

Epidemiology of Diabetic Foot Infections in India

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INTRODUCTION

Diabetes mellitus is a serious and debilitating condition worldwide and is also considered a global epidemic of the 21st century. The incidence of diabetic foot infections (DFI) has increased due to the extensive prevalence of diabetes throughout the world and the prolonged life expectancy of these patients, which in turn, increases the burden of the disease. DFI is one of the most common causes of hospitalization and lower extremity amputation (LEA) contributing to significant morbidity and mortality.

EPIDEMIOLOGY OF DIABETES

According to the International Diabetes Federation (IDF), 537 million people worldwide aged between 20 and 79 years are affected by diabetes mellitus and it is also estimated that there will be more than 700 million people affected globally by the disease by the year 2045. With the world's population expected to increase by 20%, the number of people living with diabetes is also expected to increase by 46%.¹ These numbers are more likely to multiply rapidly, especially in developing countries like India. India is considered the diabetes capital of the world with the largest number of people living with diabetes. Unfortunately, the burden of the disease is going to increase due to the increase in the prevalence of obesity, the exponential increase in population size, and the recent trends in lifestyle modifications as well as urbanization.² This, in turn, will have a significant socioeconomic impact both on the individuals as well as our nation.

PREVALENCE OF DIABETES IN SOUTHEAST ASIA

The IDF estimates that the total number of people living with diabetes in the Southeast Asian region will reach 152 million by the year 2045. India accounts for one in seven adults living

worldwide with diabetes. Over one in two (50.2%) adults living with diabetes are undiagnosed. The total number of deaths reported was 747,000.³ The age-adjusted prevalence for people living with diabetes in the age group of 20–79 years was estimated for the countries in the Southeast Asian region, which was found to be approximately around 10% in India (**Fig. 1**).³ India is one of the leading countries in terms of population affected by diabetes in the age group of 20–79 years, which is around 74.2 million in 2021 when compared to 61.3 million in 2011 (**Table 1**).³ The prevalence of diabetes was also found to be higher in the age group of 45–79 years in Southeast Asian region (**Fig. 2**).³

EPIDEMIOLOGY OF DIABETIC FOOT INFECTIONS WORLDWIDE

It is estimated that people with diabetes have a 40% increased risk for LEA and the lifetime risk of developing diabetic foot ulcer (DFU) appears to be around 25%.² Around 67% of amputations in the United States and 90% of amputations in the United Kingdom that occur annually are found to be associated with diabetes.³ The highest and lowest prevalence of DFU was found in Belgium (16%) and Australia (1.2%), respectively. The overall prevalence of DFU worldwide was found to be 6.3%. Globally, the risk of recurrence of DFU is around 50% and it is also projected that 33% of all the expenses related to diabetes are due to DFI.⁴

In high and middle-income countries worldwide, there is an exponential increase in DFU-related expenditure due to advances in treatment options and resources available to them. However, developing countries like India and China are more likely to spend less when compared to developed countries due to treatment with antibiotics and inaccessibility to novel technology for limb salvage procedures. Developed countries spend 10% of their gross domestic product (GDP) for healthcare expenditure when

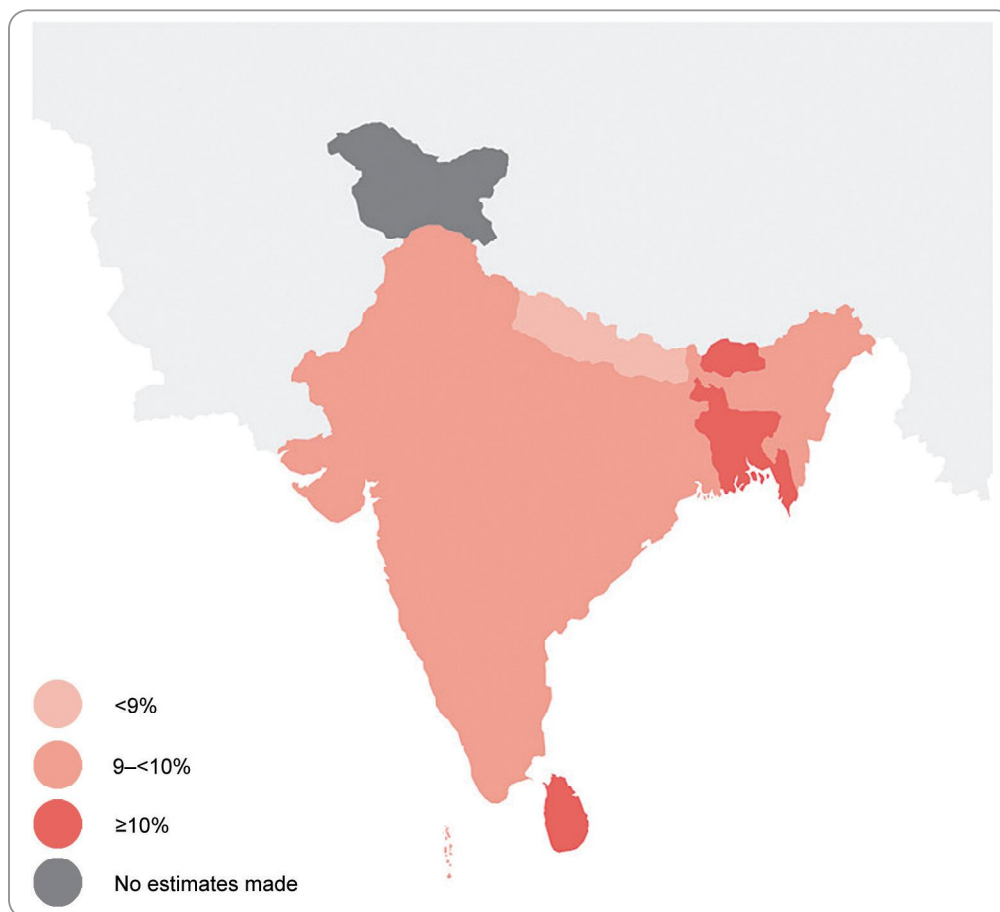


Fig. 1: The age-adjusted comparative prevalence (%) of diabetes (20–79 years) in the International Diabetes Federation (IDF) Southeast Asia Region in 2021.³

TABLE 1: The top five countries in Southeast Asia for people living with diabetes (20–79 years).³

Country	2011	2021
India	61.3 million	74.2 million
Bangladesh	8.4 million	13.1 million
Sri Lanka	1.1 million	1.4 million
Nepal	488,200	1.1 million
Mauritius	138,200	250,400

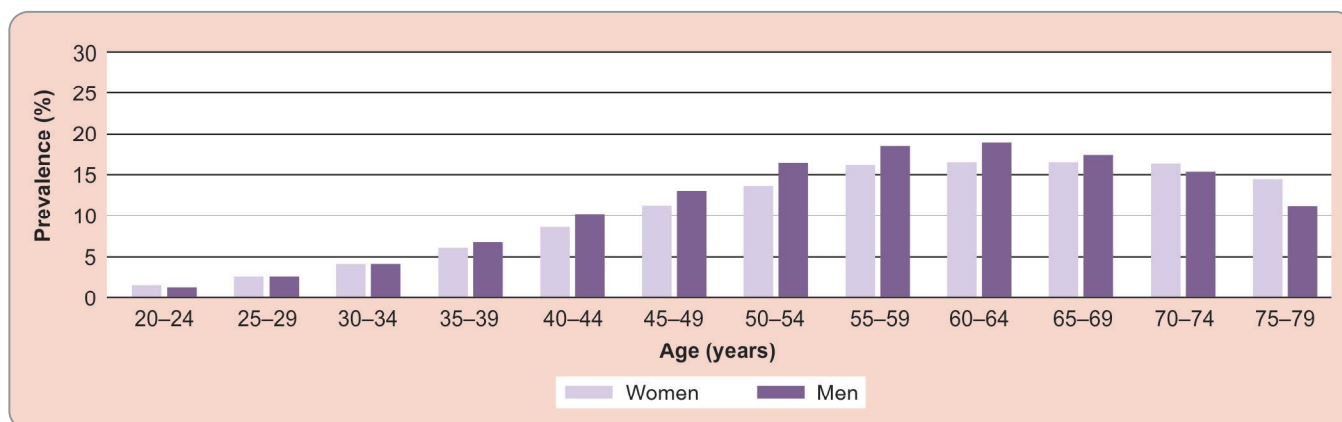


Fig. 2: Prevalence (%) estimates of diabetes by age and sex, International Diabetes Federation (IDF) Southeast Asia region in 2021.³

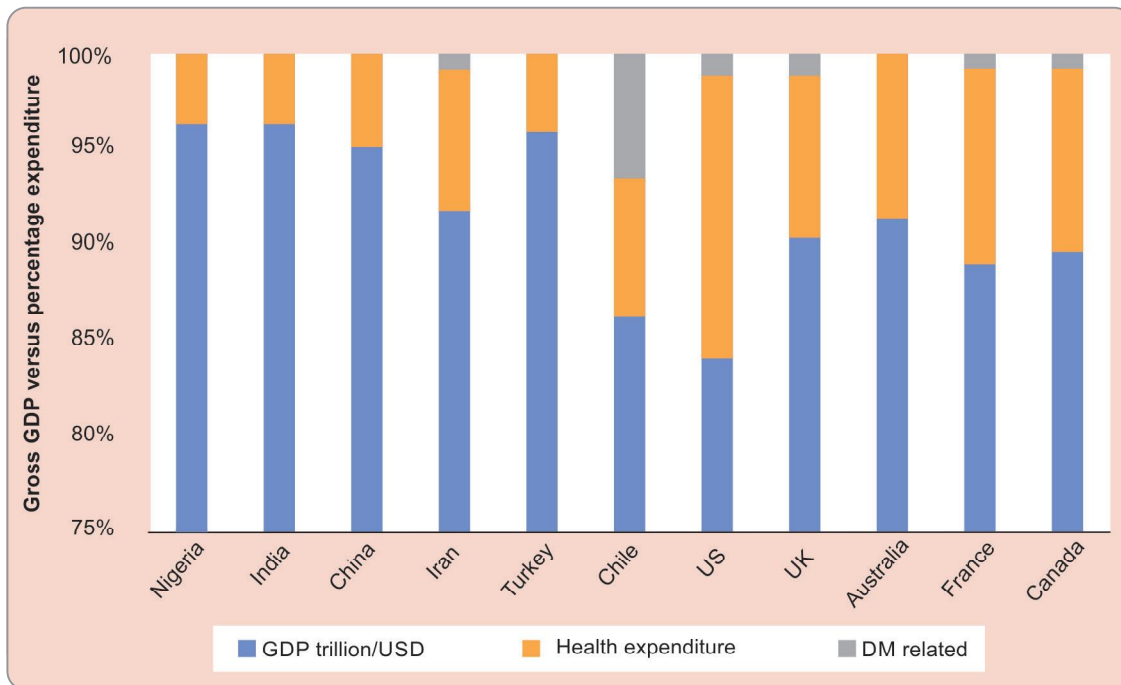


Fig. 3: Country-based comparison of diabetes-related expenditure (2016–2017).⁴
(DM: diabetes mellitus; GDP: gross domestic product)

compared to poorly developed or developing countries who spend less than 6% (**Fig. 3**).⁴

EPIDEMIOLOGY OF DIABETIC FOOT INFECTIONS IN INDIA

In developing countries like India, diabetes mellitus is associated with high rates of mortality and morbidity as well as macrovascular and microvascular complications. In a study by Vijay et al., the prevalence of DFI was found to be between 6 and 11% in India and neuropathy was recognized as the predominant factor causing DFI.⁵ In another study from North India, the prevalence of DFI was reported to be between 12.6 and 31.6% with one-third of patients with peripheral neuropathy, two-thirds of patients “at-risk” for foot ulcers and 9% had prevalent ulcers of which 20.2% required amputation.⁶ Among the newly diagnosed cases of diabetes, the prevalence of DFI was found to be between 3 and 4.5% and this could be attributed to the reporting younger age, and shorter duration of diabetes among the Indian population.⁷ In a study by Viswanathan et al., on the prevalence of diabetic foot complications, it was estimated that that infection was the major reason for amputation. Major amputation was done in 29.1% and minor amputation in 70% of the total amputations.⁸ Moreover, it is also estimated that around 50% of diabetic patients with DFU, who get amputated once, are susceptible to another amputation in consecutive years.

In India, DFU affects 15% of diabetic patients in their entire lifespan. It is also found that DFU is seen in 25% of all adults living with diabetes in India with 50% of them requiring hospitalization and 20% of them requiring

amputation. It is alarming to understand that DFUs are responsible for 80% of all nontraumatic amputations in India every year and patients with a history of DFU have a 40% higher 10-year death rate than those without the complication.⁹ India is also considered the most expensive country in terms of care related to DFU because we spend 5.7 years of an average’s patient income for its complete treatment. Two studies (Satyavani et al. and Shobhana et al.) are suggestive of the same idea that patients with DFU spend four times more than those without complications.^{10,11} The lifetime risk of a diabetic person with a foot infection is as high as 25% which, in turn, contributes to 20% of the total healthcare costs that are spent for diabetes. In a developing nation like India, it puts a heavy burden on the shoulders of healthcare professionals and educators for its effective management.

RISK FACTORS FOR FOOT INFECTION

The pathophysiological process of DFI usually arises as a combination of several risk factors, which can be classified into first-degree, second-degree, and third-degree risk factors, as shown in **Table 2**.¹²

Neuropathy is a major risk factor responsible for DFI in 50% of cases, peripheral arterial occlusive disease is seen in 15% of cases, and in 35% of cases, it is a combination of both neuropathy and angiopathy, which seem to play a pivotal role in DFI.¹² This is in accordance with a multicentric study across India by Vijay et al., which states that the prevalence of neuropathy was 65% and that of peripheral vascular disease (PVD) was 35%.⁸ Similarly, in a study from South India it is apparent that peripheral neuropathy is seen in

TABLE 2: Risk factors of diabetic foot ulceration.¹²

First-degree risk factors	<ul style="list-style-type: none"> • Presence of sensorimotor polyneuropathy • History of previous ulcers • Age of the patient
Second-degree risk factors	<ul style="list-style-type: none"> • Peripheral arterial occlusive disease (PAOD) • Structural deformities in the skeleton of the foot
Third-degree risk factors	<ul style="list-style-type: none"> • Duration of diabetes • Male gender • Late complications of diabetes mellitus: <ul style="list-style-type: none"> ○ Retinopathy ○ Nephropathy

49.5% of cases and nonhealing ulcers in 41.51% of patients with DFI.¹³ In another multicentric study by Vijay et al., the prevalence of neuropathy was found to be higher among southern Indians (15%) than northern Indians (9%).⁵ It becomes imperative to assess patients for DFI and treat them appropriately because DFI in India are the second most common reason for infection-related mortality in hospitalized patients.¹⁴ In a prospective study by Ashu et al., it is established that people with diabetes in India are at five times higher risk for mortality after the occurrence of DFU than those without foot infections. The 5-year mortality rate after a neuropathic DFU in this study was found to be 22% and limb amputation following the foot ulcer was considered to be the most important predictor for subsequent mortality.¹⁵

Improper footwear, lack of footwear, and burns were found to be the primary precipitating factors for foot infections in India.¹⁶ High barefoot pressure can be linked to ulceration, which is evident in a South Indian study for diabetic patients where a higher F/R ratio (Forefoot pressure/Rearfoot pressure) was found to be associated with neuropathy, limited joint mobility, and ulceration.¹⁷

STRATEGIES TO MANAGE DIABETIC FOOT INFECTION

A multidisciplinary approach is required to prevent as well as treat patients with DFI. In a resource-constraint country like India, a thorough history and clinical examination need to be done to assess the severity of any potential DFI.

An initial relevant antibiotic regimen must be chosen based on the patient's severity of the foot infection, which should be modified later to a more specific therapy after tissue culture and antibiotic sensitivity reports.¹⁴

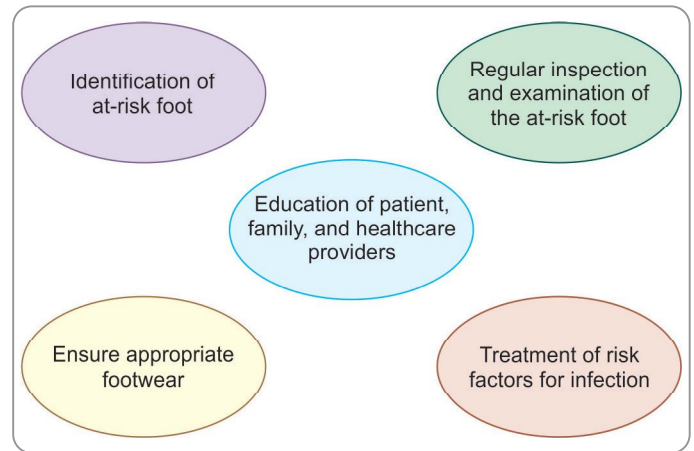


Fig. 4: The five cornerstones for prevention of diabetic foot infections (DFI) based on International Working Group on the Diabetic Foot (IWGDF) guidelines 2019.¹⁸

The microbial profiles from DFI showed a high prevalence of gram-negative bacteria. In a study by Viswanathan et al., among the aerobes causing DFI, it was found that the Enterobacteriaceae family was the most prominent (48%) followed by *Staphylococcus* (18.2%), *Streptococcus* (16.8%), and *Pseudomonas* (17%). Among anaerobes, *Peptostreptococcus* and *Clostridium* (69.4%) and gram-negative anaerobes like *Bacteroides* and *Fusobacterium* (30.6%) were present among people with DFI. The most important inference was that the healing times were longer when the strict aerobic pathogen *Pseudomonas* and strict anaerobic pathogens were present.²

The five key elements for the prevention of DFI based on International Working Group on the Diabetic Foot (IWGDF) guidelines are given in **Figure 4**.¹⁸

CONCLUSION

It is imperative to understand that diabetes in India is rampantly increasing along with the population and DFI also seems to be a very important complication that puts a huge economic burden, which in turn affects the quality of life of patients. Regular screening along with effective strategies plays a very significant role in preventing as well as managing DFI in India.

TAKE-HOME MESSAGE

There is a need to promote awareness about diabetic foot infections and also implement strategies to reduce the burden of diabetic foot and its associated complications in India.

REFERENCES

1. International Diabetes Federation. (2021). IDF Diabetes Atlas, 10th edition.. [online] Available from <https://www.diabetesatlas.org> [Last accessed March, 2023].
2. Viswanathan V. Epidemiology of Diabetic Foot and Management of Foot Problems in India. *Int J Low Extrem Wounds*. 2010;9(3): 122-6.
3. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition Scientific Committee. IDF Diabetes Atlas [Internet]. 10th edition. Brussels: International Diabetes Federation; 2021. Chapter 5: Diabetes by region. [online] Available from <https://www.ncbi.nlm.nih.gov/books/NBK581937/> [Last accessed March, 2023].
4. Jodheea-Jutton A, Hindocha S, Bhaw-Luximon A. Health economics of diabetic foot ulcer and recent trends to accelerate treatment. *Foot (Edinb)*. 2022;52:101909.
5. Viswanathan V, Thomas N, Tandon N, Asirvatham A, Rajasekar S, Ramachandran A, et al. Profile of diabetic foot complications and its associated complications: a multicentric study from India. *J Assoc Physicians India*. 2005;53:933-6.
6. Jayaprakash P, Bhansali S, Bhansali A, Dutta P, Ananthraman R. Magnitude of foot problems in diabetes in the developing world: a study of 1044 patients. *Diab Med*. 2009;26(9):939-42.
7. Sinahary K, Paul UK, Bhattacharyya AK, Pal SK. Prevalence of diabetic foot ulcers in newly diagnosed diabetes mellitus patients. *J Indian Med Assoc*. 2012;110(9):608-11.
8. Vishwanathan V, Kumpatla S. Pattern and causes of amputation in diabetic patients – A multicentric study from India. *J Assoc Phys India*. 2011;59:148-51.
9. Ghosh P, Valia R. Burden of Diabetic Foot Ulcers in India: Evidence Landscape from Published Literature. *Value in Health*. 2017;20(9):A485.
10. Kumpatla S, Kothandan H, Tharkar S, Viswanathan V. The costs of treating long-term diabetic complications in a developing country: a study from India. *J Assoc Physicians India*. 2013;61(2):102-9.
11. Shobhana R, Rao PR, Lavanya A, Vijay V, Ramachandran A. Cost burden to diabetic patients with foot complications--a study from southern India. *J Assoc Physicians India*. 2000;48(12):1147-50.
12. Volmer-Thole M, Lobmann R. Neuropathy and Diabetic Foot Syndrome. *Int J Mol Sci*. 2016;17(6):917.
13. Jyothylekshmy V, Menon AS, Abraham S. Epidemiology of diabetic foot complications in a podiatry clinic of a tertiary hospital in South India. *Indian J Health Sci Biomed Res*. 2015;8(1):48-51.
14. Rastogi A, Bhansali A. Diabetic Foot Infection: An Indian Scenario. *J Foot Ankle Surg Asia-Pacific*. 2016;3(2):71-9.
15. Rastogi A, Goyal G, Kesavan R, Bal A, Kumar H, Mangalanadanam, et al. Long-term outcomes after incident diabetic foot ulcer: Multi-center large cohort prospective study (EDI-FOCUS investigators) epidemiology of diabetic foot complications study: Epidemiology of diabetic foot complications study. *Diabetes Res Clin Pract*. 2020;162:108113.
16. Morbach S, Lutalet JK, Viswanathan V, Möllenberg J, Ochs HR, Rajashekar S, et al. Regional differences in risk factors and clinical presentation of diabetic foot lesions. *Diabet Med*. 2004;21(1):91-5.
17. Viswanathan V, Sivagami M, Seena R, Snehalatha C, Ramachandran A, Veves A. Increased forefoot to rearfoot plantar pressure ratio in South Indian patients with diabetic foot ulceration. *Diabet Med*. 2004;21:396-7.
18. Bus SA, Lavery LA, Monteiro-Soares M, Rasmussen A, Raspovic A, Sacco ICN, et al.; International Working Group on the Diabetic Foot. Guidelines on the prevention of foot ulcers in persons with diabetes (IWGDF 2019 update). *Diabetes Metab Res Rev*. 2020;36 Suppl 1:e3269.