

Original Article

Association of Serum Ferritin Levels With Glycated Haemoglobin (HbA1c) Levels In Type 2 Diabetic Patients Presenting To Benazir Bhutto Hospital, Rawalpindi

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Abstract

Objective: To assess the association between serum ferritin and glycated haemoglobin (HbA1c) levels in patients with type 2 diabetes mellitus presenting to the Benazir Bhutto Hospital.

Methods: A descriptive cross-sectional study was conducted at the Benazir Bhutto Hospital, Rawalpindi. One hundred and forty patients with the diagnosis of type 2 diabetes mellitus between the ages of 35 and 70 years were enrolled using consecutive sampling. Patients with other conditions known to affect serum ferritin levels were excluded. Serum ferritin levels and HbA1c levels were determined in blood samples. Data were analysed using SPSS version 25. Group comparisons were performed using an independent samples t-test.

Results: Of the 140 participants, 58.6% exhibited poor glycaemic control (HbA1c >7%). Serum ferritin levels and HbA1c were positively associated, with participants with HbA1c >10.5% showing higher serum ferritin levels (108.27 µg/L) than those with HbA1c 6–7.49% (71.46 µg/L). Serum ferritin levels in people with well-controlled and poorly-controlled diabetes differed significantly, according to an independent t-test (p = 0.019).

Conclusion: The study demonstrates that serum ferritin levels were higher among participants with poor glycaemic control in patients diagnosed with type 2 diabetes mellitus, suggesting that ferritin may serve as a supportive biomarker alongside routine glycaemic assessment.

Keywords: Diabetes Mellitus, Type 2; Haemoglobin A, Glycosylated; Ferritins; Glycaemic Control.

Introduction

The incidence of diabetes mellitus is rising globally, and this is a major public health emergency for both healthcare systems and society at large. Recent estimates present a formidable scenario, with the International Diabetes Federation reporting a 19.9% prevalence among adults aged 20–79 years globally in 2021.1 globally.1 Diabetes mellitus is one of the most prevalent non-communicable metabolic disorders worldwide, with its prevalence growing at an alarming rate. It is projected that diabetes will affect more than 500 million people worldwide in the coming years.1 The recent Diabetes Prevalence Survey of Pakistan (DPS-PAK) revealed a prevalence of 16.98% for type II diabetes and 10.91% for prediabetes among the Pakistani population, indicating a significant increase compared to previous estimates.2 This increasing trend is indicative of larger global trends, in which sedentary lifestyles, dietary changes, and urbanisation are contributing to the rise in the diabetic population, particularly in developing and low- and middle-income nations.3 Complications and effective diagnosis and treatment of diabetes may prevent complications and death.4 Untreated diabetes may lead to serious complications, including vasculopathy, neuropathy, nephropathy, and retinopathy.5 The duration of diabetes and how well it is managed may affect the severity of these problems. In patients with type 2 diabetes mellitus (T2DM), serum ferritin, which is typically regarded as a measure of iron storage, also serves as a marker of inflammation and is associated with insulin resistance, metabolic syndrome, and poor glycaemic control.6,7,9,11 Serum ferritin levels typically indicate the body's iron storage. However, they are also an inflammatory marker that has been associated with insulin resistance and metabolic syndrome.7,8 An elevated risk of type 2 diabetes has been linked to high-normal ferritin levels. This correlation has been confirmed in people of all races and ethnicities.11-13 This suggests that elevated ferritin, typically a measure of iron storage, could be used for the early diagnosis of diabetes.12 Recent research from China showed a strong correlation between serum ferritin and glycated haemoglobin (HbA1c) levels. Increases in serum ferritin by one standard deviation were linked with an increased risk of incident diabetes in the general population (1.17; 95% CI: 1.03-1.34).9 Serum ferritin and glycated haemoglobin (HbA1c) levels have been positively correlated in 12 different studies conducted in Bangladesh, India, Jordan, and Turkey. As HbA1c levels increase, so do blood ferritin levels in patients with type 2 diabetes (p<0.01).8,10 Given the lack of research on this topic in Pakistan, this study was conducted to determine whether serum ferritin levels could be used as a marker of uncontrolled type 2 diabetes mellitus and to avoid complications. This study aimed to ascertain the correlation between serum ferritin and glycated haemoglobin (HbA1c) levels in patients with type 2 diabetes mellitus presenting to the Benazir Bhutto Hospital.

Operational Definitions:

● **Diabetes Mellitus type II:** The World Health Organization diagnostic criteria for diabetes mellitus are as follows:

- Fasting Plasma Glucose ≥ 126 mg/dL (7.0 mmol/L) OR
- 2-hour Post Prandial Glucose ≥ 200 mg/dL (11.1 mmol/L)

Contributions:

HR SZ - Conception, Design
 HR SA¹ SA² SB DA - Acquisition, Analysis, Interpretation
 HR SZ SA¹ SA² - Drafting
 HR SZ SA¹ SA² SB DA - Critical Review

All authors approved the final version to be published & agreed to be accountable for all aspects of the work.

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- **Serum ferritin levels:** a measure of the body's iron stores with normal ranges as follows:
 - Males: 12-300 µg/L
 - Females: 10-150 µg/L
- **HbA1c:** Glycated haemoglobin level showing the level of control of diabetes mellitus over the last 3 months.
 - Controlled HbA1C : ≤7%
 - Uncontrolled HbA1C: >7%

Approval for this study was obtained from the Ethical Review Board of Rawalpindi Medical University. The patients did not bear any cost for the tests, and all participants provided informed consent for participation in the study. The research was conducted with full regard to participant privacy, confidentiality, and autonomy.

Materials And Methods

A descriptive cross-sectional study was conducted in the Department of Medicine at the Benazir Bhutto Hospital, Rawalpindi, a tertiary care facility affiliated with the Rawalpindi Medical University. The duration of data collection was one year following the approval of the synopsis. The sample size was calculated using an online sample size calculator with a 5% level of significance and 80% power, yielding a minimum required sample size of 140. A consecutive sampling technique was used. All patients with type 2 diabetes, between 35 and 70 years old, irrespective of duration, were included. Patients with conditions affecting serum ferritin levels, such as anaemia (haemoglobin < 11 mg/dL), hyperthyroidism, rheumatoid arthritis, adult-onset Still's disease, leukaemia, Hodgkin's lymphoma, liver disease, coronary artery disease, kidney disease, pregnant women, people who had received chemotherapy or radiation therapy, those who had undergone anaemia treatment within the previous two months, or those who had donated blood within the previous four months, were also excluded from the study.

Patient enrolment was conducted at the diabetes clinic and the medical OPD. Written informed consent was obtained from all enrolled patients. Data was collected on a designed form, which included age, gender, and other demographic details. Simultaneously, blood samples were collected for serum ferritin levels and HbA1c and sent to the BBH Pathology Laboratory.

Data was analyzed using SPSS v. 25. Frequency and percentages were used to display qualitative variables, whereas mean ± standard deviation was used to display quantitative variables. An independent samples t-test (Levene's test) was applied to compare mean serum ferritin levels between participants with well-controlled and poorly controlled diabetes, based on HbA1c levels. A p-value of less than 0.05 was deemed significant.

Results

This study analysed data from 140 participants with type 2 diabetes mellitus. The results revealed a significant association between diabetes control and serum ferritin levels.

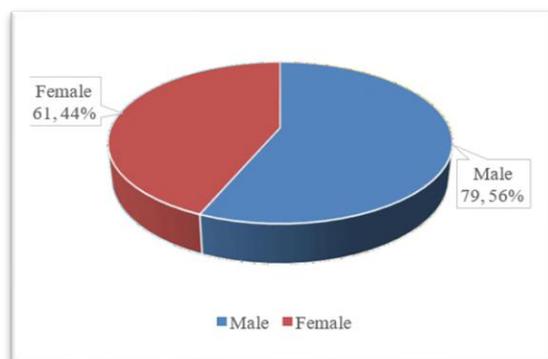


Figure 1: Gender Distribution of Participants

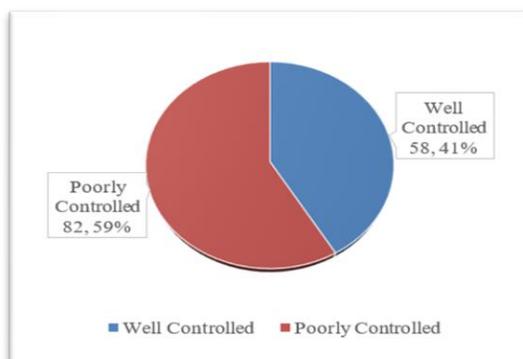


Figure 2: Control of Diabetes Among Participants

As illustrated in Figure 2, diabetes control was assessed based on HbA1c levels, which are considered the gold standard indicator of long-term glycaemic control.

• Serum Ferritin and HbA1c Levels

Serum ferritin levels were compared across the HbA1c categories. As shown in Table 1, serum ferritin levels varied across different ranges of HbA1c. Participants with HbA1c levels in the 6–7.49% range had an average serum ferritin level of 71.46 µg/L, whereas those with HbA1c levels > 10.5% had higher serum ferritin levels, averaging 108.27 µg/L. This indicates a positive trend between poor glycaemic control and elevated serum ferritin levels, which could reflect an underlying inflammatory process.

To further analyse the association between serum ferritin and HbA1c, an independent samples t-test was performed. The results showed that participants with well-controlled diabetes and those with poorly controlled diabetes had significantly different serum ferritin levels. Levene's test for equality of variances showed a significant result ($F = 16.141$; $p < 0.001$), and the t-test for equality of means showed a statistically significant difference ($t = -2.434$; $p = 0.019$). This indicated that participants with poor glycaemic control had higher serum ferritin levels than those with good glycaemic control.

Table 1: Comparison of Serum Ferritin and HbA1c Levels of Selected Participants (Serum Ferritin)

	Mean	Minimum	Maximum	Column N %	Row N %	
HbA1c	6-7.49	71.46	42.29	97.17	42.1%	100.0%
	7.5-8.99	74.07	45.44	95.83	20.7%	100.0%
	9-10.49	90.53	67.64	108.44	12.9%	100.0%
	>10.5	108.27	64.62	154.86	24.3%	100.0%

Discussion

In this study, serum ferritin levels were higher among participants with poorer glycaemic control, showing an association between ferritin and HbA1c in patients with type 2 diabetes mellitus. These findings align with previous literature, which has consistently highlighted the relationship between serum ferritin and HbA1c levels in patients with type 2 diabetes mellitus.

In a study conducted by Al-Miraj et al. (2021), a positive and noteworthy correlation was observed between serum ferritin and HbA1c levels in patients with diabetes, as rising serum ferritin levels followed an increase in HbA1c levels, which corroborates our findings.¹⁴

In another study that investigated the association between serum ferritin and HbA1c levels in patients with type 2 diabetes, out of 42 participants enrolled in the study, a direct association was observed between HbA1c and serum ferritin. Additionally, HbA1c and serum ferritin levels were positively and significantly correlated, particularly in women.¹³

A case-control study that enrolled 100 patients with type 2 diabetes and compared them with 100 non-diabetic controls also found a positive association between elevated serum ferritin levels and glycaemic control. Regardless of sex, the case group had a direct association between serum ferritin levels and HbA1c in patients with type 2 diabetes, indicating that higher ferritin levels are associated with poorer glycaemic control ($p < 0.0001$).¹⁵

Similarly, Manhas et al. demonstrated in their study that serum ferritin levels were significantly elevated in individuals with type 2 diabetes (mean $261.29 \pm 76.98 \mu\text{g/L}$) compared to healthy controls, and hence, a statistically significant trend between increased serum ferritin levels and elevated glycated haemoglobin (HbA1c) levels was observed.¹⁶ Earlier local studies have also demonstrated similar trends, in which serum ferritin and HbA1c levels showed a weak but statistically significant positive correlation in research conducted in Pakistan.¹⁷

Ferritin has also been investigated in conjunction with inflammatory markers, such as high-sensitivity C-reactive protein, in patients with type 2 diabetes, supporting its significant role in the metabolic-inflammatory milieu.¹⁸

Type 2 diabetes mellitus is now recognised as a component of a broader metabolic syndrome, with complications affecting multiple systems. Given the growing evidence linking ferritin with glycaemic control and disease progression, ferritin has potential for integration into routine diabetic screenings to enhance early identification and management of metabolic complications.

Certain limitations must be acknowledged. The study's cross-sectional methodology constrained our ability to establish causal relationships between serum ferritin and glucose regulation, and the single-center nature of the study may restrict the generalisability of findings to other populations or healthcare settings. Despite implementing strict exclusion criteria, unmeasured confounding variables, such as dietary iron intake, concurrent medications, or genetic factors, may have influenced the observed relationships between ferritin and glycaemic parameters. Finally, although the sample size was adequate for the primary analyses, a larger cohort in the future may provide more robust findings and meaningful subgroup analyses to characterise the ferritin-diabetes control relationship across different patient populations.

Conclusions

This study found that serum ferritin levels were higher among patients with poorer glycaemic control (higher HbA1c) in type 2 diabetes mellitus. These findings suggest that serum ferritin may reflect the underlying metabolic and inflammatory status and could be considered a supportive biomarker alongside routine glycaemic monitoring. However, the cross-sectional design limits the causal interpretation.

Author Information

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