



EFFECT OF HEMOGLOBIN LEVELS ON HbA1c VALUES IN PREGNANCY

Pooja Agarwal

Consultant in Department of Obstetrics and gynecology, Maharaja Agrasen Hospital, Jaipur, Rajasthan- 302039, India.

Nisha Thakur

Chief Consultant in Department of Obstetrics and gynecology, JLN Hospital and research center, Bhilai, Chhattisgarh- 490009, India

ABSTRACT

Background: HbA1c is commonly used to reflect average glycemic status over the preceding weeks. However, its accuracy is influenced by erythrocyte lifespan and hemoglobin concentration. Pregnancy is frequently associated with anemia, which may affect HbA1c values independent of actual blood glucose levels. **Objective:** To assess the effect of hemoglobin levels on HbA1c values in pregnant women. **Materials And Methods:** This prospective observational study included 350 pregnant women attending the antenatal clinic of a tertiary care hospital. Hemoglobin and HbA1c levels were measured in early pregnancy. Participants were grouped according to hemoglobin levels, and corresponding HbA1c values were analyzed. Correlation and comparative analyses were performed. **Results:** Mean HbA1c levels were higher among women with lower hemoglobin concentrations. A statistically significant inverse relationship was observed between hemoglobin levels and HbA1c values ($p < 0.05$). **Conclusion:** Hemoglobin concentration significantly influences HbA1c values during pregnancy. Anemic states may lead to falsely elevated HbA1c levels, highlighting the importance of interpreting HbA1c in conjunction with hemoglobin levels in pregnant women.

KEYWORDS : Hemoglobin, HbA1c, Pregnancy, Anemia, Red Cell Turnover

INTRODUCTION

HbA1c represents the non-enzymatic glycation of hemoglobin and reflects average blood glucose levels over the preceding 8–12 weeks. It is widely used for assessing long-term glycemic status in clinical practice and research [1,2]. However, the accuracy of HbA1c depends on normal erythrocyte lifespan and stable hemoglobin concentrations [3].

Pregnancy is associated with physiological hemodilution and a high prevalence of iron deficiency anemia, particularly in low- and middle-income countries [8,10]. Iron deficiency alters red blood cell turnover and prolongs erythrocyte lifespan, leading to increased glycation of hemoglobin and potentially elevated HbA1c levels independent of actual blood glucose values [4,6].

Several studies have reported that anemia can cause spuriously high HbA1c values, which may result in misinterpretation of glycemic status [3,5,11]. Given the high burden of anemia among pregnant women in India [12], understanding the influence of hemoglobin concentration on HbA1c during pregnancy is crucial. This study was undertaken to evaluate the effect of varying hemoglobin levels on HbA1c values in pregnant women.

MATERIALS AND METHODS

Study Design: Prospective observational study.

Study Setting: Department of Obstetrics and Gynecology, tertiary care hospital, J.L.N. Hospital and Research Centre, Bhilai, Chhattisgarh, from September 2020 to January 2022.

Study Population: Pregnant women attending antenatal clinic in early pregnancy (≤ 20 weeks gestation).

Total Sample Size: 350 pregnant women.

Inclusion Criteria:

- Singleton pregnancy
- Gestational age ≤ 20 weeks
- Apparently healthy women

Exclusion Criteria:

- Pre-existing diabetes mellitus
- Known hemoglobinopathies
- Chronic medical disorders

Laboratory Methods:

Hemoglobin estimation was performed using an automated hematology analyzer. HbA1c levels were measured using NGSP-certified standardized assays aligned with DCCT values, ensuring accuracy and comparability [2,9].

Classification Of Participants:

Participants were classified into hemoglobin categories based on World Health Organization criteria for anemia in pregnancy [10].

RESULTS

Table 1: Distribution Of Study Participants According To Hemoglobin Levels (n = 350)

Hemoglobin Category	Hb Range (g/dL)	Number (%)
Normal	≥ 11	140 (40.0)
Mild anemia	10–10.9	90 (25.7)
Moderate anemia	7–9.9	105 (30.0)
Severe anemia	< 7	15 (4.3)

Table 2: Mean HbA1c Values Across Hemoglobin Categories

Hemoglobin Category	Mean HbA1c (%) $\pm$ SD
Normal	4.9 ± 0.4
Mild anemia	5.1 ± 0.4
Moderate anemia	5.4 ± 0.5
Severe anemia	5.7 ± 0.6

A progressive rise in mean HbA1c values was observed with decreasing hemoglobin levels.

Table 3: Correlation Between Hemoglobin And HbA1c Levels

Parameter	Correlation Coefficient (r)	p-value
Hb vs HbA1c	-0.42	< 0.001

A statistically significant inverse correlation was found between hemoglobin concentration and HbA1c levels.

Table 4: Comparison Of Mean HbA1c In Non-anemic Vs Anemic Women

Group	n	Mean HbA1c (%)
Non-anemic	140	4.9
Anemic	210	5.3

The difference was statistically significant ($p < 0.05$).

DISCUSSION

The present study demonstrates a significant inverse

relationship between hemoglobin concentration and HbA1c levels in pregnancy. Women with lower hemoglobin levels exhibited higher mean HbA1c values, despite the absence of hyperglycemia.

These findings are consistent with previous studies demonstrating that iron deficiency anemia leads to falsely elevated HbA1c levels due to prolonged erythrocyte survival and altered glycation dynamics [3,4,6]. Hashimoto et al. reported that HbA1c values increase in late pregnancy due to iron deficiency rather than changes in glucose metabolism [6].

Population-based studies have also shown higher HbA1c levels in individuals with iron deficiency anemia compared to those with normal iron status [5,7]. English et al., in their systematic review, emphasized that anemia is a major confounder affecting HbA1c interpretation and should be considered in clinical practice [3].

Given the high prevalence of anemia during pregnancy in India [12], reliance on HbA1c alone may lead to overestimation of glycemic exposure. Current literature strongly supports concurrent assessment of hemoglobin while interpreting HbA1c results in pregnant women [9,11].

CONCLUSION

Hemoglobin levels significantly influence HbA1c values during pregnancy. Anemia may result in falsely elevated HbA1c independent of blood glucose levels, as supported by existing evidence [3,6,11]. Therefore, HbA1c should be interpreted cautiously in pregnant women, with simultaneous evaluation of hemoglobin concentration.

Limitations

- Single-center study
- Iron indices were not assessed

Ethical Clearance

Approval was obtained from the Institutional Ethics Committee. Written informed consent was obtained from all participants.

Data Availability Statement

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

Declaration Of Transparency

The authors confirm that this manuscript is a truthful and accurate representation of the study conducted.

Funding

None.

Conflict Of Interest

None declared.

Acknowledgements

The authors thank all participants and the staff of the Department of Obstetrics and Gynecology for their cooperation.

REFERENCES

1. World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications. Geneva: WHO; 1999.
2. American Diabetes Association. Standards of Medical Care in Diabetes. Diabetes Care. 2023;46(Suppl 1):S1–S291.
3. English E, Idris I, Smith G, Dhatariya K, Kilpatrick ES, John WG. The effect of anemia and abnormalities of erythrocyte indices on HbA1c analysis: A systematic review. Diabetologia. 2015;58(7):1409–1421.
4. Sinha N, Mishra TK, Singh T, Gupta N. Effect of iron deficiency anemia on hemoglobin A1c levels. Annals of Laboratory Medicine. 2012;32(1):17–22. [12:34 pm, 1/1/2026] Dr Pooja agarwal:
5. Kim C, Bullard KM, Herman WH, Beckles GL. Association between iron deficiency and HbA1c levels among adults without diabetes. Diabetes Care. 2010;33(4):780–785.

6. Hashimoto K, Noguchi S, Morimoto Y, Hamada S, Wasada K, Imai S. A1c but not serum glycated albumin is elevated in late pregnancy owing to iron deficiency. Diabetes Care. 2008;31(10):1945–1948.
7. Ford ES, Cowie CC, Li C, Handelsman Y, Bloomgarden ZT. Iron-deficiency anemia, non-iron-deficiency anemia and HbA1c among adults in the U.S. Journal of Diabetes. 2011;3(1):67–73.
8. BMC Pregnancy and Childbirth Editorial Group. Anemia in pregnancy: prevalence, causes and outcomes. BMC Pregnancy Childbirth. 2018;18:206.
9. Little RR, Rohlfing CL, Hanson S, Schmidt RL, Lin CN, Knowler WC. Effects of hemoglobin variants and anemia on HbA1c measurement. Clinical Chemistry. 2012;58(10):1342–1349.
10. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva: WHO; 2011.
11. Radin MS. Pitfalls in hemoglobin A1c measurement: When results may be misleading. Journal of General Internal Medicine. 2014;29(2):388–394.
12. Rajagopal L, Ganesan A, Manivannan M. Prevalence of anemia in pregnancy and its impact on maternal outcomes in South India. Journal of Obstetrics and Gynecology of India. 2020;70(5):364–369.