

Study of the Relationship between Blood Group and Lipids profile in Diabetic Patients with Diabetic Foot

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Abstract

This study was designed to investigate the relationship between blood groups and complete lipid profile parameters in male and female diabetic patients with diabetic foot in Dhi-Qar Governorate. The study sample consisted of 138 patients (60 male and 78 female) with diabetic foot complications from Dhi-Qar Governorate. The patients were categorized according to gender, ABO and Rh blood groups, and the presence or absence of bacterial infection. No female patients with diabetic foot associated with bacterial infection were identified, except for a single case. Complete lipid profile parameters were measured and analyzed. The results showed that female patients had a higher incidence of diabetic foot complications than males, while male patients had a higher incidence of diabetic foot complications than females. Furthermore, the results indicated that patients with blood type O had the highest incidence of diabetic foot complications, while those with blood type A had the lowest incidence in both male and female patients. The complications were also found to be significantly more prevalent among Rh-positive patients compared to Rh-negative patients. Diabetic foot complications were associated with varying lipid profile abnormalities in both males and females, characterized by a decrease in high-density lipoprotein (HDL) cholesterol and a decrease in low-density lipoprotein (LDL) cholesterol in both sexes. The results of this study indicate a correlation between diabetic foot complications and sex, particularly in females, as well as blood type O. These complications cause abnormalities and variations in lipid concentrations as measured by the studied parameters.

Keywords: Diabetic foot, Blood groups, Lipid profile, Bacterial infection.

دراسة العلاقة بين فصائل الدم ودهون الدم لدى مرضى القدم السكري

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الخلاصة

شملت هذه الدراسة 138 مريضاً (60 ذكراً و78 أنثى) يعانون من مضاعفات القدم السكري في محافظة ذي قار وتم تصنيف المرضى وفقاً للجنس وفصائل الدم (ABO و RH)، ووجود أو عدم وجود العدوى البكتيرية ولم تسجل أي حالات إصابة بالقدم السكري المترافقة مع العدوى البكتيرية باستثناء عينة واحدة فقط كما تم قياس وتحليل مؤشرات دهون الدم الكاملة. أظهرت النتائج أن الإناث أكثر عرضة للإصابة بمضاعفات القدم السكري من الذكور، بينما الذكور أكثر عرضة للإصابة بها من الإناث. كما أشارت النتائج إلى أن المرضى ذوي فصيلة الدم O هم الأكثر عرضة للإصابة بمضاعفات القدم السكري، بينما المرضى ذوي فصيلة الدم A هم الأقل عرضة للإصابة بها، وذلك لدى كل من الذكور والإناث. وتبين أيضاً أن المضاعفات أكثر انتشاراً بشكل ملحوظ بين المرضى ذوي العامل الريزوسي الموجب مقارنة بالمرضى ذوي العامل الريزوسي السالب. ارتبطت مضاعفات القدم السكري باضطرابات متفاوتة في مستويات الدهون لدى كل من الذكور والإناث، تميزت بانخفاض مستوى الكوليسترول عالي الكثافة (HDL) وانخفاض مستوى الكوليسترول منخفض الكثافة (LDL) لدى كلا الجنسين. تشير نتائج هذه الدراسة إلى وجود علاقة بين مضاعفات القدم السكري والجنس، وخاصة لدى الإناث، وكذلك فصيلة الدم O. وتسبب هذه المضاعفات اضطرابات وتغيرات في تركيزات الدهون وفقاً للمعايير المدروسة.

الكلمات المفتاحية: القدم السكري، فصائل الدم، دهون الدم، العدوى البكتيرية.

1. Introduction

Diabetes mellitus describes a group of metabolic disorders characterized by high blood glucose levels. People with diabetes are more likely to develop a number of serious and life-threatening health problems, leading to higher healthcare costs, reduced quality of life, and increased mortality rates [1]. It is estimated that more than 415 million people worldwide have diabetes, and this number is expected to rise to 640 million by 2040, according to a 2015 study by the International Diabetes Federation. Approximately 12% of global health budgets are allocated to treating diabetes (US\$673 billion) [2, 3].

People with diabetes are more prone to skin injuries, especially chronic ulcers, due to neuropathy (nerve damage), arterial (blood vessel) disease, or trauma. Peripheral neuropathy (nerve dysfunction in the feet) and peripheral artery disease are common in diabetic patients. These patients also suffer from immune system disorders that are not yet fully understood, which limits their ability to prevent or treat infections. Foot ulcers are a common complication in diabetic patients, who are more susceptible to developing them [3]. The lifetime risk of a diabetic patient developing a foot ulcer is estimated at 25%, with costs reaching €10,000 for an uninfected ulcer and €17,000 for an untreated ischemic ulcer in 2008 [4]. When these wounds become clinically infected, they cause high morbidity rates. Global statistics indicate that, on average, a person with diabetes undergoes a lower limb amputation every 20 seconds. Infection in a diabetic foot ulcer occurs when two or more of the classic signs of inflammation (pain or tenderness, heat, redness, and swelling) or purulent discharge (pus) are present [5].

Diabetic patients spend more time in hospitals due to foot problems than for any other diabetic complication. Diabetic foot infections, especially those that extend to the bones, are the leading cause of lower limb amputations, increasing the risk of death and raising economic costs [6]. To prevent these negative outcomes, it is essential to prevent foot infections or at least treat untreated wounds. There are many methods of administering antimicrobial therapy, such as intravenous or intramuscular injections, or other methods. Topical treatment (i.e., direct application to the site of infection) is one of the most common types of antibiotic therapy. However, even in the presence of neuropathy or vascular disease, it is often difficult to determine whether a diabetic foot ulcer is infected. In addition, the mere presence of microorganisms, even in clinically non-infected wounds, may delay wound healing, especially if they are pathogenic and in large numbers [7]. Some physicians believe that antibiotics (especially topical ones) may be effective in treating high-risk wounds even if they are not clinically infected [8, 9].

The management of diabetic foot ulcers must be based on a multidisciplinary approach that includes diverse diagnostic tools, is implemented by different specialists, and requires years of experience in treating this condition. Patients should also be educated on preventing amputations and using modern classifications to guide treatment [10, 11]. To better understand the microbiome associated with diabetic foot ulcers, it is essential to use advanced diagnostic tools such as 16S RNA sequencing of bacteria, in addition to wound characteristics, other factors such as local antibiotic susceptibility patterns, individualized treatment, regular wound cleaning, and regular assessment and dressing changes all play an important role in managing the condition [12]. Infection prevention, local inflammation control, and wound healing can be enhanced through biomolecular therapy and other factors specific to the human body.

2. Materials and Methods

2.1 Study Design

This study was designed to investigate the physiological and biochemical effects associated with diabetic foot. It was conducted on a group of 138 male and female patients attending Al-Nasiriyah General Hospital in Dhi Qar Governorate during the period from October 8th, 2025, to February 15th, 2026.

The study sample was divided into three groups:

- 1- The First Group: Patients with diabetic foot only (127 patients, 50 males and 77 females).
- 2- The Second Group: Patients with diabetic foot complicated by bacterial infections (10 male patients).
- 3- Control Group: Healthy individuals (20 males, 10 females).

Due to the absence of female patients with diabetic foot complicated by bacterial infections (only one sample) in the study sample, the female patients were divided into only two groups.

2.2 Laboratory Measurements and Standards

Blood type was performed using the Anti-A, Anti-B, and Anti-D blood typing kit supplied by the Jordanian Bio Research company. Lipid profile was measured using a Cobas c111 analyzer and the measurement kit supplied by the German Roche Company.

2.3 Statistical Analysis

All test data were statistically analyzed using Statistical Package for the Social Sciences (SPSS) version 27, employing a T-test at a probability level of 0.05 to determine the significance of differences between the group means.

3. Results and Discussion

3.1 The Relationship between Diabetic Foot Infection and Sex

The results of the current study showed that the incidence of diabetic foot infection alone was higher than the incidence of diabetic foot infection with bacterial contamination, reaching (92.03%). The incidence of diabetic foot infection in female patients was also higher than in male patients, reaching (55.80%). Furthermore, the study showed that the incidence of diabetic foot infection with bacterial contamination in males was higher than in females (7.25%), as illustrated in Table (1).

Table 1- The relationship between diabetic foot infection and sex.

Type of illness	Diabetic Foot		Diabetic Foot with Bacteria	
Number	127		11	
Percentage %	92.03%		7.97%	
Sex	Males	Females	Males	Females
Number	50	77	10	1
Percentage %	36.23%	55.80%	7.25%	0.72%

The results of the current study, shown in Table (1), indicate that the percentage of female patients with diabetic foot was higher than males, reaching (55.80%). Upon examining the study sample and the resulting findings, both in this area and in the area of the relationship between diabetic foot and occupation, it was observed that females have a higher incidence than males. This result can be explained by a range of biological, social, and behavioral factors. Biologically, hormonal differences between the sexes may contribute to females's increased susceptibility to diabetic complications. The decline in estrogen levels with age, particularly after menopause, can lead to decreased blood vessel elasticity and reduced peripheral perfusion efficiency. Furthermore, it affects the immune and inflammatory response and wound healing, increasing the likelihood of ulcers and infections associated with diabetic foot. Meanwhile, housewives are more prone to diabetic foot compared to working women. This is attributed to the nature of their daily activities, which require prolonged standing and movement within the home, thus increasing repetitive pressure on the feet, especially in female patients with peripheral neuropathy or poor blood circulation.

Furthermore, limited health awareness regarding preventive foot care and delays in seeking medical attention at the first signs of infection can contribute to the progression of the condition and increase the likelihood of ulceration and infection. From a social perspective, these results may reflect the nature of Iraqi society, where housewives bear continuous domestic responsibilities, leading to neglect of self-care and regular foot examinations, in addition to wearing unsuitable shoes or frequent walking indoors without proper protection. These factors can increase the risk of diabetic foot. Therefore, the high incidence among female patients in the current study may result from a complex interplay of hormonal, social, and behavioral factors. This necessitates strengthening educational and preventive programs targeting women, especially housewives, to reduce the development of diabetic foot complications and promote early detection. Meanwhile, the incidence of diabetic foot complicated by bacterial infection was higher in males than in female patients, reaching 7.25%, compared to 0.72% in females. This may be attributed to men's behavioral patterns, particularly the high rate of smoking, which is a factor that negatively impacts the efficiency of the body. The blood circulation and function of the peripheral blood vessels increase the likelihood of developing peripheral artery disease and poor blood supply to the foot. In addition, the nature of the work performed by men often requires continuous physical exertion and standing for long periods, which leads to increased pressure and repeated stress on the feet, which increases the likelihood of injuries. A study of [13] indicated that men are often more prone to diabetic foot complications as a result of high rates of smoking, peripheral artery

disease, exposure to injuries, and repeated pressure on the foot, which leads to an increased likelihood of ulcers and bacterial infection.

The study also revealed that men tend to neglect foot care and delay seeking medical attention, which may explain the higher incidence of bacterial diabetic foot among male patients in the current study. The current findings are consistent with those of [14], which indicated that males with diabetic foot suffer from higher rates of bacterial infection and deep ulcers compared to females. This was attributed by the study to poor blood sugar control and higher rates of smoking and vascular disease among men. [15] also pointed out that bacterial infection in diabetic foot is directly related to poor blood circulation and delayed wound healing, which increases the risk of complications and amputation, especially in male patients who have higher vascular risk factors. The lower percentage of diabetic foot cases accompanied by bacterial infection compared to cases without infection can be explained by early health care by patients to prevent diabetic foot infection, as well as the use of antibiotics and continuous medical care that limits the exacerbation of bacterial infection. However, bacterial infection remains one of the most dangerous complications of diabetic foot because of its major role in increasing the risk of gangrene and amputation, especially in patients who suffer from poor blood circulation or poor control of diabetes. Current results generally indicate that sex is one of the important factors affecting the nature of the development of diabetic foot and the occurrence of bacterial infection, but this effect is also related to the interaction of several other pathological, behavioral and health factors.

3.2 The Relationship between Diabetic Foot and Blood Type in Men

The results of the current study showed that the highest incidence of diabetic foot was in blood type O (36.67%), divided into (33.33%) in O+ and (3.33%) in O-. The lowest incidence was in blood type A (13.33%), divided into (11.66%) in A+ and (1.67%) in A-, as shown in Table (2).

Table 2- The relationship between diabetic foot and blood type in male patients.

Blood type	A		B		AB		O	
Number	8		16		14		22	
Percentage %	13.33%		26.67%		23.33%		36.67%	
According to (Rh)factor	A+	A-	B+	B-	AB+	AB-	O+	O-
Number	7	1	15	1	13	1	20	2
Percentage %	11.66%	1.67%	25%	1.67%	21.67%	1.67%	33.33%	3.33%

3.3 The Relationship between Diabetic Foot and Blood Type in Female Patients

The results of the current study indicated that the highest incidence of diabetic foot was in blood type O (34.62%), divided into (30.77%) in O+ and (3.85%) in O-. The lowest incidence was in blood type A (11.53%), divided into (10.25%) in A+ and (1.28%) in A-, as shown in Table (3).

Table 3- The relationship between diabetic foot and blood type in female patients.

Blood Type	A		B		AB		O	
Number	9		22		20		27	
Percentage %	11.53%		28.21%		25.64%		34.62%	
According to (Rh) factor	A+	A-	B+	B-	AB+	AB-	O+	O-
Number	8	1	19	3	18	2	24	3
Percentage %	10.25%	1.28%	24.36%	3.85%	23.08%	2.56%	30.77%	3.85%

The results of the current study, shown in Tables (2) and (3), indicate a difference in the incidence of diabetic foot according to blood types A, B, AB, and O among men and women. Blood type O recorded the highest incidence in both sexes, followed by blood types B and AB, while blood type A recorded the lowest incidence. These results indicate a possible association between blood types and susceptibility to diabetic foot, but this association may vary according to the genetic and environmental characteristics of the studied sample. A study of [16] indicated that blood type O is the most common at 37.5%, followed by blood type A at 32.5%, then B at 23.8%, and finally AB at 6.3%. [17] noted that blood type O is the most common at 36.07%, followed by blood type A at 30.72%, then blood type B at 24.66%, and finally blood type AB at 8.55%.

The results of the current study partially agree with what was indicated by [18] and [19], as those studies showed that blood types other than O are associated with high levels of Von Willebrand factor and Factor VIII, which are among the most important coagulation factors closely related and work together to stop bleeding, thus increasing the tendency to coagulate and impairing peripheral blood flow. However, the results of the current study did not agree with the results of the studies of [20] and [21] regarding the existence of an association between peripheral blood flow disorders and diabetic foot complications, as those two studies showed that blood type A was associated with an increased prevalence of peripheral artery disease and a low ankle-brachial index, which is an important indicator of poor blood flow to the extremities. The current study also did not agree with what was found in [22], which indicated that blood type O has a relative protective effect against vascular complications. This difference can be explained by several factors, including ethnic and geographical differences between societies, as well as the possibility of a high natural prevalence of blood type O within the Iraqi community, which may be reflected in an increase in the number of people affected within this blood type. Also, the development of diabetic foot does not depend on vascular factors alone, but is also affected by the degree of blood sugar control, the duration of the disease, the presence of infection, neuropathy, smoking, and immune factors, which are variables that may affect the results of the current study. On the other hand, the continued low incidence of diabetic foot complications in males and females with blood type A may indicate a possible protective effect of this blood type in the study sample. However, this conclusion requires further research to confirm. The study results also showed higher incidence rates among Rh-positive blood types compared to Rh-negative blood types in both sexes. Blood type O+ was the most common among patients, while Rh-negative blood types had very

low rates. This may be understandable given that Rh-positive individuals have a much higher incidence than Rh-negative individuals. Although there are few studies addressing the role of Rh factor in diabetic foot complications, these results may open the door for future studies investigating the potential contribution of Rh factor to increased susceptibility to vascular and inflammatory complications associated with diabetes. The results of the current study are consistent with those of studies [23] and [24], which indicated that the ABO blood group system may influence endothelial and inflammatory function of blood vessels by affecting the levels of endothelial adhesion molecules such as endothelial selectin (E.selectin). Individuals with blood type O have higher levels of soluble E.selectin compared to carriers of the A and AB alleles, which may affect the inflammatory response, microcirculation, and wound healing. Although the results of the current study differ from some other studies, they are consistent with those indicating that the relationship between blood types A, B, AB, and O and diabetic foot is complex and multifactorial, and may vary according to the environmental, genetic, and health background of the population. Therefore, the results of this study provide important local evidence regarding the possible link between blood type and susceptibility to diabetic foot, which may contribute in the future to identifying groups most at risk of complications and developing early preventive and treatment programs to reduce the progression of the disease and its complications.

3.4 The Relationship between Diabetic Foot and Lipid Profile in Men

The results of the current study showed a significant decrease in high-density lipoprotein (HDL) cholesterol in the first group (patients with diabetic foot) and a non-significant decrease in the second group (patients with diabetic foot complicated by bacterial infection) when compared to the third group (healthy individuals) at a probability level of $P \leq 0.05$. Regarding triglyceride (TRIG) cholesterol, the results showed a non-significant increase in the first and second groups when compared to the third group at the same probability level.

The results also indicated a significant increase in low-density lipoprotein (LDL) cholesterol in the first group compared to the second and third groups, and a significant decrease in the second group compared to the first group at a probability level of $P \leq 0.05$. As for cholesterol (CHOL) cholesterol, the results showed a significant decrease in the first group compared to the second and third groups, and a non-significant decrease in the second group compared to the third group at the same probability level, as shown in Table 4.

Table 4- The relationship between diabetic foot and lipid profile in male patients.

The Standards The Groups	Mean ± Standard Error			
	HDL (Mmol/L)	TRIG (Mg/dl)	LDL (Mmol/L)	CHOL (Mg/dl)
The First Group (Male Patients with diabetic foot)	0.675 b ± 0.08	156.17 a ± 17.59	5.15 a ± 0.24	98.74 b ± 4.75
The Second Group (Male Patients with diabetic foot and bacterial infection)	0.859 ab ± 0.10	179.14 a ± 24.37	2.024 c ± 0.20	129.21 a ± 9.05
The Third Group (Healthy individuals)	0.989 a ± 0.07	130.62 a ± 16.70	2.907 b ± 0.38	147.54 a ± 9.19
P-VALUE	0.045	0.242	0.0001	0.0007

The difference in letters indicates significant differences at the probability level ($P \leq 0.05$).

3.5 The Relationship between Diabetic Foot Disease and Lipid Profile in female Patients

The results of the current study confirmed a significant decrease in high-density lipoprotein (HDL) cholesterol concentration in the first group (female patients with diabetic foot disease) compared to the second group (healthy individuals) at a probability level of $P \leq 0.05$. Regarding triglyceride (TRIG) concentration, the results showed a significant increase in the first group compared to the second group at the same probability level.

The results also indicated a significant increase in low-density lipoprotein (LDL) cholesterol concentration in the first group compared to the second group at a probability level of $P \leq 0.05$. As for cholesterol (CHOL), the results showed a significant decrease in the first group compared to the second group at the same probability level, as shown in Table (5).

Table 5- The relationship between diabetic foot and lipid profile in female patients.

The Standards The Groups	Mean ± Standard Error			
	HDL (Mmol/L)	TRIG (Mg/dl)	LDL (Mmol/L)	CHOL (Mg/dl)
The First Group (Female Patients with diabetic foot)	0.52 b ± 0.27	190.81 a ± 63.08	5.15 a ± 1.08	107.99 b ± 19.77
The Second Group (Healthy Individuals)	1.34 a ± 0.35	114.02 b ± 36.11	3.14 b ± 1.23	149.43 a ± 43.90
P-VALUE	0.0001	0.004	0.001	0.005

The difference in letters indicates significant differences at the probability level ($P \leq 0.05$).

The results of the current study, presented in Tables 4 and 5, indicate a clear lipid profile disturbance in male and female patients with diabetic foot. This disturbance is characterized by a significant decrease in high-density lipoprotein (HDL) and an increase in low-density lipoprotein

(LDL), along with varying degrees of triglyceride (TG) elevation between the sexes (significant in females and not significant in males). Additionally, total cholesterol (CHO) is decreased. This disturbance reflects an advanced metabolic dysfunction associated with diabetic foot disease and represents a significant factor in the development of vascular and neurological complications and delayed wound healing. The findings of the current study are consistent with those of study of [25], which demonstrated that patients with idiopathic neuropathy are more prone to metabolic syndrome, including dyslipidemia, thus supporting the link between lipid profile disturbances and diabetic complications. Furthermore, [26] clarified that vascular risk factors, including lipid dysregulation, play a crucial role in the development of diabetic neuropathy, not just hyperglycemia alone. [27] also confirmed that high triglycerides and low HDL are directly associated with an increased incidence of peripheral neuropathy in patients with type 2 diabetes, which reinforces the results of our current study, especially with regard to low HDL in both sexes.

On the other hand, the results of the current study are consistent with previous studies, including study [28], which indicated that factors such as lipid disorders and vascular disease are among the most important factors associated with an increased risk of amputation in patients with diabetic foot ulcers. [29] also showed that low HDL is a strong predictive indicator of amputation and death associated with diabetic foot ulcers, while LDL and TG did not show the same predictive strength, which is partially consistent with the results of the current study in terms of the importance of HDL as a primary indicator. Likewise, [30] showed in a meta-analysis that there is a clear relationship between low HDL and an increased risk of diabetic foot, and this is consistent with the results of our current study, which showed a significant decrease in HDL in both sexes.

High-density lipoprotein (HDL) has a protective role and possesses anti-inflammatory and antioxidant properties. It contributes to the transport of excess cholesterol from tissues and blood vessels back to the liver for elimination, and protects endothelial cells from damage. Therefore, its deficiency leads to increased chronic inflammation, exacerbated oxidative stress, and impaired microvascular function, contributing to poor peripheral blood flow and delayed wound healing. Conversely, elevated LDL and triglycerides lead to increased fat accumulation in tissues and blood vessels, promoting atherosclerosis and increasing ischemia, in addition to stimulating the inflammatory response within peripheral nerves [31]. Furthermore, lipid imbalances can lead to fat accumulation within nerve cells and impaired neurotransmission, contributing to the development of diabetic neuropathy. This finding aligns with what [26] indicated regarding the pivotal role of vascular factors in peripheral nerve damage. The sex difference in triglyceride levels, with the elevation being significant in women and not significant in men, may be attributed to differing hormonal influences, particularly the role of estrogen in regulating lipid metabolism, as well as differences in lipid distribution, body type and level of physical activity between the sexes are reflected in the severity of metabolic disturbance in women to a greater extent. As for the decrease in total cholesterol (CHOL), it may reflect a state of chronic metabolic consumption associated with chronic inflammation and oxidative stress in diabetic foot disease, where fats are consumed in cellular repair processes and the inflammatory response, or it may be associated with changes in liver metabolism in chronic cases. Also, [32] indicated that inflammation associated with diabetic neuropathy is linked to the activation of TLR4 receptors and an increase in inflammatory activity in immune cells, which links chronic inflammation and lipid disturbance as an integrated pathological cycle in the development of complications. Finally, these results

confirm that the lipid profile disturbance is not merely a secondary change in diabetes, but represents an independent and important risk factor in the development of diabetic foot, which calls for focusing on lipid assessment as an essential part of the treatment strategy to reduce complications, especially neuropathy, ulcers, and amputation.

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