

Studies on the Correlation of Ferritin, Glucose and BMI Among the Diabetes, Pre-diabetes and Healthy Individuals in Tertiary Care Hospital - Prospective Study

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ABSTRACT

Background: Diabetes mellitus is a major public health concern, and increasing evidence suggests that serum ferritin may be associated with insulin resistance and hyperglycemia. Obesity and increased Body Mass Index (BMI) are also important risk factors for the development and progression of type 2 diabetes mellitus. **Objectives:** To evaluate the correlation between serum ferritin, Fasting Blood Glucose (FBG), and BMI among healthy individuals, prediabetic individuals, and patients with type 2 diabetes mellitus. **Materials and Methods:** A prospective cross-sectional study was conducted in a tertiary care teaching hospital in Khammam. A total of 150 participants were enrolled and divided into three groups: healthy controls ($n=50$), prediabetes ($n=50$), and type 2 diabetes mellitus ($n=50$). Fasting blood glucose and serum ferritin levels were estimated, and BMI was calculated from height and weight measurements. Statistical analysis was performed using SPSS version 23. One-way ANOVA was used for comparison among groups, while Pearson's correlation analysis was used to determine associations between FBG, ferritin, and BMI. **Results:** The mean FBG levels were 91.25 ± 6.33 mg/dL, 121.70 ± 18.61 mg/dL, and 169.67 ± 38.21 mg/dL in healthy, prediabetic, and diabetic groups, respectively. Mean serum ferritin levels were 24.8 ± 1.98 μ g/L, 48.63 ± 12.98 μ g/L, and 75.86 ± 19.71 μ g/L, respectively. Mean BMI values were 24.12 ± 2.90 , 25.20 ± 2.98 , and 26.12 ± 2.98 kg/m², respectively. Significant positive correlations were observed between FBG and ferritin ($r=0.894$, $p<0.001$), FBG and BMI ($r=0.301$, $p=0.006$), and ferritin and BMI ($r=0.312$, $p=0.004$). **Conclusion:** Serum ferritin levels increased progressively from healthy individuals to prediabetic and diabetic individuals and showed significant positive correlations with FBG and BMI. Serum ferritin may have potential value in identifying individuals at increased risk of developing diabetes and its associated complications.

Keywords: Body mass index, Fasting blood glucose, Glycemic status, Prediabetes, Serum ferritin, Type 2 diabetes mellitus.

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INTRODUCTION

One of the most prevalent endocrine diseases globally, Diabetes Mellitus (DM) affected around 366 million individuals in 2011, with projections that this figure will grow to 552 million by 2030 (International diabetes foundation. Diabetes Atlas; 2019). Reducing comorbidities and mortality in people with diabetes requires prompt diagnosis and treatment. Moreover, the national economies are heavily burdened by the treatment expenditures

of diseases driven on by uncontrolled hyperglycemia in DM patients (Thungathurthi *et al.*, 2012). India has the second-highest population of diabetics worldwide, with 69.1 million people living with the non-communicable disease. Diabetes mellitus is a major public health concern. As stated by the International Diabetes Federation (Nyenwe *et al.*, 2003). Diabetes Mellitus Type 2 (T2DM) is the most common kind of the disease. By 2030, it is predicted that the prevalence of type 2 diabetes would reach 9.3%, especially in the Indian population. This could be attributed to a number of factors, such as dietary changes brought about by people moving from rural to urban areas and an increase in sedentary lifestyles (Uloko *et al.*, 2014). Participants with T2DM had significantly greater serum ferritin levels than participants without diabetes (Okonta *et al.*, 2014). Elevated ferritin levels are frequently linked to insulin resistance or hyperglycemia. Serum ferritin levels are impacted by a number of disorders and are



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correlated with body iron reserves. The pandemic of overweight and obesity is a major contributor to the etiology of type 2 diabetes and many of its consequences. The current rise in type 2 diabetes prevalence appears to be mostly caused by an increase in obesity rates (Shankar *et al.*, 2011). Increased ferritin levels have also been observed in DM patients with elevated glucose levels, and this finding is associated with a higher risk of developing retinopathy, nephropathy, and vascular dysfunction.

MATERIALS AND METHODS

Definition of variables

- **Normoglycemic subject:** Subjects whose blood glucose level was less than <110 mg/dL.

Impaired Fasting Glycemia

If the blood glucose was less than <126 mg/dL and ≥ 110 mg/dL, it was considered impaired fasting glycemia.

- **Diabetic Subject:** If the amount of fasting blood glucose is ≤ 126 mg/dL, then the subject was considered diabetic.

Body Mass Index (BMI)

BMI: 18.5 - 24.9 was considered as normal, 25.0 - 29.9 as overweight or pre-obesity, and ≥ 30 as obese. BMI, less than 18.5 was classified as underweight.

Study Design

Our search was carried out at a tertiary care teaching hospital. 150 individuals participated in this cross-sectional study: 50 healthy persons made up group 1, the control group, and 50 patients with type 2 diabetes mellitus made up group 3. Group 2 had an

additional forty participants who met the American Diabetic Association's criteria for prediabetes, meaning their fasting blood glucose levels were between 100 and 125 mg/dL (Rajasekharan *et al.*, 2015). The participants gave their written consent and were informed of our protocol. The Institutional Ethics Committee approved and accepted this study.

Exclusion criteria included individuals who had a history of neuropsychiatric or cancerous illness, hypertension, systemic sickness, persistent infections, endocrine abnormalities, chronic alcoholism, or smoking. The respondents were matched for age and gender, and all pertinent demographic information was gathered. To compute BMI, anthropometric measures such as weight and height were taken.

Data collection

Subjects in each of the three groups had their fasting blood samples taken, and the following analyses were carried out. Fasting plasma glucose was determined by the MISPA EXCEL semi-autoanalyzer's end-point method. Using the same analyzer, serum ferritin was measured using the latex turbidimetric method (Atak *et al.*, 2005). The formula is:

$$\text{BMI} = \frac{\text{Weight in kilograms}}{(\text{Height in meters})^2}$$

2 was used to compute the BMI (Badrudin *et al.*, 2005).

Statistical analysis

The statistical analysis was conducted utilizing SPSS version 23 software. One-way Analysis of Variance was used to compare the means of the various parameters (ANOVA). Blood glucose, BMI, and serum ferritin were correlated using Pearson's method.

Table 1: The three groups' respective mean and standard deviations for ferritin, glucose, and BMI.

Sl. No.	Parameter	Group 1	Group 2	Group 3
		Healthy individuals Controls (n=50)	Pre diabetes (n=50)	Diabetes (n=50)
1.	Fasting plasma Blood Glucose (mg/dL) **	91.25 ^a ± 6.33	121.70 ^b ± 18.61	169.67 ^c ± 38.21
2.	Ferritin (µg/L) **	24.8 ^a ± 1.98	48.63 ^b ± 12.98	75.86 ^c ± 19.71
3.	BMI (kg/m ²) *	24.12 ^a ± 2.90	25.20 ^{a, b} ± 2.98	26.12 ^b ± 2.98

abcd columns' mean with a different superscript shows a significant difference. (* $p < 0.05$; ** $p < 0.01$) Non-significant; NS $p = 0.03$ (groups 1 and 3) for BMI.

Table 2: Ferritin, glucose, and BMI correlations between the three groups.

Sl. No.	Research Parameter	FBG	Ferritin	BMI
1.	Pearson Correlation Sig. (2-tailed method)	1	0.894**	0.301**
			0.000	0.006
2.	Pearson Correlation Sig. (2-tailed method)	0.894**	1.00	0.312
		0.000		0.004
3.	Pearson Correlation Sig. (2-tailed method)	0.301**	0.301**	1
		0.006	0.004	-

Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

RESULTS AND DISCUSSION

The three groups' serum ferritin, fasting blood glucose levels, and BMI were examined; associations were found and are shown in Tables 1 and 2, respectively. When compared the fasting blood glucose levels of the pre-diabetic and diabetic groups to those of the diabetic individuals; there was definitely a significant rise. Upon examining the serum ferritin levels, we observed that the diabetes patients in group 3 had considerably higher levels ($75.86 \pm 19.71/L$) than the normal and healthy group 1 ($24.8 \pm 1.98 \mu g/L$). In addition, we noticed that the serum ferritin levels in prediabetics were significantly greater ($48.63 \pm 12.98 \mu g/L$) than in those without diabetes, and this increase persisted between the prediabetics and the diabetics. Table 1 indicates that the BMI of those with type 2 diabetes was greater than that of the normal population. Serum ferritin and fasting blood glucose levels had a significant association ($p=0.000$). Additionally, there is a strong correlation ($p=0.003$) between the study individuals' BMI and serum ferritin. The subjects' BMI and fasting blood glucose levels were also associated ($p=0.007$).

CONCLUSION

Serum ferritin may also be used to identify high-risk individuals who are susceptible to developing diabetes in the future. It is possible to lessen their paradoxical risk of acquiring diabetes and its complications by taking steps to lower their blood ferritin levels and keep them within the normal range. It is commonly known that gaining weight exacerbates insulin resistance and impairs glucose metabolism in people with type 2 diabetes. In this study, baseline BMI had no impact on glycemic control. Lifestyle modifications such as serum ferritin levels increase in glucose-intolerant states like pre-diabetes and type 2 diabetes, and their levels positively correlate with an individual's glycemic status. The finding may have significant consequences for diabetes mellitus and its management. An individual's propensity to acquire diabetes mellitus and associated consequences, such as neuropathy, nephropathy, retinopathy, and cardiovascular illnesses, may be predicted by serum ferritin levels. Assessing the prognosis for patients who present with pre-diabetes could possibly benefit from it. Changes made to the high-risk group that presents with increased serum ferritin levels and BMI may be a significant step toward lowering the morbidity and mortality connected with type 2 diabetes mellitus.

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ABBREVIATIONS

ADA: American Diabetes Association; **ANOVA:** Analysis of Variance; **BMI:** Body Mass Index; **FBG:** Fasting Blood Glucose; **FPG:** Fasting Plasma Glucose; **HbA_{1c}:** Glycated Hemoglobin; **IEC:** Institutional Ethics Committee; **IDF:** International Diabetes Federation; **IQR:** Interquartile Range; **NS:** Not Significant; **p:** Probability Value; **r:** Pearson Correlation Coefficient; **SD:** Standard Deviation; **SPSS:** Statistical Package for the Social Sciences; **T2DM:** Type 2 Diabetes Mellitus; **$\mu g/L$:** Micrograms per Litre; **mg/dL :** Milligrams per Decilitre; **kg/m^2 :** Kilograms per Square Metre; **CI:** Confidence Interval.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHORS CONTRIBUTIONS

Dr. K. Raveendra Babu: Conceptualization, study design, supervision, data interpretation, manuscript writing, and final approval. **Thadikamalla Bhavani:** Experimental work, data collection, statistical analysis, manuscript drafting, and final approval, laboratory investigations, data compilation, literature review, and final approval. **Thogiti Swetha:** Data collection, manuscript editing, formatting, and final approval. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

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