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Association Between Anemia and Prevalence of Gestational Diabetes vs Non-Gestational Diabetes among Pregnant Women

Safdar Ali Pervez[1], Sarwat Ashraf[2], Abdul Hayee Phulpoto[1*], Ratan Kumar Ramani[1], Munir Ahmed Channa[3] and Asif Aziz[2]

[1]Department of Medicine, Khairpur Medical College, Khairpur Mir's, Pakistan
[2]Department of Medicine, Pir Abdul Qadir Shah Institute of Science, Gambat, Pakistan
[3]Department of Medicine, Muhammad Medical College, Mirpur Khas, Pakistan

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***Corresponding Author:**
Abdul Hayee Phulpoto
Department of Medicine, Khairpur Medical College, Khairpur Mir's, Pakistan
abdulhayee648@gmail.com

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ABSTRACT

Gestational diabetes mellitus (GDM) affects a large number of pregnant women globally and generates significant health complications for both mothers and their newborns. **Objectives:** To establish anemia prevalence among pregnant women with and without gestational diabetes mellitus (GDM) by investigating how various demographic and clinical factors influence this relationship. **Methods:** A six-month comparative cross-sectional study was conducted at Khairpur Medical College, Khairpur Mir's. The study enrolled pregnant women n=200 between 18-40 years of age who had single child pregnancies during the gestational period of 24 to 28 weeks. The criteria established by WHO distinguished anemia while the diagnosis of GDM followed the OGTT results using a 75g Oral Glucose Tolerance Test (OGTT) as per WHO/ADA 2013 guidelines. Data were analyzed using descriptive statistics with chi-square tests and logistic regression. **Results:** The mean age of maternal individuals (29.8 years) along with body mass index (BMI 29.4 kg/m^2) was higher in GDM group members than in non-GDM group individuals; p<0.001. GDM mothers had higher anemia prevalence at 78.3% compared to 57.1% in the other group (p=0.004), alongside lower average hemoglobin measurement results (9.8 g/dL compared to 10.5 g/dL, p=0.001). The analysis using logistic regression established both anemia along BMI and maternal age as independent risks for GDM diagnosis (OR: 2.35, p=0.006). **Conclusion:** It was concluded that anemia occurs more frequently in pregnant women with GDM, while remaining an independent GDM factor, which also correlates with elevated maternal age and BMI compared to non-GDM women.

INTRODUCTION

Gestational diabetes mellitus (GDM) represents a prevalent medical pregnancy complication because it causes glucose intolerance right after its first detection during pregnancy [1, 2]. The global prevalence of GDM continues to increase between 1% and 28% as maternal age and obesity and ethnicity, and lifestyle affect this rate [3]. GDM impacts maternal health while creating severe consequences for fetal development that result in macrosomia alongside preterm birth and cesarean section, together with long-term metabolic problems in both mother and child [4]. Pathological anemia impacts 40.5% of pregnant women worldwide and affects pregnant individuals most significantly in nations with limited or middle-income status [5]. According to the World Health Organization (WHO), the diagnostic threshold for pregnant women anemia is when their hemoglobin measures below 11 g/dL, which leads to several complications, including exhaustion and hypertension and premature birth and reduced infant birthweight and maternal death [6]. Pregnancy requires increased blood volumes while simultaneously causing nutritional deficiency of iron, folate and vitamin B12, resulting in high occurrences of anemia [7]. The connection between GDM and anemia remains unclear, although new scientific evidence suggests they might be related to each other. Maternal anemia has been identified by studies as a factor which can modify glucose

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metabolism through insulin resistance and oxidative stress, along with inflammation, which raises GDM development [8]. Multiple research studies have found that anemia does not impact GDM risk, and anemics sometimes show reduced GDM prevalence. The insufficient consensus across research studies reveals major knowledge gaps in this field, especially since anemia and gestational diabetes occur commonly among South Asian populations [9]. Maternal anemia and GDM burden remain high within Pakistan because of substandard nutrition, together with scarce prenatal care services, while maternal age increases and obesity rates continue to rise [10]. Few studies have investigated the joint occurrence of these healthcare conditions among pregnant women to determine their possible links. The relationship's comprehension is essential because it will affect procedures for antenatal screening and maternal nutritional plans, and healthcare treatment, which results in better pregnancy outcomes [11]. Pakistani women display high occurrence rates of both anemia and GDM, yet local research fails to establish their collective impact. Previous research examined these medical conditions separately without exploring their potential interconnectedness among Pakistani pregnant patients. The prevalence rates of anemia in patients with and without GDM require more detailed investigation to better understand their effects on prenatal outcomes.

This study aims to evaluate the presence of anemia among GDM and non-GDM pregnant women to analyze their relationship and examine related demographic and clinical characteristics. Also to investigate specific demographic characteristics and clinical variables associated with this relationship because these findings will enhance medical risk assessment methods while improving maternity health results.

METHODS

This comparative cross-sectional study was conducted in the Department of Medicine at Khairpur Medical College, Khairpur Mir's. over six months, from August 2024 to February 2025. Ethical approval for this study was obtained from the Institutional Review Board (IRB), Ref No. (KMC/RERC/122). All pregnant women who visited routine antenatal clinics, combined with those admitted to obstetric care during the research period, were included in the study population. Inclusion criteria: Pregnant women between 18-40 years old had singleton pregnancies at 24 to 28 weeks of gestation, which was verified through last menstrual period or early pregnancy ultrasound tests before consenting to participate in the study. Exclusion criteria: The study excluded pregnant women who had type 1 diabetes, type 2 diabetes, thalassemia or sickle cell anemia or systemic diseases or multiple pregnancies or blood transfusions during their current pregnancy. A sample size calculation utilized the $n=Z2\times p\times q/d2$ formula with Z set to 1.96 for 95% confidence, along with p representing pregnancy anemia prevalence (30%) and q (1-p), and d representing a tolerance of 7% error. A total of 200 pregnant women participated in the study after non-response adjustment, resulting in 60 GDM group participants alongside 140 participants in the non-GDM group. The researchers used non-probability consecutive sampling to select participants. The diagnosis of Gestational diabetes mellitus through a 75g Oral Glucose Tolerance Test (OGTT) occurred between weeks 24 to 28 of pregnancy. Blood samples were collected at the beginning of the test, followed by a second collection at one hour and a third at two hours after patients received glucose. GDM diagnosis followed the WHO/ADA criteria of 2013 for any fasting plasma glucose value above 92 mg/dL or one-hour plasma glucose above 180 mg/dL or two-hour plasma glucose above 153 mg/dL. Pregnant women displayed anemia according to WHO standards when their pregnancy hemoglobin levels fell below 11.0 g/dL. The clinical assessment divided anemia into mild (10.0–10.9 g/dL), moderate (7.0–9.9 g/dL) and severe (<7.0 g/dL) stages. A structured proforma collected demographic and clinical information from consenting participants who included age, pregnancy status, gestational period, BMI reading, social class, birth history, together with any family history of diabetes. The Complete Blood Count (CBC) analyzed patient hemoglobin levels for anemia grading and, alongside a 75g OGTT, evaluated patient glucose tolerance levels. The study participants were classified as GDM or non-GDM groups according to their OGTT results before researchers assessed and compared the extent and prevalence of anemia in both groups. The statistical analysis utilized SPSS version 26 for data entry and analysis. A statistical analysis of demographic and clinical variables produced mean values with standard deviations while reporting frequencies. A Chi-square test evaluated the frequency of anemia and its severity rates between patients with GDM and those without diagnosed GDM. Analysis for continuous variables included independent sample t-tests and Mann-Whitney U tests based on appropriate criteria. A logistic regression analysis determined independent anemia-related factors through an adjustment process which included age, BMI, and parity as potential confounders. The study considered statistical significance at $p<0.05$.

RESULTS

The GDM group showed higher maternal age than the non-GDM group (29.8 vs. 27.6 years) according to statistical tests ($p=0.008$). BMI levels among women with GDM reached 29.4 kg/m^2 while non-GDM women maintained 26.5 kg/m^2 ($p<0.001$). The participant demographics were similar between groups, so either group received GDM pregnancy management or regular pregnancy

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management. GDM patients showed lower hemoglobin levels than pregnant women without GDM at 9.8 g/dL compared to 10.5 g/dL (p=0.001). The prevalence of anemia in women with gestational diabetes mellitus (GDM) reached 78.3% while remaining at 57.1% in women without GDM based on significant statistical results (p=0.004). GDM women have higher BMI values while showing lower hemoglobin levels, which leads to increased prevalence of anemia (Table 1).

Table 1: Demographic and Clinical Characteristics of Study Participants

Variables	GDM Group (n=60)	Non-GDM Group (n=140)	p-value
Maternal Age (Years)	29.8 ± 4.5	27.6 ± 4.2	0.008**
Gestational Age (Weeks)	26.3 ± 1.5	26.7 ± 1.8	0.112
BMI (kg/m^2)	29.4 ± 3.9	26.5 ± 3.7	<0.001**
Parity			
Primigravida	22 (36.7%)	63 (45%)	0.215
Multigravida	38 (63.3%)	77 (55%)	
Socioeconomic Status			
Low	18 (30%)	50 (35.7%)	0.360
Middle	29 (48.3%)	60 (42.9%)	
High	13 (21.7%)	30 (21.4%)	
Hemoglobin Level			
g/dL	9.8 ± 1.2	10.5 ± 1.4	0.001**
Anemia Status			
Anemic	47 (78.3%)	80 (57.1%)	0.004**
Non-anemic	13 (21.7%)	60 (42.9%)	

The GDM patients displayed a distinct hemoglobin concentration pattern because their results showed 9.8 ± 1.2 g/dL compared to 10.5 ± 1.4 g/dL in non-GDM patients (p=0.001). The study findings demonstrated poorer glucose tolerance in patients with GDM when comparing mean fasting, 1-hour and 2-hour OGTT values between groups (p<0.001 for each) (Table 2).

Table 2: Comparison of Mean Hemoglobin Levels and OGTT Values

Parameters	GDM Group (n=60)	Non-GDM Group (n=140)	p-value
Hemoglobin (g/dL)	9.8 ± 1.2	10.5 ± 1.4	0.001
Fasting Glucose (mg/dL)	102.3 ± 8.6	87.4 ± 7.9	<0.001
1-hour OGTT (mg/dL)	178.5 ± 24.7	132.2 ± 18.5	<0.001
2-hour OGTT (mg/dL)	152.7 ± 21.3	116.3 ± 16.7	<0.001

The logistic regression analysis demonstrated that anemia functioned as an independent factor for increased GDM odds because it produced an adjusted odds ratio of 2.35 (95% CI: 1.28–4.30, p=0.006). Both BMI and maternal age function as independent prognostic variables for GDM risk because the chances increase by 22% when BMI rises by one unit (OR: 1.22, p<0.001) and maternal age advances by one year (OR: 1.08, p=0.048). Parity status and socioeconomic standing did not establish a meaningful relationship with GDM (Table 3).

Table 3: Logistic Regression Analysis for Factors Associated with GDM

Variables	Adjusted OR (95% CI)	p-value
Anemia (Yes vs No)	2.35 (1.28–4.30)	0.006
BMI (per kg/m^2 Increase)	1.22 (1.10–1.36)	<0.001
Maternal Age (Per Year)	1.08 (1.00–1.17)	0.048
Parity (Multigravida vs Primigravida)	1.35 (0.72–2.54)	0.340
Socioeconomic Status (Low vs High)	1.15 (0.60–2.22)	0.660

Women who had GDM (78.3%) showed an anemic condition more frequently than their non-GDM counterparts (17.9%), and the difference reached statistical significance at p=0.021 (Figure 1).

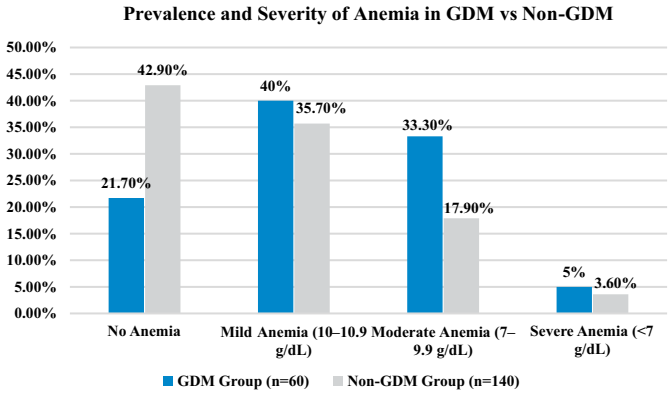

Figure 1: Prevalence and Severity of Anemia in GDM vs non-GDM

DISCUSSION

Current research confirmed that maternal age, together with BMI, served as important risk factors for GDM as demonstrated in existing literature. Maternal subjects diagnosed with GDM averaged 29.8 years old with a BMI measurement of 29.4 kg/m^2, which exceeded the values of non-GDM patients. Studies show that both increased BMI and older maternal age function as principal risk factors for GDM because elevated BMI causes insulin resistance, and maternal ageing diminishes pancreatic β-cell function in Table 1 [12]. Current research showed that parity status and socioeconomic background failed to establish any clear connection with developing GDM despite past research indicating otherwise. Women with reduced socioeconomic status exhibited elevated GDM risks according to Roustaei *et al.*, because they had limited healthcare services and dietary access [13]. Our study results might show that socioeconomic characteristics within our research population maintained a similar distribution because this possibly explains the missing connection between these variables. Our findings about GDM risk factors relate to Gnanasambanthan *et al.*, because we saw similar results that showed parity does not contribute to GDM development [14]. The GDM patient group demonstrated a statistically lower average hemoglobin level compared to the non-GDM group participants. Women with GDM experienced higher physiological stresses because their

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insulin resistance potentially worsened their anemia condition [15]. The research from Guo *et al.*, matches our findings about anemia and GDM, but their work highlighted dietary habits and genetic background as elements affecting this connection [16]. Current study expands existing research by factoring in BMI and maternal age variables, which helps verify anemia as a standalone risk element for GDM [17]. Several research studies have backed our findings by demonstrating elevated anemia rates among pregnant women who have GDM. Anemia was detected in 72% of women with GDM based on the findings of Rasmussen *et al.*, and these findings are compatible with our study outcomes. The inflammatory and metabolic changes linked to GDM cause women with the condition to develop anemia at higher rates [18]. Our research investigated whether anemia exhibits any connection with gestational diabetes mellitus (GDM) prevalence during pregnancy in maternal patients in figure 1. Anemia produces a major connection with GDM, specifically in those cases of moderate anemia [19]. The prevalence of anemia among pregnant women with GDM at 78.3% exceeded the 57.1% rate observed in women without GDM, and moderate anemia commonly afflicted GDM patients. Pregnant women with GDM showed a statistically significant decrease in mean hemoglobin levels at 9.8 g/dL versus non-GDM group women who measured at 10.5 g/dL. The results of logistic regression validated anemia as an independent GDM risk factor with an adjusted OR of 2.35, together with BMI and maternal age being established predictors of GDM in Table 2 [20]. Some research findings fail to detect meaningful correlations between anemia and Gestational Diabetes Mellitus conditions. The research conducted by Santhakumar *et al.*, showed no clear connection between anemia and gestational diabetes within their study population. Another possible factor, including when anemia is detected and regional eating habits, potentially resulted in these contradictory findings. The methodological control adjustments in current study with confounding factors such as BMI, age and parity differ from their studies, which did not address these variables in Table 3 [21]. Current study establishes its diagnostic criteria for GDM and anemia through the WHO and ADA guidelines, thus proving the validity of its results. A 75g Oral Glucose Tolerance Test operated in our study served as a dependable GDM diagnostic method, which enables the results to match those from other worldwide research.

CONCLUSIONS

The results of this study indicate that pregnant women who have gestational diabetes mellitus demonstrate substantially higher rates of anemia in comparison to women without GDM. The study showed that moderate anemia establishes an independent link to the development of GDM among pregnant women. The study established higher maternal age and body mass index (BMI) as key elements in developing this condition. Early screening for anemia, along with glucose tolerance, must occur during antenatal care because it benefits all pregnant women who face GDM risk. The combination of anemia treatment with demographic and clinical factor management will create better results for mothers and their babies during pregnancy.

Authors Contribution

Conceptualization: SAP
Methodology: SA, AHP, RKR
Formal analysis: SA, AA
Writing review and editing: SAP, AHP, RKR, MAC

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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