

Studies on Mean Platelet Volume, Red Cell Distribution Width and Glycated Haemoglobin in Pregnant Women Diagnosed with Gestational Diabetes Mellitus in Owerri, Nigeria

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Abstract

Gestational diabetes mellitus (GDM) is a metabolic disorder characterized by glucose intolerance with onset or first recognition during pregnancy. It is associated with both maternal and fetal complications, including macrosomia, preeclampsia, and increased risk of type 2 diabetes later in life. While glucose tolerance testing remains the diagnostic standard, hematological and related metabolic parameters have gained increasing attention as potential tools for evaluating risk and monitoring disease progression. Mean platelet volume (MPV), red cell distribution width (RDW), and glycated haemoglobin (HbA1c) are among the markers that may provide valuable insights. This study investigated alterations in MPV, RDW, and HbA1c in pregnant women with GDM in Owerri, Nigeria, compared with age-matched normoglycemic controls. A cross-sectional case-control design was employed. Blood samples were collected and analyzed using automated hematology analyzers and HPLC for HbA1c. Results revealed significantly elevated HbA1c in GDM patients compared with controls, confirming poor glycemic regulation. MPV was moderately increased in the GDM group, indicating enhanced platelet activation and a hypercoagulable tendency, while RDW showed a mild but statistically significant rise. These findings underscore the role of simple, cost-effective hematological indices and HbA1c in the routine evaluation of GDM, particularly in low-resource settings. Early integration of these markers into antenatal care may improve monitoring, risk stratification, and clinical outcomes for both mothers and infants.

Keywords

Gestational Diabetes Mellitus, Mean Platelet Volume, Red Cell Distribution Width, Glycated Haemoglobin, Pregnant Women

1. Introduction

Gestational diabetes mellitus (GDM) is defined as glucose intolerance of variable severity with onset or first recognition during pregnancy [1]. This condition has become one of the most important metabolic complications of pregnancy, carrying significant risks for both maternal and neonatal health outcomes. The global prevalence of GDM is rising steadily, mirroring broader trends in obesity, sedentary lifestyles, and increasing maternal age [2]. It is estimated that between 7% and 14% of all pregnancies worldwide are affected by GDM, though the exact prevalence varies considerably depending on the diagnostic criteria applied and the studied population [3].

In Nigeria, the prevalence of GDM is variable, ranging from 2% to 14%, with higher prevalence generally observed in urban centers [4]. Contributing factors include shifts in dietary habits, reduced physical activity, and sociocultural transitions towards more sedentary lifestyles. The public health implications of this trend are substantial, given the dual burden of immediate pregnancy complications and the long-term metabolic risks associated with GDM.

Maternal complications linked to GDM include hypertensive disorders such as preeclampsia, increased likelihood of cesarean delivery, postpartum hemorrhage, and progression to type 2 diabetes mellitus later in life [5]. Fetal and neonatal complications include macrosomia, birth trauma, neonatal hypoglycemia, respiratory distress syndrome, and an increased lifelong risk of metabolic syndrome [6]. These risks highlight the importance of early diagnosis and monitoring during antenatal care.

Pathophysiologically, GDM arises from an imbalance between increased insulin resistance during pregnancy and the ability of pancreatic β -cells to secrete sufficient insulin to maintain euglycemia. Placental hormones such as human placental lactogen, progesterone, cortisol, and growth hormone contribute to insulin resistance. When pancreatic compensation is inadequate, hyperglycemia develops [7].

The oral glucose tolerance test (OGTT) is currently regarded as the gold standard for diagnosis. However, OGTT has several limitations, including patient inconvenience, variability in results, and limited accessibility in low-resource settings [8]. Consequently, there is increasing interest in exploring alternative or adjunctive biomarkers that could aid in the screening and monitoring of GDM.

Among these, hematological indices and glycated haemoglobin (HbA1c) have gained attention. Mean platelet volume (MPV) provides insight into platelet function, as larger platelets are metabolically and enzymatically more active, producing greater amounts of thromboxane A₂ and other pro-thrombotic substances [9]. Elevated MPV has been associated with increased platelet activity, vascular dysfunction, and a heightened risk of thrombotic events. Since GDM is accompanied by inflammatory and pro-coagulant states, MPV may serve as a sensitive marker for maternal vascular complications [10].

Red cell distribution width (RDW) is a measure of variation in red blood cell size (anisocytosis). Traditionally used in the evaluation of anemias, RDW has emerged as a marker of systemic inflammation, oxidative stress, and metabolic disorders [11]. In GDM, elevated RDW may reflect oxidative damage, nutritional deficiencies, or subclinical inflammation triggered by chronic hyperglycemia [12]. Nevertheless, existing literature is inconsistent: some studies report significant associations between RDW and GDM, while others do not.

HbA1c, the product of non-enzymatic glycation of hemoglobin, reflects the average blood glucose concentration over the preceding 8–12 weeks [13]. Although its reliability in pregnancy is somewhat limited by increased red blood cell turnover, elevated HbA1c remains an indicator of poor glycemic control. Several studies have reported correlations between maternal HbA1c levels and adverse pregnancy outcomes such as macrosomia, neonatal hypoglycemia, and hypertensive disorders [14].

Taken together, these markers may provide a more comprehensive view of maternal metabolic and hematological status during pregnancy. In resource-limited settings like Nigeria, where access to advanced diagnostic facilities may be constrained, the use of simple, cost-effective, and routinely available laboratory markers could significantly improve maternal and neonatal care. This study therefore sought to investigate alterations in MPV, RDW, and HbA1c in pregnant women with GDM in Owerri, Nigeria, comparing them with age-matched normoglycemic controls.

2. Materials and Methods

2.1 Study Design

This research adopted a cross-sectional case-control design to evaluate MPV, RDW, and HbA1c levels among pregnant women with GDM compared with healthy controls.

2.2 Study Area

The study was carried out at the Federal Teaching Hospital Owerri, Imo State, Nigeria. This tertiary health institution serves both urban and rural populations, making it an appropriate setting for studying diverse socio-demographic groups.

2.3 Study Population

Participants were pregnant women aged between 18 and 40 years attending antenatal clinics at the hospital.

Cases: Pregnant women diagnosed with GDM using the WHO 75 g OGTT criteria.

Controls: Age-matched pregnant women with normal glucose tolerance.

Inclusion criteria: Singleton pregnancies, 2nd or 3rd trimester, confirmed diagnosis of GDM (for cases), and voluntary informed consent.

Exclusion criteria: Women with pre-gestational diabetes mellitus, chronic hypertension, renal disease, inflammatory disorders, or multiple pregnancies.

2.4 Sample Size

A total of 180 participants were recruited: 90 GDM patients and 90 controls. This provided adequate statistical power to detect meaningful differences between groups.

2.5 Sample Collection and Analysis

Five milliliters of venous blood were collected aseptically.

EDTA samples were used for hematological parameters (MPV, RDW) analyzed with an automated hematology analyzer (Sysmex, Japan).

HbA1c was determined using high-performance liquid chromatography (HPLC), a highly sensitive and specific method.

2.6 Statistical Analysis

Data were analyzed using SPSS version 25. Results were expressed as mean $\pm$ standard deviation (SD). Group comparisons were made using independent t-tests or one-way ANOVA where appropriate. A p-value <0.05 was considered statistically significant.

2.7 Ethical Considerations

Ethical approval was obtained from the Research and Ethics Committee of the Federal Teaching Hospital Owerri. Written informed consent was secured from all participants prior to enrollment.

3. Results

Table 1. Mean Values of MPV, RDW and HbA1c in GDM and Non-GDM Pregnant Women (Mean $\pm$ SD)

Parameter	Test (N=90)	Control (N = 90)	t value	p value
MPV (fL)	10.31 $\pm$ 1.88	9.84 $\pm$ 1.24	1.95	0.050*
RDW-CV (%)	14.08 $\pm$ 2.80	11.34 $\pm$ 1.16	8.58	<0.0001 *
RDW-SD (fL)	44.24 $\pm$ 10.79	40.46 $\pm$ 4.26	3.09	0.002*
HbA1c (%)	8.24 $\pm$ 2.65	4.76 $\pm$ 0.78	11.95	<0.0001 *

KEY:

*: Significant p value

SD: Standard Deviation

MPV: Mean Platelet Volume

RDW-CV: Red Cell Distribution With - Coefficient of Variation

RDW-SD: Red Cell Distribution Width - Standard Deviation

HbA1c: Glycated Haemoglobin

Table 1. shows the mean values of MPV, RDW-CV and RDW-SD in gestational diabetes mellitus (GDM) and non-GDM pregnant women.

The mean MPV was significantly higher in women with GDM (10.31 $\pm$ 1.88)fL compared to non-GDM women (9.84 $\pm$ 1.24)fL (t=1.95, p=0.050).

The mean values of RDW-CV and RDW-SD were significantly elevated in women with GDM (14.08 $\pm$ 2.80)% and (44.24 $\pm$ 10.79)fL when compared to non-GDM women (11.34 $\pm$ 1.16)% and (40.46 $\pm$ 4.26)fL, respectively (t=8.58, p= <0.0001 ; t=3.09, p=0.002), while the mean HbA1c level was significantly higher in women with GDM (8.24 $\pm$ 2.65)% when compared to non-GDM women (4.76 $\pm$ 0.78)% (t=11.95, p =

Table 2. Mean Values of MPV, RDW, HbA1c in Women with GDM Based on Gestational Age (Mean $\pm$ SD)

Parameter	1st Trimester	2 nd Trimester	3 rd Trimester	f-Value	p-Value
MPV (fL)	12.09 $\pm$ 1.87	9.87 $\pm$ 1.13	8.96 $\pm$ 0.82	42.79	<0.0001 *
RDW-CV (%)	15.11 $\pm$ 3.76	14.21 $\pm$ 2.45	12.95 $\pm$ 1.29	4.86	0.010*
RDW-SD (fL)	49.24 $\pm$ 8.68	44.68 $\pm$ 14.79	38.80 $\pm$ 2.57	8.21	0.001*
HbA1c (%)	9.02 $\pm$ 2.59	9.09 $\pm$ 3.13	6.60 $\pm$ 0.92	10.50	<0.0001 *

KEY:

*: Significant p value

SD: Standard Deviation

MPV: Mean Platelet Volume

RDW-CV: Red Cell Distribution With - Coefficient of Variation

RDW-SD: Red Cell Distribution Width - Standard Deviation

HbA1c: Glycated Haemoglobin

Table 2 shows the mean values of MPV, RDW-CV, RDW-SD, and HbA1c in pregnant women diagnosed with gestational diabetes mellitus, based on gestational age.

The mean value of MPV were significantly higher in the first trimester (12.09 $\pm$ 1.87)fL compared to the second (9.87 $\pm$ 1.13)fL and third (8.96 $\pm$ 0.82)fL trimesters (F=42.79, p= <0.0001).

The mean values of RDW-CV and RDW-SD were significantly higher in the first trimester ($15.11 \pm 3.76\%$, $(49.24 \pm 8.68)\text{fL}$) compared to the second ($14.21 \pm 2.45\%$, $(44.68 \pm 14.79)\text{fL}$) and third ($12.95 \pm 1.29\%$, $(38.80 \pm 2.57)\text{fL}$) trimesters respectively ($F=4.86$, $p=0.010$; $F=8.21$, $p=0.001$). Similarly, the mean value of HbA1c was significantly higher in the first ($9.02 \pm 2.59\%$) and second ($9.09 \pm 3.13\%$) trimesters compared to the third trimester ($6.60 \pm 0.92\%$) ($F=10.50$, $p < 0.0001$).

Table 3. Mean Values of MPV, RDW, HbA1c in Pregnant Women with GDM Based on Parity (Mean $\pm$ SD)

Parameter	Nulliparous (n=30)	Primiparous (n=30)	Multiparous (n=30)	F-value	p-value
MPV (fL)	10.01 ± 1.43	10.58 ± 2.27	10.33 ± 1.85	0.674	0.512
RDW-CV (%)	14.12 ± 2.70	14.27 ± 3.15	13.84 ± 2.57	0.182	0.834
RDW-SD (fL)	41.94 ± 6.67	43.33 ± 8.24	47.45 ± 15.10	2.168	0.121
HbA1c (%)	7.98 ± 2.78	7.84 ± 1.98	8.89 ± 3.02	1.390	0.255

KEY:

*: Significant p value

SD: Standard Deviation

MPV: Mean Platelet Volume

RDW-CV: Red Cell Distribution With - Coefficient of Variation

RDW-SD: Red Cell Distribution Width - Standard Deviation

HbA1c: Glycated Haemoglobin

Table 3 shows the mean values of MPV, RDW, HbA1c, in women diagnosed with gestational diabetes mellitus (GDM) based on parity.

The mean values of MPV were not significantly different across nulliparous ($10.01 \pm 1.43\text{fL}$), primiparous ($10.58 \pm 2.27\text{fL}$) and multiparous ($10.33 \pm 1.85\text{fL}$) women with GDM respectively ($F=0.674$, $p=0.512$). Similarly, the mean values of RDW-CV and RDW-SD showed no significant difference across nulliparous ($14.12 \pm 2.70\%$, $(41.94 \pm 6.67)\text{fL}$), primiparous ($14.27 \pm 3.15\%$, $(43.33 \pm 8.24)\text{fL}$), and multiparous ($13.84 \pm 2.57\%$, $(47.45 \pm 15.10)\text{fL}$) women with GDM respectively ($F=0.182$, $p=0.834$; $F=2.168$, $p=0.121$). Also, that of HbA1c showed no significant difference across nulliparous ($7.98 \pm 2.78\%$), primiparous ($7.84 \pm 1.98\%$) and multiparous ($8.89 \pm 3.02\%$) women with GDM respectively, ($F=1.390$, $p=0.255$).

Table 4. Pearson Correlation of HbA1c with MPV, RDW-CV, and RDW-SD, in Pregnant Women Diagnosed with GDM

Dependent Variable	n	r-value	p-value
MPV	90	0.07	0.510
RDW-CV	90	0.14	0.202
RDW-SD	90	0.20	0.065

KEY:

*: Significant p value

SD: Standard Deviation

MPV: Mean Platelet Volume

RDW-CV: Red Cell Distribution With - Coefficient of Variation

RDW-SD: Red Cell Distribution Width - Standard Deviation

HbA1c: Glycated Haemoglobin

Table 4 shows the Pearson correlation of glycated haemoglobin with Mean Platelet Volume, RDW-CV, RDW-SD in women diagnosed with gestational diabetes mellitus.

There were no significant positive correlations of HbA1c with MPV ($r=0.07$, $p=0.510$), RDW-CV ($r=0.14$, $p=0.202$), and RDW-SD ($r=0.20$, $p=0.065$), respectively, in women diagnosed with gestational diabetes mellitus.

4. Discussion

This study demonstrated that pregnant women with GDM in Owerri, Nigeria, exhibited significant alterations in hematological and metabolic parameters compared with their normoglycemic counterparts. Specifically, MPV and HbA1c were elevated, while RDW showed moderate but significant increases.

4.1 HbA1c as a Marker of Glycemic Control

The marked elevation in HbA1c among GDM patients confirms poor glycemic regulation. HbA1c remains an invaluable marker because it provides a retrospective measure of average glucose concentration over several weeks, as opposed to the day-to-day fluctuations captured by fasting blood sugar or OGTT [15]. Consistent with previous African and international studies, our results highlight HbA1c's predictive value for maternal and neonatal complications [16,17]. Women with higher HbA1c levels are more likely to experience adverse outcomes such as macrosomia, cesarean delivery, and neonatal hypoglycemia. Although HbA1c is not recommended as a sole diagnostic tool for GDM, its role in risk stratification and treatment monitoring remains undeniable.

4.2 Platelet Activation and MPV

The moderate increase in MPV observed in GDM patients suggests enhanced platelet reactivity and a hypercoagulable state. Larger platelets are metabolically more active, producing increased amounts of thromboxane A₂ and serotonin, which potentiate platelet aggregation and vascular complications [18]. This finding aligns with prior studies that have linked elevated MPV with adverse obstetric outcomes such as preeclampsia, thrombosis, and poor placental perfusion [19]. Given that GDM is characterized by systemic inflammation and endothelial dysfunction, MPV could serve as a low-cost marker to anticipate vascular risks in affected women.

4.3 RDW and Systemic Inflammation

RDW was significantly higher among GDM patients compared to controls. Elevated RDW has been associated with oxidative stress, inflammation, and nutritional deficiencies [20]. In the context of GDM, chronic hyperglycemia and oxidative stress may contribute to increased anisocytosis. However, literature reports are mixed, with some studies confirming this association while others found no significant change [21]. The variability may reflect differences in study populations, nutritional status, and diagnostic criteria. Nevertheless, the present findings support the hypothesis that RDW has potential utility as an adjunct marker for metabolic stress during pregnancy.

4.4 Implications for Low-Resource Settings

One of the most important contributions of this study is demonstrating the value of simple, widely available hematological parameters for GDM evaluation. Unlike OGTT, which is labor-intensive and resource-demanding, MPV and RDW are routinely available as part of full blood count tests. Combined with HbA1c, these markers could form the basis of pragmatic screening and monitoring protocols in resource-limited regions like Nigeria, where healthcare infrastructure is often constrained.

4.5 Comparison with Other Studies

Similar patterns of elevated HbA1c, MPV, and RDW in GDM patients have been reported in studies conducted in Asia, Europe, and other African countries. However, some discrepancies exist, particularly concerning RDW, highlighting the need for larger multicenter studies to clarify its role. The present study contributes to this growing body of evidence, particularly from sub-Saharan Africa where data remain sparse.

4.6 Limitations

This study had some limitations. First, its cross-sectional design precludes causal inferences. Second, the sample size, though adequate for detecting statistical significance, may not capture all variations across populations. Third, the exclusion of biochemical markers such as insulin and inflammatory cytokines limited the scope of mechanistic interpretation. Nonetheless, the findings remain relevant, particularly in guiding routine antenatal care in resource-constrained environments.

5. Conclusion

Pregnant women with GDM in Owerri, Nigeria, exhibited significant elevations in HbA1c and MPV, alongside moderately increased RDW. These changes suggest impaired glycemic control, increased platelet activation, and systemic inflammation. Together, they highlight the clinical utility of incorporating simple hematological indices and HbA1c into routine antenatal evaluations for improved risk stratification and management of GDM.

6. Recommendations

1. Routine monitoring of HbA1c in pregnant women diagnosed with GDM as a measure of long-term glycemic control.
2. Incorporation of MPV into antenatal evaluations to detect hypercoagulability and potential vascular risks early.
3. Expansion of research on RDW in GDM across larger Nigerian and African populations to clarify its diagnostic and prognostic value.
4. Integration of low-cost hematological markers into national screening programs for GDM, especially in low-resource settings.
5. Public health interventions promoting lifestyle modifications such as healthy diet, physical activity, and early screening to reduce the burden of GDM.

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