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ORIGINAL ARTICLE

# Frequency of vascular insufficiency in patients presenting with diabetic foot ulcer.

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**ABSTRACT… Objective:** To determine the prevalence of vascular insufficiency in patients presenting with diabetic foot ulcers and analyze associated demographic and clinical factors. **Study Design:** Cross-sectional Observational Study. **Setting:** Department of Medicine, Ghulam Muhammad Mahar Medical Teaching Hospital, Sukkur. **Period:** October 2023 to March 2024. **Methods:** Included 122 patients aged 35–75 years, diagnosed with diabetes mellitus for at least one year, and presenting with diabetic foot ulcers. Vascular insufficiency was assessed using Doppler ultrasound and laboratory tests. **Results:** The prevalence of vascular insufficiency was 17.2%. No significant associations were found with gender ($p = 0.524$), age ($p = 0.204$), or duration of diabetes ($p = 0.240$). Hypertension, ischemic heart disease, and smoking also showed no statistically significant associations. Compared to regional and global studies, the prevalence was slightly lower, potentially due to population-specific characteristics and differences in diagnostic methods. **Conclusion:** Vascular insufficiency remains a prevalent concern among DFU patients, although the observed frequency was lower than reported in other studies. Early vascular assessment and targeted interventions are critical for improving outcomes and reducing complications in resource-limited settings.

**Key words:** Diabetic Foot Ulcers, Diabetes Mellitus, Doppler Ultrasound, Peripheral Arterial Disease, Vascular Insufficiency.

## INTRODUCTION

Diabetes Mellitus is a non-communicable disease that is highly prevalent globally.[1-2] One of the common complications of Diabetes Mellitus is diabetic foot ulcer, which often leads to lower extremity amputation. A recent meta-analysis found a 6.3% global prevalence of diabetic foot ulcer among adults with diabetes, which equates to approximately 33 million people affected by diabetic foot ulcers. Historically, diabetic foot ulcer (DFU) has been reported at the highest rates in North America.[3] According to the International Diabetes Federation ATLAS REPORTS 2022, the prevalence of diabetic foot ulcers in the Middle East and North Africa Region ranges between 5.0% and 20.0%.[4]

A meta-analysis and systematic review conducted in Pakistan on the prevalence of diabetic foot ulcers show increasing trends over the last two decades. The prevalence was highest during the latest period, from 2011 to 2022 (19.54%), compared to the early 2000s (4.55%).[5] Among diabetic patients, foot ulcers and amputations are common in Pakistan due to a lack of sanitation, hygiene, and poverty.[6] For individuals with diabetic foot ulcers, the greatest concern is vascular insufficiency, a common consequence of diabetes.[7]

Impaired vascular supply in diabetic foot ulcers is linked to worse outcomes, including reduced healing potential, recurrent ulcers, greater amputation risks, and higher mortality.[7] This highlights the vital role of early vascular assessment and treatment in enhancing healing, preventing amputations, and improving survival outcomes.

A study by Abdulmajeed Altoijry et al. revealed

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that vascular insufficiency accounts for around 19.1% of diabetic foot ulcers. Identifying the extent of vascular insufficiency in diabetic foot patients is pivotal for improving outcomes, lowering complication rates, and optimizing resource utilization. This practice forms a central part of a multidisciplinary approach to diabetic foot care that prioritizes patient quality of life.[8]

The rationale for this study stems from the high prevalence of diabetic foot ulcers (DFUs) and their association with vascular insufficiency, a major complication that can lead to poor outcomes, including amputation. Diabetic foot ulcers are a common cause of morbidity in diabetic patients, and vascular insufficiency, which impairs blood circulation to the affected area, is a critical factor in the delayed healing of these ulcers. Despite the known relationship between these two conditions, there is limited data on the prevalence of vascular insufficiency specifically in patients with diabetic foot ulcers in this region. By identifying the frequency of vascular insufficiency and evaluating associated risk factors, this study aims to provide valuable insights into the management of DFUs and improve patient care by highlighting the importance of early detection and intervention for vascular abnormalities in this population.

## METHODS

This cross-sectional observational study aimed to determine the frequency of vascular insufficiency in patients presenting with diabetic foot ulcers. The study was conducted in the Department of Medicine at Ghulam Muhammad Mahar Medical Teaching Hospital, Sukkur, over six months (October'23 to March'24) following the approval of the synopsis by the ethical committee (Reg No: 058/2023, Dated: 01-May-2023) and CPSP.

The sample size for the study was 122 patients, calculated using the WHO sample size calculator with a 95% confidence interval, a 7% margin of error, and an expected prevalence of 19.1% of vascular insufficiency among diabetic foot ulcer patients. Non-probability consecutive sampling was used to recruit eligible participants.

Patients with a confirmed diagnosis of diabetes mellitus for at least one year (including Type 1 or Type 2 diabetes) and presenting with an open sore or wound on the foot, such as ulcers on the plantar surface, toes, heel, or metatarsal heads, were included. Participants ranged in age from 35 to 75 years, and both male and female patients were eligible.

Exclusion criteria included patients with foot ulcers caused by conditions other than diabetes (e.g., traumatic injuries, autoimmune disorders, or infectious diseases) and those with non-atherosclerotic chronic vascular conditions of the lower extremity, such as radiation arteritis, vasculitis, or Buerger's disease. Pregnant women and individuals with severe, unstable cardiovascular disease, including recent myocardial infarction or stroke, were also excluded to minimize potential risks and confounding factors.

Prior to participation, all individuals provided written informed consent. Demographic details such as age, gender, address, and socioeconomic status were carefully recorded. A thorough medical history was collected, and all patients underwent a comprehensive physical examination. An experienced consultant with at least three years of post-fellowship experience supervised the entire process.

Vascular insufficiency was assessed according to operational definitions, utilizing laboratory tests and Doppler ultrasound to confirm blood flow abnormalities. All patients with diabetic foot ulcers were managed according to hospital protocols, and their data were documented on a pre-designed proforma. Vascular insufficiency in patients with diabetic foot ulcers is defined as an Ankle-Brachial Index (ABI) of ≤ 0.9, indicating peripheral arterial disease (PAD) and reduced blood flow to the lower extremities on Doppler ultrasound.

**Classification Based on ABI:**

- Normal Perfusion: ABI 0.91-1.30
- Mid Vascular Insufficiency: ABI 0.71-0.90
- Moderate Vascular Insufficiency: ABI 0.41-0.70
- Severe Vascular Insufficiency (Critical

Ischemia): ABI < 0.40.
- Non-compressible Arteries (Suggestive of Medical Calcification): ABI > 1.30 (Requires TBI assessment)

Data were analyzed using SPSS version 25. Quantitative variables, such as age and duration of diabetes, were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution. Normality was assessed using the Shapiro-Wilk test. Qualitative variables, including gender, symptoms of vascular insufficiency, history of diabetic foot ulcers, history of foot trauma, hypertension, ischemic heart disease, smoking, drug history, family history of diabetes, and vascular insufficiency, were summarized as frequencies and percentages. Stratification was performed for factors such as age, gender, history of trauma, family history of vascular disease, hypertension, ischemic heart disease, smoking, and previous diabetic foot ulcers to evaluate their effects on vascular insufficiency. Post-stratification analysis was done.

## RESULTS

The majority of participants (59.0%) were aged between 35 and 50 years, while 41.0% were aged 51–75 years. Gender distribution was nearly equal, with 49.2% female and 50.8% male participants. Regarding residential status, 55.7% of the participants lived in rural areas, whereas 44.3% were from urban areas. Hypertension was present in 61.5% of the participants, while 38.5% did not have hypertension. Ischemic heart disease was reported by 40.2% of participants, with the remaining 59.8% unaffected. Smoking history was noted in 25.4% of participants, whereas 74.6% were non-smokers. Family history of diabetes was documented in 44.3% of the participants, while 55.7% reported no such history.

Vascular insufficiency was observed in 17.2% of participants, while the majority (82.8%) did not have vascular insufficiency. Symptoms of vascular insufficiency were present in 20.5% of participants, with 79.5% reporting no symptoms. A history of trauma was noted in 21.3% of participants, while 78.7% had no such history. Additionally, 36.1% of participants reported a history of diabetic foot ulcers, compared to 63.9% without such a history. This data highlights the prevalence of various demographic and health conditions within the study population, emphasizing the distribution of key risk factors and comorbidities.

No significant associations were found in vascular insufficiency across variables. It was observed in 28.6% of patients aged 35–50 vs. 71.4% in those aged 51–75 ($p = 0.204$). Males (57.1%) vs. females (42.9%) ($p = 0.524$), urban (38.1%) vs. rural (61.9%) residents ($p = 0.532$), and shorter (42.9%) vs. longer (57.1%) diabetes duration ($p = 0.240$) showed no significant differences. Hypertension (66.7% vs. 33.3%, $p = 0.591$), ischemic heart disease (33.3% vs. 66.7%, $p = 0.483$), smoking (9.5% vs. 90.5%, $p = 0.066$), family history of diabetes (38.1% vs. 61.9%, $p = 0.532$), symptoms (23.8% vs. 76.2%, $p = 0.679$), and trauma history (28.6% vs. 71.4%, $p = 0.372$) also showed no significant associations.

Among patients with a history of diabetic foot ulcers, 47.6% (10 out of 44) had vascular insufficiency, while 52.4% (11 out of 78) of those without such a history were affected. The p-value was 0.226, indicating no significant association.

## DISCUSSION

Vascular insufficiency, including peripheral arterial disease (PAD), plays a critical role in the development and progression of DFUs. This study explored the frequency of vascular insufficiency among patients presenting with DFUs in a tertiary care hospital and compared its findings with existing literature.

The prevalence of vascular insufficiency in this study was 17.2%, which is slightly lower than several previous studies. For instance, Bajaj et al[10] reported a prevalence of 30% for PAD among DFU patients in North India. Similarly, Rathnaganpathi et al[11] reported a PAD prevalence of 29%, emphasizing the need for early recognition and management of high-risk populations. Abdulmajeed Altoijry et al[8] documented a vascular insufficiency prevalence of 19.1% in patients with DFUs, which is closer to our findings but still slightly higher. These

differences may reflect variations in diagnostic criteria, population demographics, and healthcare access. Globally, Armstrong et al[15] highlighted the increasing prevalence of neuropathic and neuroischemic wounds, particularly in developed nations. However, our findings indicate a lower prevalence of vascular insufficiency, suggesting that population-specific factors and resource constraints might influence these outcomes.

Our findings revealed no significant association between gender and vascular insufficiency (p = 0.524). This aligns with the study by Khalid Usman et al[12] who reported a higher prevalence of PAD in male DFU patients but without statistical significance. Bajaj et al[10] also observed a predominance of neuroischemic ulcers (NIUs) among males, potentially reflecting gender-related disparities in healthcare-seeking behavior or lifestyle factors like smoking.

| Variable | | Count | Percent |
|---|---|---|---|
| Age(years) | 35-50 | 72 | 59.0 |
| | 51-75 | 50 | 41.0 |
| Gender | Female | 60 | 49.2 |
| | Male | 62 | 50.8 |
| Residential Status | Rural | 68 | 55.7 |
| | Urban | 54 | 44.3 |
| Hypertension | Yes | 75 | 61.5 |
| | No | 47 | 38.5 |
| Ischemic Heart Disease | Yes | 49 | 40.2 |
| | No | 73 | 59.8 |
| Smoking | Yes | 31 | 25.4 |
| | No | 91 | 74.6 |
| Family History of Diabetes | Yes | 54 | 44.3 |
| | No | 68 | 55.7 |
| Vascular Insufficiency | Yes | 21 | 17.2 |
| | No | 101 | 82.8 |
| Symptoms of Vascular Insufficiency | Yes | 25 | 20.5 |
| | No | 97 | 79.5 |
| History of Trauma | Yes | 26 | 21.3 |
| | No | 96 | 78.7 |
| Previous Diabetic Foot Ulcer | Yes | 44 | 36.1 |
| | No | 78 | 63.9 |

**Table-I. Clinical and demographic details of the patients (n=122)**

| Variables | | Yes | No | Total | P-Value |
|---|---|---|---|---|---|
| Age (years) | 35-50 | 6 | 44 | 50 | 0.204 |
| | | 28.6% | 43.6% | 41.0% | |
| | 51-75 | 15 | 57 | 72 | |
| | | 71.4% | 56.4% | 59.0% | |
| Gender | Male | 12 | 50 | 62 | 0.524 |
| | | 57.1% | 49.5% | 50.8% | |
| | Female | 9 | 51 | 60 | |
| | | 42.9% | 50.5% | 49.2% | |
| Residential status | Urban | 8 | 46 | 54 | 0.532 |
| | | 38.1% | 45.5% | 44.3% | |
| | Rural | 13 | 55 | 68 | |
| | | 61.9% | 54.5% | 55.7% | |
| Duration of diabetes mellitus | Yes | 9 | 30 | 39 | 0.240 |
| | | 42.9% | 29.7% | 32.0% | |
| | No | 12 | 71 | 83 | |
| | | 57.1% | 70.3% | 68.0% | |
| Hypertension | Yes | 14 | 61 | 75 | 0.591 |
| | | 66.7% | 60.4% | 61.5% | |
| | No | 7 | 40 | 47 | |
| | | 33.3% | 39.6% | 38.5% | |
| Ischemic Heart Disease | Yes | 7 | 42 | 49 | 0.483 |
| | | 33.3% | 41.6% | 40.2% | |
| | No | 14 | 59 | 73 | |
| | | 66.7% | 58.4% | 59.8% | |
| Smoking | Yes | 2 | 29 | 31 | 0.066 |
| | | 9.5% | 28.7% | 25.4% | |
| | No | 19 | 72 | 91 | |
| | | 90.5% | 71.3% | 74.6% | |
| Family History of Diabetes | Yes | 8 | 46 | 54 | 0.532 |
| | | 38.1% | 45.5% | 44.3% | |
| | No | 13 | 55 | 68 | |
| | | 61.9% | 54.5% | 55.7% | |
| Symptoms of vascular insufficiency | Yes | 5 | 20 | 25 | 0.679 |
| | | 23.8% | 19.8% | 20.5% | |
| | No | 16 | 81 | 97 | |
| | | 76.2% | 80.2% | 79.5% | |
| History of trauma | Yes | 6 | 20 | 26 | 0.372 |
| | | 28.6% | 19.8% | 21.3% | |
| | No | 15 | 81 | 96 | |
| | | 71.4% | 80.2% | 78.7% | |
| Previous diabetic foot ulcer | Yes | 10 | 34 | 44 | 0.226 |
| | | 47.6% | 33.7% | 36.1% | |
| | No | 11 | 67 | 78 | |
| | | 52.4% | 66.3% | 63.9% | |

**Table-II. Vascular Insufficiency according to various modifiers**

Patients aged 51–75 years had a higher prevalence of vascular insufficiency (71.4%) compared to those aged 35–50 years (28.6%), though this difference was not statistically significant ($p = 0.204$). This finding is consistent with studies by Khan et al[13] and Abdulmajeed Altoijry et al[8] who reported an increasing trend of PAD with advancing age. Age-related vascular changes and prolonged exposure to diabetic complications likely contribute to this pattern. A longer duration of diabetes was associated with higher vascular insufficiency prevalence (57.1% in patients with >2 years' duration), though the difference was not statistically significant ($p = 0.240$). This is in line with findings by Bajaj et al[10] who observed a strong association between longer diabetes duration and PAD. Hypertension and ischemic heart disease, common comorbidities in diabetes, were also frequently observed in our cohort but did not show significant associations with vascular insufficiency, similar to findings by Rathnaganpathi et al.[11]

Smoking, a well-known risk factor for PAD, showed a noticeable but non-significant association with vascular insufficiency in our study ($p = 0.066$). Bajaj et al[10] and Khan et al[13] both reported significant associations between smoking and PAD, underscoring the importance of smoking cessation in DFU management. This study's lower prevalence of vascular insufficiency may reflect a higher proportion of neuropathic ulcers (NPUs) compared to neuroischemic ulcers (NIUs). Megallaa et al[14] reported 86.7% NPUs and 11.1% ischemic DFUs, similar to our observations. Abdulmajeed Altoijry et al[8] emphasized the growing recognition of neuroischemic wounds as an important subset of DFUs. Khalid Usman et al[12] found a much higher PAD prevalence (58.3%), possibly due to differences in diagnostic modalities such as angiography and Doppler ultrasound.

The findings highlight the need for comprehensive vascular assessments in DFU patients, even in resource-limited settings. Identifying vascular insufficiency early can inform treatment strategies such as revascularization, thereby improving outcomes and reducing amputation rates. Armstrong et al[15] emphasized the importance of interdisciplinary care and integrating clinical trials to advance DFU management, an approach that should be prioritized in local healthcare systems. The study's cross-sectional design limits causal inferences. Additionally, the use of non-invasive diagnostic methods may have underestimated vascular insufficiency prevalence compared to studies employing advanced techniques like angiography.

## CONCLUSION

This study underscores the prevalence and clinical burden of vascular insufficiency in DFU patients. The observed prevalence was slightly lower than other regional and global studies, including Abdulmajeed Altoijry et al[8] who reported a prevalence of 19.1%. While the reasons for this discrepancy require further investigation, factors such as diagnostic differences, population-specific characteristics, and healthcare access may play a role. The findings emphasize the importance of targeted interventions and multidisciplinary care to improve outcomes for DFU patients.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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| 2 | **Iftikhar Ali Shah:** Discussion writing, review of manuscript. |
| 3 | **Muhammad Faheemullah Kamboh:** Data collection, paper writing. |
| 4 | **Saleh Muhammad Channa:** Review of manuscript. |
| 5 | **Bashir Ahmed Chandio:** Data analysis, manuscript writing. |
| 6 | **Umair Ali Shah:** Discussion writing, review of manuscript. |