ORIGINAL RESEARCH PAPER

General Medicine

GLYCATED HEMOGLOBIN A1C LEVELS AND IRON DEFICIENCY ANEMIA: A CROSS-SECTIONAL STUDY

KEY WORDS: Glycated Hemoglobin A1c, Iron Deficiency Anemia, Diabetes, Hemoglobin, Serum Iron, Transferrin Saturation

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ABSTRACT

This case-control cross-sectional study was conducted at the hospitals under Bangalore Medical College and Research Institute among 131 patients with Iron deficiency anemia to assess whether there is an association between HbA1c levels and Iron deficiency anemia. Demographic characteristics and clinical examination and laboratory examination were done and measures of HbA1c, hemoglobin, serum iron, and transferrin saturation were taken. In terms of the results, there is evidence of a positive correlation between HbA1c values and age, hemoglobin, serum iron, and transferrin saturation, so high levels of the latter variables correlate with high levels of the former, suggesting that this might imply the possibility that Iron deficiency anemia could spuriously raise measurements of HbA1c. This hints that Iron deficiency anemia should be considered in the explanation of HbA1c values in the diagnosis of diabetes mellitus and that further studies must be carried out to define the mechanisms involved and appropriate reference range for HbA1c in patients with Iron deficiency anemia.

INTRODUCTION:

Diabetes Mellitus remains a significant public health challenge across the globe affecting 537 million adults. This figure is projected to increase to 643 million by 2030 and 783 million by 2045.[1] Glycated hemoglobin A1c (HbA1c) is a key marker at a threshold of 6.5% widely used for screening, diagnosing, and monitoring hyperglycemia. It reflects average plasma glucose levels over the past two to three months.

Iron deficiency anemia can significantly contribute to the pathogenesis of diabetes by promoting glycation, a process that involves the non-enzymatic reaction between sugars and proteins. The mechanism underlying this association involves oxidative stress or peroxidation. Iron deficiency anemia can cause an artificial increase in HbA1c levels. On the other hand, non-iron deficiency anemia forms of anemia may result in lower HbA1c values. These variations can complicate the diagnosis of diabetes when relying on HbA1c measurements.

Despite its widespread use, the reliance on HbA1c measurement alone in diabetes management remains controversial. Studies have shown that Iron deficiency anemia can lead to falsely elevated HbA1c levels, though the underlying mechanism is not well understood. This review aims to explore the potential causes of the association between increased HbA1c levels and Iron deficiency anemia.

Aims And Objective Of The Study:

To correlate Glycated Hemoglobin A1c Levels and Iron Deficiency Anemia

Methodology:

This hospital-based cross-sectional study was conducted from August 2022 to November 2023 in hospitals attached to Bangalore Medical College and Research Institute (BMCRI) for 1 year.

Inclusion Criteria:

1. Age > 18 years of either sex
2. Patients willing to provide written consent for the study.

Exclusion Criteria:

1. Patients receiving cancer chemotherapy or on cytotoxic therapy, or those using colony-stimulating factors or who are immunocompromised.
2. Patients who have received multiple blood/blood component transfusions within 3 months before presentation at our hospital.
3. Patients with a known history of diabetes mellitus
4. Patients were too sick to undergo the proposed diagnostic workup.
5. Patients who were not willing to provide written consent.

Data Collection:

The study was conducted after obtaining the permission of the Institutional Ethics Committee. After obtaining consent from the participants, a detailed history, clinical examinations, and investigations were conducted. The data was collected using a proforma and then transferred in MS Excel.

Statistical Analysis:

The collected data was analyzed using IBM SPSS Statistics software version 26.

RESULTS:

The study included a total of 131 patients with Iron Deficiency Anemia.

Table 1. Mean Values Of Quantitative Variables

Variable	Mean ± SD
Age	45.57 ± 13.89
Hemoglobin	6.65 ± 1.17
HBA1C	6.67 ± 0.31
Serum Iron	44.03 ± 3.27
Transferrin Saturation	13.16 ± 2.54

The data indicates that the average age of the participants is approximately 45.57 years. The mean hemoglobin level is 6.65 g/dL, indicating anemia among participants. The average HBA1C level is 6.67%, slightly above the normal range.

The mean serum iron level is 44.03 µg/dL, which is on the lower end of the normal range, pointing to iron deficiency. Additionally, the average transferrin saturation is 13.16%, below the normal range, further confirming iron deficiency anemia.

Overall, the participants have low hemoglobin, serum iron, and transferrin saturation levels, along with elevated HBA1C

levels.

Table 2. Correlation Matrix Of Hba1c With Hemoglobin, Serum Iron And Transferrin Saturation

HbA1C	Age	Hemo globin	Serum iron	Trans Ferrin
Pearson Correlation	0.328*	0.468*	0.781*	0.468*
P-Value	0.000	0.000	0.000	0.000

* Correlation is significant at the 0.05 level (1-tailed)

The correlation matrix indicates that HbA1c has significant positive correlations with age (r=0.328, p=0.000), hemoglobin (r=0.468, p=0.000), serum iron (r=0.781, p=0.000), and transferrin saturation (r=0.468, p=0.000), with all correlations being significant at the 0.05 level.

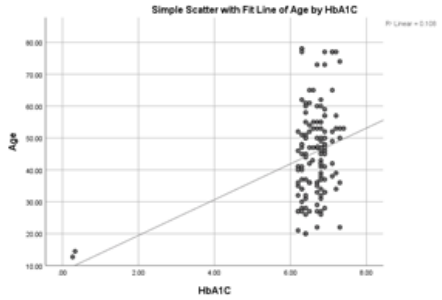

Figure 1. Correlation graph of HbA1c with age

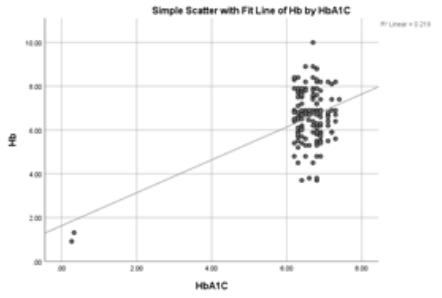

Figure 2. Correlation graph of HbA1c with Hemoglobin

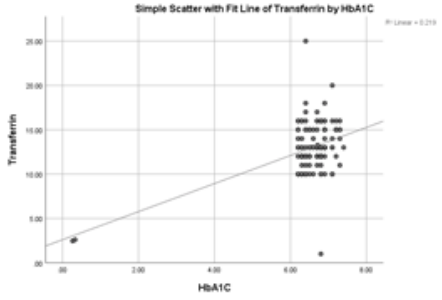

Figure 3. Correlation graph of HbA1c with Serum Iron

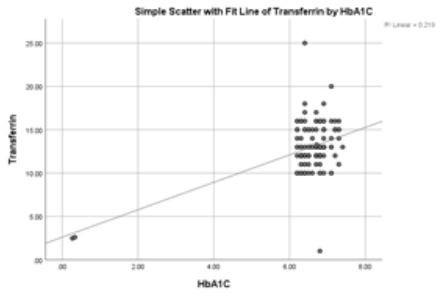

Figure 4. Correlation graph of HbA1c with Tranferrin

The graphs demonstrate a significant positive correlation between hemoglobin, transferrin, and serum iron levels with HbA1C. As the levels of hemoglobin, transferrin, and serum iron increase, the HbA1C levels also rise. This indicates that higher levels of these variables are associated with higher HbA1C levels, suggesting that in patients with iron deficiency anemia, the HbA1C levels can also rise, which does not necessarily indicate that the patient is suffering from diabetes or prediabetes, and vice versa.

DISCUSSION:

This study aimed to associate HbA1c with Iron Deficiency Anemia through a hospital-based cross-sectional study at Bangalore Medical College and Research Institute. The study findings show a highly significant positive association of HbA1c with age, hemoglobin, serum iron, and transferrin saturation in which male subjects were declared to have higher mean values of most of the variables compared with the female group.

A study by Kim et al reported that iron deficiency could raise HbA1c when non-glycemic and affected the female gender disproportionately, increasing the odds of HbA1c ≥5.5% but was no more so for HbA1c ≥6.5%.[2] This is consistent with our study wherein serum iron levels were significantly correlated with HbA1c.

Another study conducted by Sinha et al. found that there is a statistically significant difference in the mean levels of HbA1c between anemic and non-anemic populations. Hence, anemia might influence the level of HbA1c.[3] Similarly, in our study, we find significant correlations between HbA1c and the level of hemoglobin, which supports the notion that anemia influences the measurements of HbA1c.

A study done by English et al. revealed that iron deficiency, with or without anemia, resulted in higher HbA1c values compared to controls.[4] Our findings in this study were that there was a significant positive correlation between HbA1c and serum iron.

A study by Attard et al. noted that iron deficiency anemia could result in more extensive glycosylation of hemoglobin molecules, thereby increasing HbA1c levels.[5] This supports our observation of major positive correlations between HbA1c and serum iron.

CONCLUSION:

HbA1c levels and iron deficiency anemia are strongly positively correlated. Thus, iron deficiency raises HbA1c levels independently of glycemia, which has an extremely important implication for the use of HbA1c as a diagnostic tool in diabetes in populations with a high prevalence of iron deficiency anemia. Further studies are needed to identify the mechanisms involved so that adequate reference ranges can be perceived for HbA1c in patients with iron deficiency anemia.

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