring**

Scoring systems aid physicians in diagnosis and management of diabetic foot ulcers (Tables 1 & 2) [13, 14]. Diabetic neuropathy is a risk factor for foot infection, as patients with neuropathy are ten times more likely to develop a bacterial infection [15]. Interestingly, many patients with foot ulcers will develop an infection before complete healing of the lesion [16]. The most commonly used scores worldwide are the Wagner-Meggitt classification or the PEDIS score. This score classifies the ulceration according to extension and severity of the wound (Table 1). Moreover, a number of scoring criteria are available in the literature, each with their own limitations [17]. Many classification systems focus on local pathology of DFU while phasing out ulcer healing parameters. Other classification systems incorporate standardized definitions of ischemia, infection and take systemic variables important for wound healing into consideration. Only a number of classification systems have been validated, yet no general consensus has been made [18]. The healthcare professional should be aware of the common classifications and also the risks associated with ulcer development, especially within the context of an in-patient (Table 3) [19]. Patients unaware of appropriate foot care are at risk of injury and ulceration [3]. These care practices include daily examination of feet, hygiene and application of moisturizers.

**Hyperglycaemia**

Diabetic patients with unchecked glucose control will inevitably develop neuropathic and vascular damage. Peripheral vascular injury may manifest as intermittent claudication, ischemic ulceration, limb ischemia, and eventual amputation if untreated. Studies have reported

low-level of education as a risk factor for uncontrolled diabetes [2, 20].

**Table 1: Wagner -Meggitt Score**

Grade	Manifestation
0	No Ulceration (Pre- or Post-ulcerative Lesion)
1	Superficial Diabetic Ulcer
2	Extension Involves Ligaments, Tendons, Joints or Fascia
3	Deep Ulceration with Abscess or Osteomyelitis
4	Partial Gangrene
5	Whole Foot Gangrene

**Table 2: PEDIS\* Score**

Grade	Manifestation
P	Perfusion
E	Extent of Ulcer Area
D	Depth of Wound
I	Active Infection
S	Intact Sensation
*acronym for perfusion, extent, depth, infection and sensation	

**Diabetic Neuropathy and Vasculopathy**

Peripheral neuropathy -a long term complication of diabetes- has a critical role in the development the diabetic foot [21]. It affects the protective sensation that results in repetitive foot trauma and undetected weight-bearing planter surface of the foot. Foot deformities carry the risk of hammertoe, muscle wasting, hallux valgus, bunion, prominent metatarsal head, Charcot joint- of the DFU incident [21-24]. It is proven that neuropathy alone carries the risk of 14-19% of DFU, and 50-65% in those with a history of an ulcer [25]. Charcot's neuro-osteoarthropathy results after significant neuropathy; brittle bones are then liable to fractures and malformation. Physicians should investigate footwear and apparent foot deformity as they are important clinical signs that are often missed in the busy clinic. Peripheral arterial disease proved to be an important risk factor, as reduced blood supply slows the healing of the foot trauma or the ulcer, resulting in much prolonged time and more risk for the development of an infection. The presence of the infection increases the chance of amputation, and even the mortality rate [26-28].

**Table 3: Risks for Ulceration\***

Grade	Factor
Low	Callus Formation.
Moderate	Previous Deformity, Neuropathy, or Non-critical Limb ischemia
High	Previous Ulceration or Amputation; Combined Neuropathy with Callus or Deformity or Non-critical Limb Ischemia
*Adapted from the National Institute of Clinical Excellence.	

### Sociodemographic

Socioeconomic status and education levels were noted to have a great impact. A higher incidence was noted between those of low socioeconomic status, and this was due to the inability to afford treatment expenses. The education level seemed to play another important factor; the lower is the level, the higher is the chance to develop and the higher is the rate of amputation; these two not only have role in the occurrence rate but also have subsequent complications such as infection of the ulcer, recurrence, and amputation [29]. Applying insulin therapy that is linked as risk factor, shows poor glycemic control and accelerates the occurrence rate. A recent study found that an HbA1c level of 8% (64 mmol/mol) is an important factor owing to DFU development [30]. Another noted risk factor among Dm2 patients is patients' life style including the smoking status, patient's weight, and lack of exercise. These doomed to predict the occurrence and prognosis. Hypertension existence as a comorbid disease increases the risk of DFU [31].

### Preventive Methods

The best treatment is prevention (Table 4). In patients who forgo routine screening, diabetic foot ensues after development of peripheral neuropathy —another complication of uncontrolled diabetes. Primary prevention concerns vulnerable patients with diabetic foot. The physician should focus on promoting proper foot hygiene, health education, and excellent glycaemic control. Poor education about the disease and its complications is directly associated with poor foot care. Educating patients on proper foot hygiene is actively preventive against diabetic foot [31]. Knowledge of diabetic foot care has ample room for improvement. In type 2 diabetes, patients are checked immediately at diagnosis and annually thereafter. It will take around 3–5 years since diagnosis of type 1 diabetes for checkups to be done annually [32]. Moreover, physicians should direct patients for appropriate testing during clinic appointments (Table 3) [32]. Modification of risk factors for ulceration should focus on preventing neuro-vascular injury. Cessation of smoking may prevent cardiovascular morbidity in diabetic patients, including non-critical limb ischemia, a known-cause of ulceration.

**Table 4: Prevention of Diabetic Foot Ulcers**

		Checkup*
Primary	Preventing Ulcer Formation	Education, Continuous Screening
Secondary	Prevent Complications and Recurrence	Appropriate Management, Monitoring

Secondary prevention focuses on patients previously afflicted with diabetic foot ulceration, in other words, we prevent recurrences and delay exacerbations of ulcers and

other hyperglycaemic complications. We prevent hyperglycaemic status to delay neuropathic damage. A patient with destructed peripheral neural pathways will not be able to sense pressures on the sole, hence injury occurs and damage persists without sensation [33]. Furthermore, foot deformities such as hammertoe and small muscle wasting, further contribute to increased plantar pressure, particularly at the metatarsal heads where bony prominences reside [33].

### Multidisciplinary Approach

A multidisciplinary team, ideally includes specialized nursing, endocrinologist, vascular and orthopaedic surgeons, and radiologist is required for a holistic approach [34]. Another tool for the prevention of recurrent plantar foot ulcers is the use of daily foot skin temperature measurements [35]. However, analysis based on intensive versus brief educational approach showed that intensive educational intervention was associated with reduced incidence of DFU [36]. Besides, patient education has also been shown to be an important element in delaying the onset or recurrence of DFU. This includes providing information on basic foot care advice including advice on appropriate footwear and wound care. Current DFU prevention interventions focus on many aspects, first of all, reducing high plantar pressures by custom-made footwear and/or insoles which propose to offload pressure from high-risk areas by accommodating foot deformities [33]. These interventions have been shown to significantly reduce ulceration rates. However, footwear interventions are often associated with poor adherence [33].

### CONCLUSION

Foot care has been suggested to be the most important factor in preventing DFU and it should be included in the overall management plan for the patients with diabetes, which include daily foot examination, to ensure that it has become a routine task that is not easily forgotten, and annual foot checking with a multidisciplinary team.

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