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Relationship of Serum Lipids Levels with Erythrocyte Sedimentation Rate in Female Type 2 Diabetic Mellitus Patients

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ABSTRACT

Aims Type 2 diabetes is a major public health threat that affects millions of people worldwide, particularly women. This study aimed to investigate the correlation between serum lipid levels and erythrocyte sedimentation rate in female patients with type 2 diabetes.

Materials & Methods This retrospective experimental study was conducted at Al-Karkh Private Laboratory, Baghdad, Iraq, from 3 July 2022 to 8 March 2023 in female patients records who were diagnosed with type 2 diabetes. Fifty-nine type 2 diabetes patients and 23 healthy individuals were selected using the appropriate sampling method. Data was collected from medical records and laboratory results of the patients. The relationship of serum lipids and erythrocyte sedimentation rate with diabetes was evaluated using an independent sample T-test.

Findings Patients with higher ESR, VLDL, LDL, TG, or total cholesterol levels had lower HDL levels, indicating a correlation with type 2 diabetes. There were significant differences between the two groups of diabetic patients and healthy individuals below and over 30 in every parameter except HDL.

Conclusion Increased levels of very-low-density lipoprotein are associated with an increased risk of type 2 diabetes and coronary heart disease. High levels of low-density lipoprotein are associated with an increased risk of heart disease and diabetes.

Keywords Type 2 Diabetes; Serum Lipids; Erythrocyte Sedimentation Rate; Triglycerides; Cholesterol

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Introduction

Diabetes mellitus (DM) refers to a set of metabolic conditions marked by elevated blood sugar levels and impairments in insulin secretion, its action, or both [1]. Type 2 diabetes (T2DM) is a major public health threat that affects millions of people worldwide, particularly women. In 2017, approximately 462 million individuals were affected by T2DM globally, equivalent to 6.28% of the world's population [2]. The global prevalence of diabetes in adults over 18 years of age has increased from 4.7% in 1980 to 9.3% (463 million) in 2019 and is estimated to increase to 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045 [3]. T2DM is more prevalent among women than men in most regions and increases with age. T2DM can lead to serious illnesses, premature death, and increased healthcare costs [4]. T2DM is associated with numerous risk factors, such as obesity, an unhealthy diet, and genetic susceptibility. The global T2DM epidemic will worsen in the coming years, particularly in low- and middle-income countries [5]. Symptoms of T2DM include increased thirst, frequent urination, increased hunger, unintentional weight loss, fatigue, blurred vision, or slow healing of wounds [6]. T2DM can cause serious complications, such as eye, kidney, nerve, heart, and vascular damage.

Risk factors for developing T2DM in women include being overweight or obese, having a family history of diabetes, lack of physical activity, having prediabetes or a history of gestational diabetes, and having high blood pressure, high cholesterol, or high triglycerides [7].

To prevent or delay T2DM and its complications, maintaining a healthy weight, consuming a balanced diet, regularly exercising, and monitoring blood sugar levels are essential.

Despite advancements in medical technology and extensive diabetes research, the condition remains a lifelong metabolic disease with challenging curative prospects. Consequently, the emphasis on diabetes diagnosis and treatment has shifted towards minimizing complications, managing their progression, and enhancing overall quality of life [8].

Erythrocytes, commonly known as red blood cells (RBCs), represent the cells with the highest glucose consumption. Prolonged hyperglycemia inevitably induces alterations in erythrocyte morphology, metabolism, and function, contributing to subsequent effects on hemorheology and microcirculation [8].

Currently, monitoring levels of glycated hemoglobin (HbA1c) or the Hemoglobin A1c test is an important blood test, and its results may indicate how well a person is managing their diabetes. This accurately measures the average control of blood sugar levels over the past three months. Diagnostic tests mostly rely on blood and urine [1]. The erythrocyte sedimentation rate (sedimentation rate, sed rate, or ESR for short) is a commonly performed hematology test that may indicate and monitor an increase in inflammatory activity within the body caused by one or more conditions such as autoimmune disease, infections, or tumors. The ESR is not specific for any disease but is used with other tests to determine the presence of increased inflammatory activity. The ESR has long been used as a "sickness indicator" due to its reproducibility and low cost. Over many decades, several methods have evolved to perform the test. However, the reference method for measuring the ESR proposed by the International Committee for Standardization in Haematology (ICSH) is based on the findings described by Westergren a century ago [9].

Some studies have found a correlation between erythrocyte sedimentation rate (ESR) and inflammation. Type 2 diabetes is one of the leading causes of severe inflammation in the body, which can lead to an increase in ESR [8].

Elevated levels of blood lipids can also increase the likelihood of developing atherosclerosis and damage to blood vessels. Studies indicate that low levels of high-density lipoprotein (HDL) cholesterol and high levels of very-low-density lipoprotein (VLDL) cholesterol, as well as elevated levels of low-density lipoprotein (LDL) cholesterol and total triglycerides and cholesterol, are associated with an increased risk of coronary heart disease in type 2 diabetes patients [9].

Certainly, one of the primary characteristics of T2DM is diabetic dyslipidemia, affecting approximately 72–85% of T2DM patients [1]. The precise mechanisms underlying diabetic lipoprotein abnormalities are not entirely comprehended. One widely accepted explanation posits that dyslipidemia results from quantitative and qualitative changes [10]. Quantitative changes involve variations in lipoprotein cholesterol concentrations, encompassing increases and decreases, a facet that has not been thoroughly explored or reviewed. Qualitative changes, conversely, pertain to alterations in the size and density of lipoprotein cholesterol particles, contributing to lipid abnormalities. Key quantitative abnormalities in lipoproteins include elevated levels of triglycerides (TG) and low-density lipoprotein cholesterol (LDL-c), coupled with reduced levels of high-density lipoprotein cholesterol (HDL-c) [1].

Recent findings from a Chinese cohort study underscore TG as the most robust predictor for diabetes onset. Additionally, one standard deviation increase in body mass index (BMI) correlates with a 1.29 times higher risk compared to individuals with normal glucose tolerance and prediabetes [11]. Another cohort study observes that heightened serum levels of total cholesterol (TC), TG, TC/HDL-c, and TG/HDL-c ratios may elevate the risk of T2DM incidence [12]. Beyond quantitative alterations, researchers also propose that the "quality" of LDL-c

could significantly influence T2DM, pointing to the identification potential of dense LDL-c in individuals at higher risk [13]. The mechanisms behind the contribution of lipoprotein size to T2DM pathogenesis may be linked to the modulation of inflammatory responses that compromise beta-cell function and mass [14].

This study aimed to investigate the potential relationship between blood lipid levels and ESR in female patients with T2DM.

Materials and Methods

This retrospective experimental study was conducted at Al-Karkh Private Laboratory, Baghdad, Iraq, from 3 July 2022 to 8 March 2023 in female patients records who were diagnosed with type 2 diabetes. Fifty-nine type 2 diabetes patients in two groups of over (n=16) and below (n=43) 30 years old and 23 healthy individuals in two groups of over (n=9) and below (n=14) 30 years old were selected using the appropriate sampling method.

Data was collected from medical records and laboratory results of the patients. Venous blood samples (5ml) were collected after an overnight fast (more than 10 hours) to measure blood lipids (total cholesterol, triglycerides, erythrocyte sedimentation rate, very low-density lipoprotein, low-density lipoprotein, and high-density lipoprotein). Blood samples were centrifuged for 10 minutes at a speed of 500rpm to obtain approximately 2.5ml of serum. The cumulative blood glucose levels (Bio Hermes enzymatic kit; Japan), erythrocyte sedimentation rate (ESR) using a fast-track method, and lipids profile using an enzymatic method on a dry chemistry biochemistry (Fuji; Japan).

Data was statistically analyzed using SPSS 25 software. The relationship of serum lipids and erythrocyte sedimentation rate with diabetes was evaluated using an independent sample T-test at a 0.05 significance level.

Findings

The mean age of the below-30 control group was 19 years, and the sample group was 21 years (p>0.05). The mean age of the over-30 control group was 39 years, and the sample group was 43 years (p>0.05).

There were significant differences between the two groups of diabetic patients and healthy individuals below and over 30 years of age in every parameter except HDL (Table 1).

Table 1. Comparison of the research parameters between the patient and control groups below and over 30 years

Parameter		Control	Patient	p-Value
ESR	Below 30	5.38±0.86	20.89±12.28	0.002
	Over 30	8.33±2.67	26.46±18.37	0.016
VLDL	Below 30	6.60±1.61	34.09±28.46	0.001
	Over 30	8.55±2.99	46.12±25.33	0.006
LDL	Below 30	1.23±0.44	33.00±5.81	0.001
	Over 30	1.75±0.26	36.26±7.62	0.001
HDL	Below 30	7.67±3.24	5.93±1.09	0.454
	Over 30	10.36±4.90	8.21±2.78	0.785
Triglycerides (TG)	Below 30	2.09±1.24	174.00±139.95	0.002
	Over 30	5.67±0.29	246.56±134.53	0.007
Total Cholesterol	Below 30	2.16±1.45	6.55±2.82	0.005
	Over 30	4.45±1.67	7.92±2.45	0.005

Discussion

This study investigated the potential relationship between blood lipid levels and ESR in female patients with T2DM.

The results showed a significant relationship between T2DM and ESR, VLDL, LDL, TG, and T. CHOL. However, there was no significant relationship between T2DM and HDL. The finding is inconsistent with a study by Cochran *et al.* [15], which suggests that HDL may play an important role in the development and management of diabetes, that HDL levels are often lower in diabetic patients, and that low HDL levels may contribute to the development of diabetes. As age decreases, the HDL level increases because high HDL levels help clear cholesterol from the bloodstream. High HDL cholesterol levels are associated with a lower risk of heart disease. HDL cholesterol is often called "good" cholesterol because it picks up excess cholesterol in the blood and returns it to the liver, where it is broken down and removed from the body.

It is important to note that no significant relationship between HDL and T2DM in this study is based on a specific sample and should be interpreted cautiously. Further research is needed to confirm these results and to determine the exact nature of the relationship between T2DM and lipid profile markers. In this regard, Sheng *et al.* [16] concluded that HDL could be a useful tool for identifying individuals at risk of developing diabetes and, therefore, can be helpful in guiding strategies for diabetes prevention as a predictor of the risk of developing diabetes. On the other hand, Wu *et al.* [17] found that HDL was associated with an increased risk of type 2 diabetes. Specifically, the study found that for each unit increase in the ratio of HDL-monocyte ratio, the risk of developing type 2 diabetes increased by 58%. HDL-monocyte ratio may be a useful biomarker for predicting the risk of developing type 2 diabetes, and interventions aimed at reducing monocyte accumulation or increasing HDL levels may help prevent the development of type 2 diabetes. A study

by Ishibashi [18] found that high levels of "good" cholesterol were associated with a decreased risk of cardiovascular disease and all-cause mortality in individuals with diabetes. The association was stronger in women than in men and individuals with type 2 diabetes compared to those with type 1 diabetes. Overall, the study suggests that maintaining high levels of "good" cholesterol may be beneficial for individuals with diabetes in terms of reducing the risk of cardiovascular disease and all-cause mortality. The results indicated a relationship between type 2 diabetes in women and the erythrocyte sedimentation rate. As the blood sugar level increases, the ESR also increases because diabetic patients are susceptible to vascular, nerve, eye, and kidney infections. Due to the accumulation of sediments in the blood vessels accompanying diabetes, the affected areas receive a weak blood supply, reducing the body's ability to fight infections and heal wounds. As the blood sugar level increases, white blood cells have difficulty moving through the bloodstream, weakening the immune system and making the person more susceptible to diseases. the relationship between them is that high blood sugar levels may lead to increased inflammation in the body, thus increasing the ESR, and on the other hand, high ESR levels may exacerbate diabetes complications, such as heart and vascular diseases and kidney diseases. This is consistent with studies by Wang *et al*. [19] that found a long-term effect of high blood sugar on the structure and function of erythrocytes and their sedimentation rate, and Kiyani *et al*. [20], that found a direct relationship between ESR level in cardiovascular diseases and DM. A high ESR level in patients with cardiovascular diseases helps diagnose diabetes in them. Kaleta *et al*. [21] suggest that the erythrocyte sedimentation rate strongly predicts bone and bone marrow inflammation in suspected cases of diabetic foot infection. Guo *et al*. [22] found that the erythrocyte sedimentation rate increases in type 2 diabetic kidney patients.

There is a relationship between type 2 diabetes in women and very low-density lipoprotein protein. As the sugar level increases, the VLDL level also increases, especially in individuals over 30, because high levels of VLDL contain a high proportion of triglycerides, a common type of fat found in the bloodstream. Doctors can indirectly determine the amount of circulating fat in the bloodstream by measuring VLDL levels in the blood. VLDL works to accumulate cholesterol in the arteries, forming plaques that accumulate on the arterial walls, causing a condition called atherosclerosis. This plaque buildup in the arteries makes them narrow, slowing down the flow of blood to the heart, resulting in a decrease in oxygen transported through the blood to and from the heart, leading to arterial blockage and ending in angina or a heart attack due to a sudden clot formation. This is consistent with studies by Feng *et al*. [23], which concluded that very high levels of VLDL without treatment were significantly associated with the risk of type 2 diabetes mellitus in a large group of patients. In a study conducted by Janghorbani *et al*. [24], which examined the relationship between very low-density lipoprotein protein and the risk of developing type 2 diabetes, it was found that an increase in very low-density lipoprotein levels was significantly associated with an increased risk of T2D. Another study by Prenner *et al*. [25] found a positive association between VLDL levels and the risk of developing type 2 diabetes, and this association was more evident in women than in men. A study by Jin *et al*. [26] concluded that high levels of VLDL were associated with an increased risk of developing type 2 diabetes and coronary heart disease.

The findings indicate a relationship between type 2 diabetes in women and triglycerides in the patient group. Also, there was a significant difference in favor of the sample's mean for individuals over 30. As age increases in individuals with diabetes, triglyceride levels tend to rise, leading to arterial thickening (arteriosclerosis), which increases the risk of stroke or heart attack. The significant triglyceride increase can also lead to acute pancreas inflammation (pancreatitis). Typically, high triglyceride levels are markers of abnormal cholesterol levels in the blood. These findings are consistent with a study by Kong *et al*. [27], which suggests that elevated triglycerides in the blood may be a useful marker for identifying individuals with type 2 diabetes who are at increased risk for cardiovascular diseases. Another study by Beshara *et al*. [28] found that elevated triglyceride levels are independently associated with an increased risk of type 2 diabetes, regardless of other risk factors. A study by Su *et al*. [29] found that the triglyceride index may be useful for predicting cardiovascular risks in type 2 diabetes patients because it is a simple and inexpensive procedure that can be easily calculated from routine laboratory tests. Finally, a study by Zheng *et al*. [30] highlights the importance of monitoring triglyceride levels in insulin-treated patients with type 2 diabetes. The study found high triglyceride levels were associated with poor blood sugar control in type 2 diabetes patients, as measured by HbA1c levels.

The results indicated a relationship between type 2 diabetes in women and total cholesterol levels in the patient group. Also, there was a statistical difference in favor of the sample mean for individuals over 30. As age increases in diabetic patients, total cholesterol levels also increase, leading to thicker arterial walls (arteriosclerosis), which increases the risk of stroke or heart attack. This is consistent with a study by Simonen *et al*. [31], which suggests that diabetes contributes to abnormal cholesterol metabolism, even in the absence of obesity, highlighting the importance of controlling fat levels in diabetic patients to reduce the risk of heart disease. They found that diabetic patients have low levels of high-density lipoprotein cholesterol, the "good"

cholesterol, and higher levels of triglycerides and low-density lipoprotein cholesterol, the "bad" cholesterol. A study by Rhee *et al*. [32] found that people with a large variation in total cholesterol levels have a higher risk of developing diabetes compared to those with a smaller variation in cholesterol levels. Li *et al*. [33] showed a positive relationship between cholesterol and the incidence of type 2 diabetes mellitus, with a 5% increased risk of T2DM. This association was stronger in women than in men. Another study by Peng *et al*. [34] found that middle-aged and elderly adults with high blood cholesterol and low high-density lipoprotein levels are more vulnerable to diabetes, and some lipid criteria are better predictors of T2DM.

Conclusion

Increased levels of very-low-density lipoprotein are associated with an increased risk of type 2 diabetes and coronary heart disease. High levels of low-density lipoprotein are associated with an increased risk of heart disease and diabetes.

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