"FREQUENCY AND OUTCOME OF DYSLIPIDEMIA IN DIABETIC FOOT PATIENTS"

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ABSTRACT
Background: Diabetic foot is a serious complication of diabetes mellitus, contributing to significant morbidity, mortality, and healthcare burden worldwide. Dyslipidemia is frequently observed in diabetic patients and has been implicated in vascular dysfunction and poor ulcer healing. However, limited data exist on its prevalence and impact in diabetic foot patients in Pakistan.
Objective: To identify the prevalence of dyslipidemia and its clinical outcomes among patients with diabetic foot who present to Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan.
Methods: This cross-sectional descriptive study was performed between October, 2024 and April, 2025 at the Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan. One hundred and eighty patients who had diabetic foot ulcers and type 2 diabetes were enrolled. Clinical assessment, ulcer grading, and fasting lipid profiles were conducted. Measures of outcomes evaluated were ulcer healing, surgical intervention, amputation, and in-hospital mortality.
Results: Out of 180 patients, 108 (60%) were male and 72 (40%) were female, with a mean age of 56.8 years ± 9.4 years. There was dyslipidemia in 124 patients (68.9%). Abnormalities that were most widespread included high LDL-C (52.8%), high triglycerides (47.2%), and low HDL-C (42.6%). In dyslipidemic patients, complete healing of the ulcer was observed in 33.1% and 14.5% major amputation and death, respectively. On the contrary, patients without dyslipidemia showed better healing (62.5%), amputation (5.3%), and mortality (5.3%).
Conclusion: Dyslipidemia is extremely common in diabetic foot and is linked to unhealing wounds, higher amputation rates, and mortality. The management and screening of lipids at an early age should be part of the diabetic foot care in Pakistan.

INTRODUCTION

Diabetes mellitus has become one of the most serious health issues in the world, and its complications have contributed to higher morbidity, mortality, and economic burden. Diabetic foot is one of the most severe complications, which not only deteriorates the quality of life of patients but also causes greater hospitalization, amputation, and death (1). According to recent studies, the complex relationship between metabolic imbalances, e.g., dyslipidemia, and the development of diabetic foot complications has been indicated. The poor vascular condition and poor wound healing in diabetic patients have been directly linked to the abnormal levels of total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides, and low levels of high-density lipoprotein cholesterol (HDL-C) (2). It is suggested that lipid abnormality plays a role in both microvascular and macrovascular dysfunction, thus making a person vulnerable to diabetic foot ulceration and the wound healing process. Disturbed lipid metabolism has also been associated with increased systemic inflammation and endothelial injury, which further increases the likelihood of acquiring diabetic foot complications (3,4). Diabetic patients are predisposed to diabetes related foot ulcers by a combination of various risk factors in patients with type 2 diabetes. The other significant cause of this risk is chronic diabetes, other than dyslipidemia, poor glycemic control, high blood pressure, and body obesity (5). The clinical importance of dyslipidemia among diabetic populations is also regional in nature and is usually more than 70 percent in distinct cohorts (6).

In Saudi Arabia and other Middle Eastern nations, where the majority of patients had type 2 diabetes, a significant proportion had lipid abnormalities that propagated their vascular complications (7). Similarly, a survey carried out in Jordan observed that the most common tendencies of dyslipidemia were elevated triglyceride rates and decreased HDL-C, which are much more suggestive of defect and rupture of the vessels (8). Additionally, diabetic foot ulcer patients are often characterized by peripheral arterial disease, a disease highly dependent on lipid disorders, which exacerbates ischemia and decreases the rate of limb salvage (9). Thus, dyslipidemia is a comorbidity and a potential prognostic factor in diabetic foot. Glycemic variability and dyslipidemia are also associated with the complexity of the disease process. Poor vascular outcomes and consequently oxidative stress, which causes ulceration and delayed wound healing, have been proven to be caused by hypoglycemic episodes in diabetic patients (10). Regional Chinese studies support that dyslipidemia prevalence is not effectively controlled in the diabetic population, and the therapies and control are not optimally achieved in different healthcare systems (11). Surprisingly, studies have been unable to say the same when they discovered that some diabetic foot ulcer patients had tighter lipid profiles, possibly due to inflammatory reactions in the body, but with worse overall vascular results (12).

The observations above indicate that the pathophysiology of lipid metabolism and diabetic foot is complex. Additionally, the issue of diabetes complications is not confined to the vascular and neuropathic damage, but rather other associations, such as hearing loss, have been reported in diabetic patients, which are generally related to either microvascular damage or dyslipidemia, reflecting the systemic effects of lipid imbalance (13). The emergence of other diseases worsening the general state of human health may also be predetermined by the metabolic load of type 2 diabetes. Malnutrition is also stated to be at a very high level in diabetic patients, and with the combination of dyslipidemia, may also result in the inability to heal properly and resist infections (14). Genetic factors leading to dyslipidemia and diabetes are also present, such as polymorphisms of methylenetetrahydrofolate reductase (MTHFR), making it difficult to treat diabetic patients clinically (15). Neuropathy is also associated with dyslipidemia and poor metabolic control, and has been identified as one of the most frequent causes of diabetic foot ulcers. The abnormal nerve conduction pattern has been observed in diabetic patients and is likely to result in long-term metabolic dysfunctions (16). Besides general and abdominal obesity being strongly linked to dyslipidemia, general and abdominal obesity have been identified to predict diabetic neuropathy itself, elevating the risk of ulceration (17). The length of diabetes and the continuity of abnormal metabolism are also determining factors in the occurrence of diabetic peripheral neuropathy, and once again highlight the mutually reinforcing factor of

dyslipidemia (18). In addition to neuropathy and vascular complications, dyslipidemia in diabetes has also exerted other systemic effects, such as auditory dysfunction, in which disturbed blood flow to the cochlea has been linked to lipid abnormalities in diabetic patients (19).

These various associations are used to emphasize the fact that dyslipidemia is not a comorbid metabolic condition but a major etiological determinant in the progressive continuum of diabetic complications, such as the diabetic foot. Together, the evidence indicates that lipid abnormalities can be used as a marker and as a mediator of a poor prognosis in diabetic foot disease (11). Diabetic foot is a local health issue in the Pakistani healthcare system, and each year, thousands of patients are admitted to tertiary care hospitals in search of treatment for ulcers and related complications. Though the problem of dyslipidemia as a risk factor has begun to receive more and more attention, little regional data has been conducted to investigate the prevalence and outcome of dyslipidemia in diabetic foot patients. The existing literature in Pakistan has concentrated on the general dyslipidemia in diabetics or the vascular diseases, including stroke, but has not discussed the direct consequences of dyslipidemia in foot ulcer and its associated morbidity (13). Since diabetes is a significant problem in Pakistan and patients are at risk of losing their limbs, the question of the regularity and consequences of dyslipidemia in diabetic foot deserves immediate investigation. In this way, clinicians will be able to stratify the risk to a greater degree, maximize the benefits of lipid-lowering therapies, and enhance the multidisciplinary treatment of such patients (18). The current study, which is being conducted in Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan, seeks to address this gap by assessing the prevalence of dyslipidemia in patients with diabetic foot and the prognosis of the same within a given period of time.

Objective: To estimate the prevalence of dyslipidemia and clinical implications of dyslipidemia among diabetic foot patients who are under treatment Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan, during the months of October, 2024 and April, 2025.

MATERIALS AND METHODS
Study Design and Setting: Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan
Duration of the Study: From October, 2024 to April, 2025.
Inclusion Criteria: Men and women aged 30 and above with type 2 diabetes mellitus who have known diabetic foot ulcers of any grade. The number of subjects in the sample was limited to those who agreed to undergo the lipid profile assessment with informed consent. The patients with newly diagnosed diabetic foot ulcers, along with the previously known diabetic foot ulcers, were eligible.
Exclusion Criteria: Patients who had a history of chronic kidney disease, chronic liver disease, and thyroid disorder, or were already taking a long-term lipid-lowering medication, were excluded. Patients who had traumatic ulcers not associated with diabetes, and those who declined to participate, were also excluded. Patients with serious systemic sickness who needed critical care immediately were excluded from the study.

Methods: Each of the eligible patients underwent a systematic clinical evaluation, based on a detailed medical history, diabetes duration, levels of glycemic control, and comorbidities. The diabetic foot was carefully examined to grade the severity of the ulcers. Blood samples were taken following overnight fasting to determine lipid profile, i.e., total cholesterol, triglyceride, LDL-C, and HDL-C. Dyslipidemia was established based on standard criteria. The evaluated outcomes were the healing of ulcers, their progression, the requirement of any surgical intervention (amputation), and mortality during the stay in the hospital. The information was noted on a pre-designed proforma and tabulated to establish the frequency and the outcome of dyslipidemia in diabetic foot patients.

RESULTS
The study population was 180 patients diagnosed with diabetic foot ulcers enrolled in the Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan, between the study period of October, 2024

to April, 2025. These included 108 (60%) males and 72 (40%) females with an average age of 56.8/9.4 years. Most of the patients (62%) were aged 50-60 years. The average time of diabetes was 11.2 +5.6 years, and 70 percent of the patients had poor glycemic control with HbA1c levels exceeding 8 percent.

Table 1. Baseline characteristics of study participants

Variable	Frequency (n=180)	Percentage (%)
Age (years, mean ± SD)	56.8 ± 9.4	–
Gender (Male/Female)	108 / 72	60 / 40
Duration of diabetes (years, mean ± SD)	11.2 ± 5.6	–
HbA1c ≥ 8%	126	70
Hypertension	102	56.7
Smoking history	64	35.6

Among 180 individuals, 124 patients had dyslipidemia, which had a frequency of **68.9%.** The predominant abnormality in those who had dyslipidemia was increased LDL-C (52.8%), followed by high triglycerides (47.2%) and low HDL-C (42.6%). Patients with several lipid abnormalities were found to have more severe ulcer grades than those without dyslipidemia.

Table 2. Lipid profile abnormalities in study participants

| Lipid abnormality	Frequency (n=124)	Percentage (%)
Elevated LDL-C	94	52.8
High Triglycerides	85	47.2
Low HDL-C	77	42.6
High Total Cholesterol	68	37.8

Upon stratification based on the outcome of ulcer, dyslipidemic patients had worse healing and increased complications. Among 124 dyslipidemic patients, 41 (33.1%) and 52 (41.9%), respectively, were completely healed and needed slight surgical treatment like debridement. Major amputation was done in 18 (14.5%) cases, and 13 (10.5%) patients died in the hospital. Conversely, 35 (62.5%) of 56 non-dyslipidemic patients were completely healed, 15 (26.8%) needed minor surgery, only 3 (5.3%) had amputations, and 3 (5.3%) died.

Table 3. Clinical outcomes of diabetic foot patients with and without dyslipidemia

Outcome	Dyslipidemia (n=124)	No Dyslipidemia (n=56)
Complete healing	41 (33.1%)	35 (62.5%)
Minor surgery/debridement	52 (41.9%)	15 (26.8%)
Major amputation	18 (14.5%)	3 (5.3%)
Mortality	13 (10.5%)	3 (5.3%)

Comparative analysis revealed that dyslipidemic patients had almost twice the probability of undergoing amputation in contrast to non-dyslipidemic patients. Likewise, the dyslipidemic group had a higher mortality rate, indicating that lipid abnormalities are detrimental to the prognosis of diabetic foot.

Graph 1. Outcomes of diabetic foot patients by dyslipidemia status

Outcomes of Diabetic Foot Patients by Dyslipidemia Status
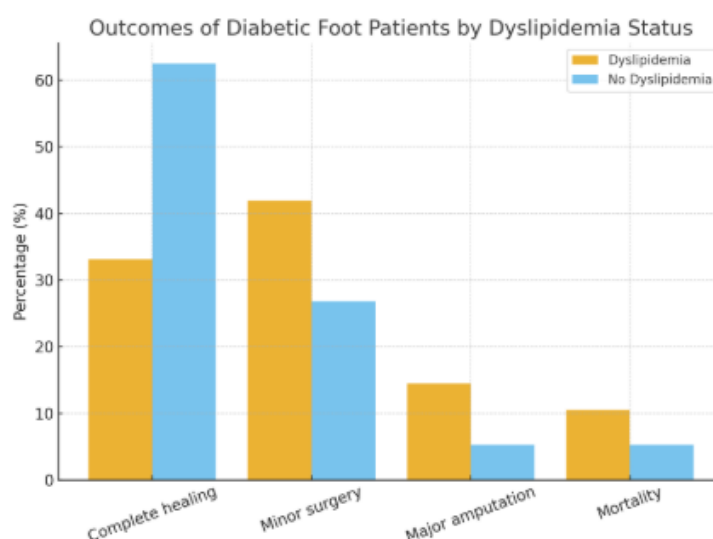
The overall results indicate a high incidence of dyslipidemia in diabetic foot patients and indicate that its existence is correlated with slower healing, increased risk of amputation, and increased mortality rate in comparison with the absence of dyslipidemia.

Discussion
The current research showed that the prevalence of dyslipidemia was high (68.9%) in patients with diabetic foot ulcers found at Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan. Additionally, dyslipidemia was also highly correlated with poor clinical results, such as reduced healing, increased risk of amputation, and increased mortality, compared to the group that was not affected by lipid abnormalities. These results confirm the hypothesis that dyslipidemia is a significant comorbid condition but also a determinant of prognosis in diabetic foot disease (1). Findings align with previous data that lipid aberrations are among the factors that cause vascular dysfunction and delayed wound healing in diabetes. AbdAllah and Sharafeddin emphasized that dyslipidemia changes the microvascular circulation and results in an increase in the risk of ulceration and slow recovery among diabetic individuals. Likewise, Vujčić et al. found that biomarkers of dyslipidemia, like apolipoproteins, are heavily correlated with diabetic foot ulcers, as well as evidence of lipid disruptions in the pathophysiology of ulcers (2). Ardelean et al. even reported contradictory results with some diabetic foot patients showing a positive response in terms of lipid levels with a systemic change in inflammation but poor outcomes, which is similar to the results that reveal prognosis correlates with long-term metabolic derangements instead of a single measurement (3). Zhang et al. also showed dyslipidemia negatively affects the prognosis of diabetic foot ulcers, exhibiting the same tendencies of less healing and increased complications (4).

Diabetic foot is a multifactorial condition, and the effect of dyslipidemia on this condition is synergistic with other risk factors, including poor glycemic control, hypertension, and obesity. HbA1c levels of 70 percent of patients in our cohort were above 8 percent of normal glucose regulation. This is related to the findings of Ouyang et al., who reported inadequate glycemic regulation and metabolic disturbances as the most important risk factors of diabetic foot ulcer (5). Bawah et al. and Al Ghadeer et al. also found that dyslipidemia was high in type 2 diabetes patients, with a prevalence as high as over 60 percent, just short of the prevalence of the study (6,7). The Al Quran et al. The Jordanian sample served to make the triglycerides and low HDL-C the most common abnormalities, as it was in our samples of patients (8). Peripheral arterial disease is another important mechanism linking diabetic foot and dyslipidemia. Our research findings indicated that patients who had dyslipidemia had worse ulcers and amputations, and this is comparable to the findings of Azhar et al., who demonstrated that peripheral arterial disease worsens ischemia and significantly reduces limb salvage

among patients with diabetic foot (9). This highlights the importance of vascular protection with aggressive lipid control in the treatment of diabetes. Agrawal et al. also found hypoglycemia to be a risk factor for vascular complications and found that repeated hypoglycemia episodes increase oxidative stress and vascular injury (10). When combined, the interplay between lipid abnormalities and glucose changes could be the reason behind the slow healing of wounds and increased complications in the dyslipidemic patient group. Management of dyslipidemia in diabetic patients is still suboptimal. Li et al. discovered that despite the comparatively high treatment rates of dyslipidemia in China, the real control rates were significantly lower, which means that the risk of complications remained high (11).

The same case can be observed in the environment, where the majority of patients were brought with untreated lipid disorders or poorly managed. In addition to the vascular and metabolic effects, studies by Al-Rubeaan et al. and Jaffar et al. have shown that diabetes and dyslipidemia have a systemic effect, including hearing loss (12). These results further highlight the systemic effect of untreated dyslipidemia. Dyslipidemia is also very prevalent in diabetic populations due to nutritional and genetic reasons. Vural Keskinler et al. managed to establish that malnutrition was not that uncommon in diabetics, and when it is combined with lipid abnormalities, it deteriorates their overall prognosis (13). On the same note, Elqadi et al. showed that genetic polymorphisms like MTHFR C677T are strongly linked to dyslipidemia in diabetic patients (14). These results suggest that genetic screening and nutritional screening can prove useful in the early detection of high-risk patients. Another life-threatening aspect of diabetic foot, neuropathy, has been closely associated with dyslipidemia. El-Bably et al. established that abnormal nerve conduction patterns were more prevalent in patients with metabolic disturbances, whereas Zhou et al. and Alshammari et al. established that obesity, dyslipidemia, or longer duration of diabetes were significant risk factors in type 2 diabetics with neuropathy. These findings are in line with the result that dyslipidemic patients exhibited worse ulcers, which could probably be attributed to neuropathic and vascular impairment (15).

Dyslipidemia has a systemic effect that is not localized to the foot. Madhan et al. found that dyslipidemia was a factor in hearing impairment in diabetic patients, suggesting once again that lipid abnormalities are not limited to cardiovascular risk but are a universal metabolic risk (16). Dyslipidemia, in this case, not only augmented diabetic foot results, but also augmented the cumulative load of hospitalization, presumptive long-term health results. Regarding public health, the existing levels and low rates of good outcomes of dyslipidemia in diabetic foot patients in Pakistan evidently demonstrate the need to employ a combined approach in management (17). Lipid screening is to become mandatory for all diabetic patients with foot ulcers since early diagnosis and treatment can prevent severe implications of the disease, such as amputation. Moreover, interdisciplinary treatment with endocrinologists, vascular surgeons, nutritionists, and podiatrists must be provided to meet the complex needs of such patients (18). Education of the population on diet and exercise, as well as drug compliance, can also be important in decreasing the burden of dyslipidemia. Limitations of this study should be cited. As a single-center cross-sectional study, it may not reflect the prevalence of dyslipidemia in various regions of Pakistan. In addition, long-term results after the duration of the study were not evaluated, which restricts the possibility of measuring recurrence or long-term survival.

Nevertheless, regardless of these shortcomings, this research is informative about the commonness and consequences of dyslipidemia in diabetic foot patients of one of the largest tertiary care hospitals in Pakistan. Results validate the fact that dyslipidemia is extremely common in patients with diabetic foot and is linked to poor outcomes, such as increased amputation and mortality. Diabetic foot prevention and management plans in Pakistan and other medical institutions should also address lipid abnormalities in diabetic patients as a key element of diabetic foot prevention and management.

Conclusion
The presented study emphasizes that the prevalence of dyslipidemia is very high among diabetic foot patients in Department of Medicine, Aziz Fatima Hospital, Faisalabad, Pakistan, where dyslipidemia is observed in almost seven out of ten patients. Lipid abnormalities, especially high LDL-C and

triglycerides, and low HDL-C, were found to be strongly related to worse clinical results, such as slower healing of ulcers, increased surgical intervention, risk of amputation, and mortality. The results obtained indicate that dyslipidemia is not a comorbidity but a significant prognostic factor in diabetic foot disease. Management of lipid disorders, as well as stringent glycemic control, would have a significant positive effect on patient outcome and may help lower the burden of diabetic foot complications. Diagnostic screening of dyslipidemia, early lipid-lowering treatment, and multidisciplinary care should be emphasized among diabetic patients in Pakistan. Multicenter studies extending over a longer duration of follow-up time are suggested in the future to understand better the effects of dyslipidemia on diabetic foot prognosis over the long term.

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