# Serum transferrin level in type-2 diabetic patients in association with sociodemographic profile and dietary habits

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## ABSTRACT

The management of type 2 diabetes mellitus (T2DM) involves lifestyle changes. Glycated hemoglobin levels have been found to decrease with proper management of T2DM, which includes medication and dietary adjustments high in key nutrients. Iron and transferrin levels are two of the markers associated with high blood sugar levels and the chance of developing type 2 diabetes. Furthermore, iron deficiency can worsen anemia, impaired kidney function, and heart failure in diabetics. To reduce the risk and treat diabetes, assessment of nutrition and lifestyle modifications is essential. Given the importance of dietary habits and sociodemographic factors for transferrin levels, individuals with diabetes with T2DM were the primary focus of this study, which has the objectives of determining the transferrin protein level in individuals with diabetes and contrasting the sociodemographic background and nutritional habits of diabetic individuals with their transferrin levels. Lahore Medical Research Center and Lahore Garrison University hosted the randomized (single-blinded) study. There were 80 diabetic individuals in the sample. The patients were divided into three groups based on their eating habits: normal nutrition, at high risk of malnutrition, and malnourished. Based on their sociodemographic characteristics, patients were classified as high class, middle class, or poor class. The calculations for statistical analysis were performed using GraphPad Prism (version 8.2). The study investigated the connection between dietary practices and sociodemographic characteristics and transferrin levels. Patients with a regular diet had the lowest transferrin levels, whereas those with a poor diet (malnourished) had the highest levels. In a comparable way, the sociodemographic profile revealed that the transferrin level was higher in the middle and lower classes and lower in the top class. The findings demonstrated the major role of dietary practices and sociodemographic characteristics in preserving normal transferrin levels in diabetic individuals. Given these findings, it may be worthwhile for future research endeavors to concentrate on examining the processes that determine dietary and sociodemographic factors that influence transferrin levels. Thus, initial transferrin level assessment may lead to appropriate therapy and a longer life expectancy in people with diabetes.

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Informed consent: all patients were informed about the study's objectives, procedures, potential risks, and benefits, and they voluntarily agreed to participate by providing written informed consent.

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## Introduction

Type 2 diabetes mellitus (T2DM) is a major global health issue. It occurs when there is an imbalance in blood sugar, which can cause inflammation and oxidative damage. Taking medication and adhering to a nutritious diet are essential

lifestyle modifications for optimal blood sugar control. Diabetes is a disease that makes it difficult for the body to use food as fuel.[1] Insulin helps cells absorb glucose so they can produce energy. However, the release of insulin is either not enough or improperly used when a person has diabetes. This raises blood sugar levels, which over time can result in major complications like renal disease, heart disease, and visual difficulties.[2]

Chronic hyperglycemia in diabetes mellitus (DM) is strongly associated with long-term damage, including harm to vital organs, including the heart, kidneys, liver, nerves, and eyes, which frequently leads to malfunction and failure.[3] Patients with diabetes are more at risk of experiencing atherosclerosis and stroke, as well as other micro- and macrovascular issues. Co-factor iron is essential for the transportation of electrons and fuel oxidation, but excessive levels can cause damage due to oxidation.[4]

Ferritin is an essential marker that serves a critical role. Research on people with relatives who have a history of a condition known as bleeding disorder (hemochromatosis) has led to a thorough examination of the relationship between blood ferritin levels and the chance of developing T2DM.[5] Iron deficiency has been associated in several studies with an elevated risk of the development of T2DM. Although iron plays a crucial role in vital biological processes, including DNA synthesis, electron transfer, and oxygen transport, it is also linked to the production of highly reactive free radicals that oxidatively modify a wide range of molecules.[6] It is impossible to overstate the importance of the iron profile in preserving the best possible health. Deviations from the typical iron profile may provide a risk for a variety of illnesses. Excess iron buildup in the body can cause harm to many cellular components, which can increase oxidative stress and related issues. Therefore, research on the iron profile in relation to other illnesses, such as DM, is necessary to completely comprehend its consequences.[7] Iron overload or excess can accelerate a number of ailments, such as diseases of the liver, cancer, insulin resistance, and a condition called congestive heart failure. Abnormal iron buildup affects several organs, including the kidney, liver, pancreas, and heart. Transferrin saturation is a valuable biomarker used to assess iron levels in the body. It is calculated by measuring the amount of iron bound to transferrin (the primary iron transport protein in the blood) and dividing it by the total iron-binding capacity.[8] A high risk of elevated iron indicators is linked to diabetes. Excess iron may have a part in the development of diabetes and, subsequently, in blood sugar regulation. Furthermore, there ought to be a substantial connection between iron markers and anemia in those with diabetes.[9] The liver produces a protein called transferrin. It attaches itself to iron and transports it to the body's necessary components. It influences the blood's absorption of iron. Transferrin, the glycoprotein in charge of carrying ferric ions, is a crucial part of the metabolism of iron.[10] The ideal range for transferrin levels is 215-380 mg/dL. Anemia is caused by transferrin levels below 215-380 mg/dL. Weakness and troubled breathing might result from iron deficiency anemia. It usually happens as a result of insufficient red blood cell supply.[11] Diabetic complications, including harm to the eyes as well as nerves, may be more common in anemic individuals.[12] Under normal conditions, erythroid cells are the main source of soluble transferrin receptors (sTfR). Reduced sTfR levels are associated with a reduction in red blood cells as a side effect of bone marrow diseases. When iron is insufficient, the sTfR concentration rises at the onset of iron-poor red blood cells and continues to grow until anemia occurs, which happens quite early in the process of iron shortage. Although sTfR levels alone do not increase in severe inflammatory anemia, they do when combined with low iron levels.[13] Diabetes, the leading cause of premature death and disability globally, is one of the greatest and most urgent public health challenges of our day. T2DM affects around 90% of diabetic patients, and a poor diet and inactivity are two of the main causes of this epidemic. In this instance, it is crucial to consume a balanced diet before taking any medication. Variable and balanced meals encourage both regular calorie restriction and stable blood sugar levels throughout the day.[14]

Gender, age, earnings, schooling, religion, household as well, marriage status, employment, and the number of people residing in a single home are all included in the sociodemographic profile. A person's sociodemographic status reveals their social and demographic place in a population. According to the age-adjusted rate of T2DM with income, those in the lowest income category had a greater chance of acquiring T2DM.[15]

The aim of this research was to measure blood transferrin levels in T2DM patients and how they related to sociodemographic profile and dietary habits, in light of the fact that transferrin plays an important role in the development of the disease and that these factors influence the patients' individual experiences with the disease.

## Materials and Methods

A single-blind randomized study was conducted at Lahore Garrison University and Lahore Medical Research Center. This study included 80 participants diagnosed with T2DM, with grouping based on dietary habits and sociodemographic status. Three categories were established based on eating habits: normal nutrition, at risk of malnutrition, and malnourished. The classes were divided into upper class, middle class, and lower class to illustrate the sociodemographic status. Blood samples (5 cc) were taken from the hand and arm veins of volunteer diabetic patients using a Becton Dickson-sterilized disposable syringe following the acquisition of written informed permission. Centrifugation was used to separate the blood serum, and enzyme-linked immunoassay (ELISA) was used with a human transferrin ELISA kit (bioassay technology laboratory) Cat. No. E3273-Hu, which has a sensitivity of 0.025 mg/mL and a standard curve range of 0.05-15 mg/mL. There were 48/96 wells in the package. Following 10 minutes of ELISA, an optical density was measured at a wavelength of 450 nm. The World Health Organization's criteria for the diagnosis of DM involved random blood glucose testing, glucose monitors, and glucometers.

Dietary frequency questionnaires such as the Mini Nutritional Assessment (MNA) from the NESTLE Nutrition Institute are a common methodology used in dietary research on nutrition, as well as 24-hour recalls and a brief nutritional evaluation. The primary objective of this study was to examine the eating habits and sociodemographic profiles of participants. To achieve this, a concise and easy-to-complete dietary evaluation form was developed, which participants filled out voluntarily. In addition to providing blood samples, patients with diabetes were asked to complete a questionnaire that in-

cluded questions about their dietary plans, income, gender, age, and other relevant issues. In addition, participants filled out a consent form guaranteeing the privacy of their personal data and promising not to reveal who they were in any publications.

The following calculation [Eq. 1] was used to determine the sample size based on the 16.98% prevalence rate of DM at a 95% confidence level and an 8% margin of error.

$$n = \frac{z\hat{}2-\alpha/2\ p\ (p-1)}{d\hat{}2} \quad \text{[Eq. 1]}$$

Where, $p$ is the proportion of poor knowledge (=0.16989); $d$ is the marginal error set at 8%; $\alpha$ is 0.05; $Z$ is the standard normal deviation for 95% confidence interval and n is the number of respondents (=80).

## Statistical data analysis

GraphPad Prism 8.2 was the most recent version used for the statistical analysis. Using descriptive statistics, the mean, standard deviation, and percentage were examined. The p-value was computed using the usual one-way analysis of variance method and *t*-test.

## Ethical considerations

The Biosafety and Research Ethical Committee (BSRE.NO.021) of the Lahore Garrison University in Lahore, Pakistan, approved this study and approval form for a license to gather research data from Akhuwat Medical Services. To protect the private information of research participants, the study complied with all ethics committee criteria.

# Results

A total of 80 individuals with diabetes were included in this research among which, 54 (67.5%) patients were female, and 26 (32.5%) were male. Figure 1 shows that the transferrin level according to socioeconomic profile was 355± 0.000, 335.7±40.57, and 642.5±331.5. The p-value was >0.05, showing the insignificant difference in transferrin level according to the socioeconomic profile (Table 1).

Figure 2 shows that the transferrin levels according to the nutritional assessment of diabetic patients were 480±0.000, 631.9±332.9, and 611.0±335.8. The p-value was >0.05, which shows the insignificant difference between the transferrin levels according to the nutritional assessment of diabetic patients (Table 1).

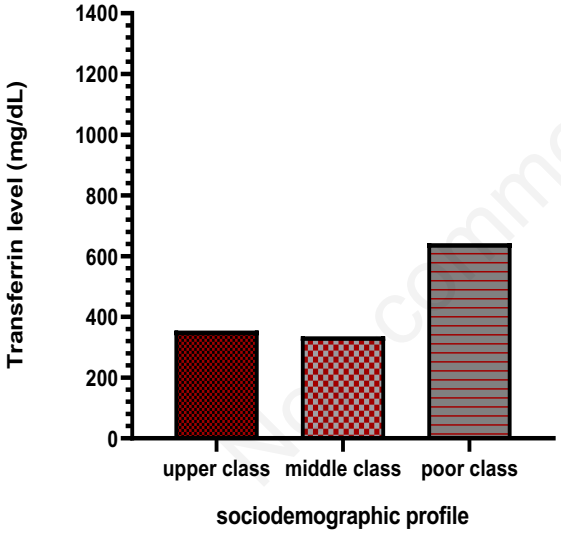


**Figure 1.** Graphical distribution of transferrin levels (mg/dL) according to sociodemographic profile.

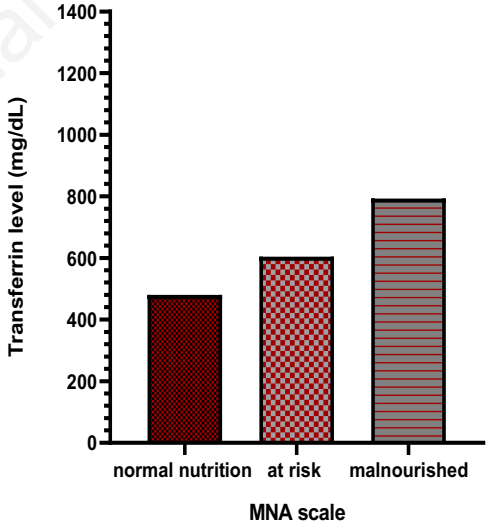


**Figure 2.** Graphical distribution of transferrin levels (mg/dL) according to Mini Nutritional Assessment scale.

**Table 1.** Transferrin levels according to socioeconomic profile and Mini Nutritional Assessment scale.

| | Number of patients | Mean ± standard deviation | p |
|---|---|---|---|
| Socioeconomic profile | | | |
| Upper class | 2 | 355±0.000 | 0.0971 |
| Middle class | 4 | 335.7±40.57 | |
| Poor class | 74 | 642.5±331.5 | |
| Mini Nutritional Assessment scale | | | |
| Normal nutrition | 2 | 480±0.000 | 0.2566 |
| At risk of malnourished | 47 | 631.9±332.9 | |
| Malnourished | 8 | 611.0±335.8 | |

Figure 3 shows the comparison of transferrin levels with the sociodemographic profile. MNA was 355.5±0.000 in the upper class and 480±0.000 was normal nutrition; 335.7±40.57 was middle class and 631.9±332.9 was at risk of malnutrition, and 642.5±331.5 was poor class and 611.0±335.8 was malnourished (Table 2). The p-value was >0.05 in the sociodemographic profile according to transferrin levels, and it was >0.005 in the MNA according to transferrin levels.

## Discussion

The present study aimed to investigate the correlation between sociodemographic profile, food habits, and transferrin protein levels in diabetic patients. Of the total 80 patients, there were 16 (20%) patients under 40, and 42 (52.5%) between the ages of 41 and 50. Only 8 patients (10%) were between the ages of 51 and 60. The number of patients over 60 was 14 (17.5%). A similar study was done by Thakkar *et al*., in which (55.4%) were males and (44.6%) were females, having 58% diabetic males and 42% diabetic females.[16] Santosh *et al*. reported that 32.31% of patients had DM between the ages of 60 and 80, whereas 56.12% of patients were in the 40 to 60 age range.[17] The results of our study indicated that the total amounts of transferrin in men and females were, respectively, 793.8±447.3 and 536.3±211.2. The p-value was 0.0007, indicating a substantial difference in the levels of transferrin between both genders. Our study's observation of a noticeable variation in the transferrin protein levels among males and females raises exciting inquiries about possible underlying processes and their impact on health outcomes. These results are consistent with earlier studies showing gender variations in transferrin levels. For instance, a study by Zantek *et al*. (2015) reported higher transferrin levels in males compared to females.[18] There are several potential explanations for the reported gender differences in transferrin levels, including changes in iron metabolism, hormonal variances, and genetic variants. For instance, it has been demonstrated that estrogen affects iron homeostasis by controlling the synthesis of genes related to iron metabolism, which may result in females having lower transferrin levels than males.[19] The results of our study showed that patients in different age groups did not significantly differ in their transferrin levels. In particular, the research comprised 16 patients under 40, 42 patients between 41 and 50, 8 patients between 51 and 60, and 14 patients above 60. We tested and compared the transferrin levels in each of these age groups; the mean values were 686.8±399.6, 549.6±270.4, 844.3±466.4, and 626.7±267.6, in that order. As the analysis' p-value was higher than 0.05, it was determined that there was actually no statistically significant variation in transferrin levels between the age groups. This suggested that transferrin levels in this specific patient group might not have been significantly influenced by age. There is not a patient over 80 here. Above 80, transferrin levels tend to rise. However, we do not have any patients older than 80, and the data indicate an unequal distribution of patients.

Based on our study findings, the distribution of individuals across the sociodemographic groups was found to be as follows: the majority of subjects (four people) belonged to the middle class, while the upper class and poor class only had 2 and 74 individuals, respectively. The socioeconomic classes had mean transferrin levels that ranged from 355±0.000 for the elite class to 335.7±40.57 for the middle class, and 642.5±331.5 for the low class. However, the statistical analysis concluded that the variations were not significant, as shown by the p-value (>0.05). There might have been several consequences from the lack of a detectable variation in transferrin levels between socioeconomic groups. It could have suggested that transferrin levels were more significantly influenced by variables other than socioeconomic status. In this specific cohort, socioeconomic variables may not have had as much of an impact on transferrin levels as dietary habits, predispositions due to genes, or other health-related activities. Merely, a tiny proportion of diabetic individuals were found to have appropriate nutrition, while the rest were either malnourished or in danger of malnutrition. This is concerning since malnutrition can make diabetic problems worse and make it more difficult to control the illness. Because of a smaller number of participants and an uneven patient distribution, the transferrin levels of low-income groups are lower than those of the middle-class groups. Additionally, there are fewer patients in the impoverished class than in the middle

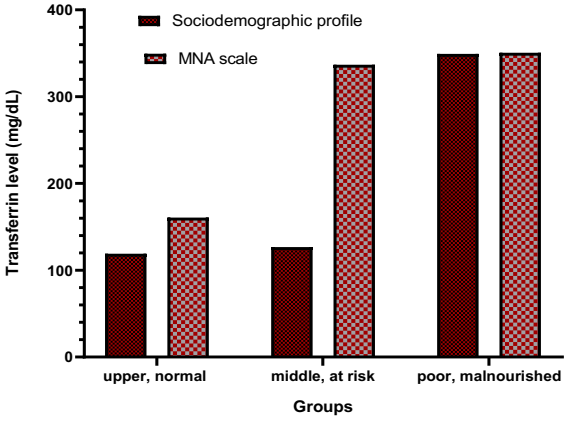


**Figure 3.** Graphical comparison of sociodemographic profile and Mini Nutritional Assessment scale.

**Table 2.** Comparison of transferrin levels with sociodemographic profile and dietary habits.

| Groups | Sociodemographic profile Mean ± standard deviation | Groups | Mini Nutritional Assessment scale Mean ± standard deviation |
|---|---|---|---|
| Upper class | 355.5±0.000 | Normal nutrition | 480±0.000 |
| Middle class | 335.7±40.57 | At risk | 631.9±332.9 |
| Poor class | 642.5±331.5 | Malnourished | 611.0±335.8 |
| p | 0.0971 | p | 0.2566 |

class. If we expand the patient population while maintaining an equal proportion of male and female patients, the findings could indicate a notable difference. In our study, the average transferrin levels were 480±0.000 for people with appropriate nutrition, 631.9±332.9 for people who were at risk, and 611.0±335.8 for people who were malnourished. However, statistical analysis showed that there was no statistically significant difference in transferrin levels between the different nutritional assessment groups, with a p-value that was greater than 0.05. These findings imply that although diabetes individuals with varying nutritional situations may have changes in transferrin levels, these variations are not statistically important. The limited number of people and variations in sample sizes among groups might be the cause of the outcome.

Future studies must take into account the possibility that other variables, including liver function, infection, and inflammation, may also have an impact on transferrin levels, as the graphical distribution illustrates the difference between transferrin levels and nutritional statuses. According to Rezazadeh *et al*., red meat and refined carbs, which are bad for you, were included in healthy dishes; for this reason, this style was considered to be semi-healthy. It showed that there was a negative correlation between central obesity and the dietary pattern characterized by an appropriate balance in diet.[20] In a study by Toscano (2004), it was discovered that more than half of the patients suffered from alcoholism, tobacco addiction, smoking addiction, or all. Of these, 28% were dependent on alcohol, 11.2% on cigarettes, and 9.4% on both. Among those with T2DM, smokers made up 30.2% of the cases, while alcohol users made up 26.4%. This study examined 66 T2DM patients who were enrolled in a family health program in Maringá, Paraná, Brazil. The majority of patients tested were married e (74.24%) and female (84.85%), based on socioeconomic and demographic variables.[21] Eating a lot of eggs each day might increase your overall cholesterol levels even if they are an excellent source of dietary cholesterol.[22] Despite what a men's prospective research revealed, we discovered that consuming legumes such as lentils, peas, or beans simmered with meat was linked to higher blood glucose and cholesterol levels. However, we did discover that beans are a rich source of nutritional fiber, which enhances glycemic management and lowers total cholesterol.[23] The comparison of transferrin levels with sociodemographic profile and MNA was 355.5±0.000 in the upper class and 480±0.000 was normal nutrition, 335.7±40.57 in the middle class and 631.9±332.9 was at risk of malnutrition, and 642.5±331.5 in the poor class and 611.0±335.8 was malnourished. In the sociodemographic profile according to transferrin levels, the p-value was >0.05; and in the MNA according to transferring level, the p-value is >0.005. The comparison shows the negative results, but we find that the diabetic patients with normal nutrition and who belong to the upper class have lower transferrin levels. The patients with poor diet (malnourished) and who belong to the lower class have higher transferrin levels.

The current study shows that the difference between normal nutrition and risk of malnourishment was 480±0.000 and 631.9±332.9. The p-value is >0.005, which shows and insignificant result. However, we see the variation between graphs. This shows that in normal nutrition, transferrin levels are lower than in patients at risk of malnourishment. This is because of a healthy and balanced diet. It is also demonstrated that the difference between normal nutrition and malnourishment was 480±0.000 and 611.0±335.8.

The present study shows that the difference between the risk of malnourishment and malnourishment was 631.9±332.9 and 611.0±335.8. The p-value is >0.005, which shows an insignificant result. This shows that the level of transferrin is lower than in patients who are malnourished. This is because the patients who are at risk of being malnourished have better diets than patients who are malnourished. Moreover, the difference between normal nutrition and the middle class was 480±0.000 and 335.7±40.57. The p-value is <0.005, which shows a significant result. The difference between normal nutrition and poor class was 480±0.000 and 642.5±331.5. The p-value is >0.005, which shows an insignificant result. This is because the patients who belong to the upper class have normal diets and they have lower levels of transferrin than all other groups.

## Conclusions

The study's findings provide a thorough overview of the health indicators, transferrin levels, and demographics of people with T2DM, with particular attention paid to disparities in age, gender, sociodemographic profile, and diet.

A greater percentage of female involvement, negligible variations in mean transferrin levels, and other health indicators between genders from a major disparity in transferrin levels that favor males are among the main results. Furthermore, there were significant gender disparities in height. Transferrin levels were not significantly impacted by dietary practices or sociodemographic status, yet there are differences across the groups. Patients with a regular diet had the lowest transferrin levels, whereas those with a poor diet (malnourished) had the highest levels. Similarly, transferrin levels were found to be higher in the middle and lower classes and lower in the upper class according to sociodemographic profiles. The findings demonstrated the significance of dietary practices and sociodemographic characteristics in preserving normal transferrin levels in diabetic individuals. Better management of diet and lifestyle choices can help prevent or postpone the onset of secondary conditions while also improving the effectiveness of current treatments for the illness. Medical goals need to be taken into account in all stages of life to prevent or decrease consequences. Since it is important for patients and their families to actively engage in the disease's treatment, it is crucial to educate and enlighten them to accomplish these aims. Dietary guidelines pertaining to cleanliness are among the most crucial things to instruct and inform patients about in general. Therefore, early transferrin level measurement in diabetic patients may lead to improved life expectancy from efficient therapy.

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