Zeynep Kamil Med J 2024;55(4):196–200
DOI: 10.14744/zkmj.2024.90775

ORIGINAL ARTICLE

Comparison of hemogram parameters in pregnant women with gestational diabetes mellitus and healthy pregnant women

Mehmet KAĞITÇI
Nalan KURUCA
Deniz DERECİ DELİBAŞ
Şenol ŞENTÜRK

Department of Obstetrics and Gynecology, Recep Tayyip Erdoğan University Faculty of Medicine, Rize, Turkey

ORCID ID
MK : 0000-0002-9141-1301
NK : 0000-0002-8803-5819
DDD : 0000-0002-4585-4785
ŞŞ : 0000-0001-7712-7278

ABSTRACT

Objective: Gestational diabetes mellitus (GDM) is the most common endocrinopathy in pregnant women. The aim of this study is to investigate the relationship between changes in complete blood count parameters, a common and inexpensive test, and GDM.

Material and Methods: In this retrospective study, changes in the complete blood count parameters of pregnant women who underwent a 75-gram oral glucose tolerance test at 24–28 weeks of gestation between October 2021 and October 2022 were compared with healthy pregnant women.

Results: A total of 424 pregnant women were included in the study. Of these, 107 (25.2%) were in the GDM group, and 317 (74.8%) were in the control group. The levels of white blood cell, neutrophil, red blood cell, hemoglobin, and hematocrit were higher in the GDM group (p=0.015, 0.02, 0.025, 0.01, 0.000). Basophil and mean corpuscular hemoglobin concentration (MCHC) levels were found to be lower in GDM patients (p=0.029, 0.009). Logistic regression analyses showed relationships between age, basophil, MCHC, and hematocrit levels. ROC analyses of the relevant blood parameters showed low sensitivity or specificity.

Conclusion: Complete blood count parameters are affected in GDM patients, but clinical use seems challenging. Advanced age is also associated with an increased GDM risk.

Keywords: Basophile, gestational diabetes mellitus, hemoglobin, hemogram, neutrophil, white blood cell.

Cite this article as: Kağıtçı M, Kuruca N, Dereci Delibaş D, Şentürk Ş. Comparison of hemogram parameters in pregnant women with gestational diabetes mellitus and healthy pregnant women. Zeynep Kamil Med J 2024;55(4):196–200.

Received: November 25, 2023 **Revised:** July 04, 2024 **Accepted:** July 29, 2024 **Online:** November 28, 2024
Correspondence: Mehmet KAĞITÇI, MD. Recep Tayyip Erdoğan Üniversitesi Tıp Fakültesi, Kadın Hastalıkları ve Doğum Anabilim Dalı, Rize, Türkiye.
Tel: +90 505 316 28 90 **e-mail:** mehmetkagitci1@hotmail.com
Zeynep Kamil Medical Journal published by Kare Publishing. Zeynep Kamil Tıp Dergisi, Kare Yayıncılık tarafından basılmıştır.

INTRODUCTION

Gestational diabetes mellitus (GDM) is a common endocrine pathology during pregnancy. It is defined as glucose intolerance first detected during pregnancy.[1] The prevalence of GDM has been reported in a wide range of 1.8–25.1% in various studies.[2] It is associated with many obstetric complications such as preeclampsia, polyhydramnios, increased cesarean section rates, fetal macrosomia, and perinatal mortality.[3] Diagnosis and treatment of GDM are of great importance because it is so common and is associated with perinatal complications.

Complete blood count (CBC) is a common and inexpensive examination that includes many parameters. Changes in CBC parameters can be used for diagnosis and follow-up in many infectious, inflammatory, or malignant diseases.[4,5] Cells such as white blood cells (WBC), lymphocyte (Ly), monocyte (Mo), platelet (Plt) show changes in response to systemic inflammation.[6] Low or high hemoglobin (Hb) levels can occur as a cause or consequence of many diseases. Likewise, platelet levels are an important component of the coagulation system. In a disease such as GDM, which affects many tissues, organs, and systems, changes in CBC parameters would be expected. However, conflicting results have been obtained in studies examining changes in first or second trimester CBC parameters in GDM patients.

The aim of this study is to investigate the relationship between second trimester CBC parameters and GDM.

MATERIAL AND METHODS

Pregnant women who applied to the pregnancy outpatient clinic of our hospital between October 2021 and October 2022 and performed a 75-g oral glucose tolerance test (OGTT) were included in this retrospective study. Pregnant women were considered to have GDM if one of the following plasma glucose values was met or exceeded according to the International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria: Fasting ≥92 mg/dl; 1st hour ≥180 mg/dl; 2nd hour ≥153 mg/dl.

Age, number of previous pregnancies, number of births, gestational week, and complete blood count parameters were recorded for each patient. The gestational age determination was based on the last menstrual period and ultrasonography. The patients were divided as pregnant women with gestational diabetes mellitus and healthy pregnant women.

Inclusion Criteria

Pregnant women between the ages of 18–46 years and at 24–28 weeks of pregnancy.

Exclusion Criteria

Multiple pregnancies, stillbirth, preeclampsia, pregestational diabetes mellitus, hypertension, systemic disorders such as chronic liver and kidney diseases, active smoking, and infection (urinary, respiratory, or gastrointestinal).

Our study was reviewed and prepared in accordance with the "Declaration of Helsinki" and the "Good Clinical Practice Guide." Ethics approval for this study was granted from the Recep Tayyip Erdoğan University Non-invasive Clinical Research Ethics Committee (decision no: 2023/41 date: 14/09/2023).

Statistical Evaluation

Statistical analysis and ratios were made using SPSS 21.0 program. Parameters that fit the normal distribution were compared with Student's t-test, and parameters that did not fit were compared with the Mann-Whitney U test. In the evaluation, $p<0.05$ was considered significant within the 95% confidence interval.

RESULTS

A total of 424 pregnant women were included in the study. Of these pregnant women, 107 (25.2%) were in the GDM group and 317 (74.8%) were in the control group. The differences between the average age, gravida, and parity were statistically significant. The difference between the average gestational ages was not statistically significant. Demographic data of individuals are shown in Table 1.

The differences between the groups in second trimester WBC, neutrophil, basophil, RBC, Hb, Hct, and MCHC averages were found to be statistically significant (Mann-Whitney U test p=0.018, 0.021, 0.02, 0.031, 0.013, 0.000, 0.006). The comparison of the second trimester hemogram parameters of the pregnant women included in the study is shown in Table 2.

Binary logistic regression analysis was performed using age, lymphocyte (Ly), basophil (Ba), hematocrit (Hct), mean corpuscular hemoglobin concentration (MCHC), and neutrophil-lymphocyte ratio (NLR) to determine the risk of GDM. It was determined that age, blood Ba,

Table 1: Demographic data of pregnant women included in the study (Mann-Whitney U test)

	GDM (n=107) Mean±SD	Control (n=315) Mean±SD	Total (n=424) Mean±SD	p
Age	29.84±5.39	32.64±5.04	30.54±5.44	0.000
Gravida	2.2±1.44	2.6±1.47	2.3±1.46	0.003
Parite	0.87±1.03	1.18±1.07	0.94±1.04	0.004
Gestational age /day	178.67±9.47	176.93±8.85	178.24±9.34	0.119

GDM: Gestational diabetes mellitus; SD: Standard deviation.

Table 2: Comparison of 2 trimester hemogram parameters (Mann-Whitney U test)

	Control Mean±SD	GDM Mean±SD	Total Mean±SD	p
WBC (10^3/uL)	10.11±2.2	10.6±2.2	10.23±2.21	0.015
LY (10^3/uL)	1.85±0.45	1.89±0.5	1.86±0.46	0.591
MO (10^3/uL)	0.53±0.15	0.55±0.15	0.54±0.15	0.543
NE (10^3/uL)	7.54±1.89	7.97±1.94	7.65±1.91	0.02
EO (10^3/uL)	0.15±0.1	0.16±0.13	0.15±0.1	0.592
BA (10^3/uL)	0.023±0.012	0.02±0.011	0.022±0.012	0.029
LY%	18.7±4.29	18.26±4.78	18.59±4.42	0.258
MO%	5.33±1.11	5.22±1.17	5.3±1.12	0.15
NE%	74.22±4.76	74.75±5.61	74.36±4.98	0.183
EO%	1.49±0.94	1.54±1.21	1.5±1.01	0.818
BA%	0.23±0.12	0.2±0.1	0.22±0.12	0.015
RBC (10^6/uL)	3.8±0.3	3.87±0.28	3.82±0.3	0.025
HB (g/dL)	11.39±0.95	11.69±0.82	11.46±0.93	0.01
HCT %	34.19±2.72	35.32±2.39	34.48±2.69	0.000
MCV (fl)	90.07±5.88	91.18±4.32	90.35±5.54	0.245
MCH (pg)	30.02±2.28	30.19±1.74	30.07±2.16	0.679
MCHC (g/dL)	33.31±0.95	33.1±0.79	33.26±0.92	0.009
PLT (10^3/uL)	243.67±57.7	241.4±57.11	243.1±57.49	0.822
MPV (fl)	9.98±1.12	9.97±1.19	9.98±1.13	0.497
PCT (%)	0.24±0.05	0.23±0.05	0.23±0.05	0.888
PDW (fl)	16.07±0.34	16.11±0.32	16.08±0.33	0.273
IMG (10^3/uL)	0.15±0.74	0.12±0.12	0.14±0.64	0.786
NRBC (10^3/uL)	0.002±0.033	0.0002±0.0017	0.0016±0.029	0.661
PLCR (%)	25.98±7.9	26.02±8.56	25.99±8.06	0.578
PLCC(10^3/uL)	61.18±18.14	60.32±17.81	60.96±18.04	0.586
NLR	4.24±1.29	4.46±1.49	4.3±1.35	0.238
PLR	137.46±41.44	134.17±39.43	136.63±40.92	0.639

GDM: Gestational diabetes mellitus; SD: Standard deviation; WBC: White blood cell; LY: Lymphocyte; MO: Monocyte; NE: Neutrophil; EO: Eosinophil; BA: Basophil; RBC: Red blood cell; HB: Hemoglobin; Hct: Hematocrit; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; PLT: Platelet; MPV: Mean platelet volume; PCT: Platecrit; PDW: Platelet distribution volume; IMG: Immature granulocyte; NRBC: Nucleated red blood cell; PLCR: Platelet large cell ratio; PLCC: Plasma leukocyte cell count; NLR: Neutrophil lymphocyte ratio; PLR: Platelet lymphocyte ratio.

Hct, and MCHC levels (p=0.001, 0.006, <0.001, and 0.009; Exp(B)=1.1, 0.044, 1.18, and 0.684) showed a statistically significant difference in determining the risk of GDM (Table 3). ROC analysis and specificity and sensitivity values of age, Ba, Hct, and MCHC values are given in Table 4.

DISCUSSION

One of the physiological changes required to maintain a healthy pregnancy is adaptations in glucose metabolism. Glucose sensitivity increases in the early stages of pregnancy, and glucose is stored in adipose tissues to meet the needs of the fetus in the following weeks of pregnancy. In the following weeks of pregnancy, insulin resistance increases under the influence of hormones such as estrogen, progesterone, leptin, cortisol, and placental lactogen.[7] Accordingly, a mild hyperglycemia is achieved in the maternal blood. This physiological adaptation, which is expected to occur in every healthy pregnancy, may lead to the development of GDM in susceptible individuals.

Insulin resistance and chronic hyperglycemia cause low-level systemic inflammation. Immune system cells and pro-inflammatory cytokines play an important role in controlling this inflammation. Due

Table 3: Logistic regression analysis of age, gravity, parity, WBC, RBC, Hb, Hct, Neu, Ba and MCHC in determining the risk of GDM

Variable	(B)	SE	z	p	(Exp(B))	Min	Max
(Cut point)	-1.419	5.778	-0.246	0.806	0.242	0	20041.49
Age	0.096	0.023	4.232	<0.001	1.1	1.053	1.15
LY	0.157	0.088	1.784	0.074	1.17	0.985	1.39
BA	-3.133	1.1	-2.848	0.004	0.044	0.005	0.376
Hct	0.169	0.048	3.493	<0.001	1.184	1.077	1.302
MCHC	-0.38	0.145	-2.613	0.009	0.684	0.514	0.909
NLR	0	0	1.568	0.117	1	1	1.001

GDM: Gestational diabetes mellitus; SE: Standard error; WBC: White blood cell; RBC: Red blood cell; LY: Lymphocyte; BA: Basophil; HB: Hemoglobin; Hct: Hematocrit; MCHC: Mean corpuscular hemoglobin concentration; NLR: Neutrophil lymphocyte ratio; Min: Minimum; Max: Maximum.

Table 4: ROC analyses of parameters related to GDM

	AUC	Sensitivity	Specificity	Cut off value
Age	0.66	0.67	0.61	30.5
Basophile	0.42	0.96	0.04	0.05
Hct	0.61	0.63	0.56	34.6
MCHC	0.58	0.80	0.37	33.6

ROC: Receiver operating characteristic; GDM: Gestational diabetes mellitus; AUC: Area under curve; MCHC: Mean corpuscular hemoglobin; Hct: Hematocrit.

to the high costs and difficulties in measuring these pro-inflammatory cytokines, research has focused on the relationship of blood inflammatory cells with GDM. The results of studies investigating the relationship of various inflammatory markers with GDM have yielded different results. High leukocyte levels in early pregnancy have been found to be associated with the development of GDM.[8] There are also studies that detect a relationship with other inflammatory parameters, such as platelet-lymphocyte ratio and neutrophil-lymphocyte ratio.[9,10] Similarly, inflammation-related parameters such as MPV, platelet, and plateletcrit (PCT) have been found to be associated with GDM.[6] Contrary to these, there are also studies showing that changes in GDM and CBC parameters are not related to GDM.[11] One study shows that while the neutrophil-lymphocyte ratio is high in GDM patients, the platelet-lymphocyte ratio, another inflammatory parameter, is not related.[12] The data obtained in our study show that WBC, neutrophil, and basophil counts are higher in GDM patients.

Both high and low Hb concentration may be associated with complications in pregnancy. High Hb levels have been identified as a risk factor for GDM.[13,14] Moreover, the risk of GDM seems to decrease in pregnant women with iron deficiency.[15] Iron is an essential element that plays important roles in many physiological reactions. For this reason, iron deficiency is an important health problem in pregnant women, and iron supplementation is routinely recommended for pregnant women in many countries.[16] However, excess iron stored in the body can also pose a risk for many diseases because reactive oxygen radicals are synthesized at high iron levels. This situation causes oxidative stress. Data showing that pancreatic beta cells are sensitive to oxidative stress seem to be parallel to the increase in the risk of GDM.[17] Chronic inflammation due to oxidative stress may be another underlying cause. Another risk of high Hb levels may be problems related to increased blood viscosity. Increased viscosity negatively affects the transmission between the fetoplacental unit and the fetus and mother. Negative effects on this placental exchange may lead to complications such as low birth weight, preeclampsia, GDM, and stillbirth. The data obtained in our study show that Hb, Hct, and RBC levels in GDM patients are higher than in healthy pregnant women.

The regression analysis we conducted in our study shows that advanced age and low Ba values can be used to predict the risk of GDM. In the literature, advanced age is considered a risk factor for GDM.[18] In addition, there is data showing that Ba values are low in GDM patients.[19] The literature also suggests a relationship between MCHC and GDM,[20] particularly indicating that the risk of GDM seems to increase after the age of 30.5 years. If low Ba values are detected in older pregnant women, these patients should be carefully evaluated for GDM. In the current study, mean Ba levels of the GDM and control groups were 0.002 and 0.0023 $10^3/\mu L$. Additionally, Hct and MCHC values were very close between the control and GDM groups. In the ROC analyses of the basophil, Hct, and MCHC, sensitivity or specificity were low. Therefore, while the differences were found to be statistically significant, low sensitivity or specificity makes them less useful for clinical practice.

Studies provide varying results when examining the prevalence of GDM and changes in various CBC parameters. The reasons for these differences may be due to the different diagnostic tests applied or genetic and environmental differences in the screened population. This variability complicates the use of CBC parameters in the diagnosis of GDM. It is also possible that statistically significant results may not be clinically significant. Therefore, more research and examination are needed before a definitive threshold value of any parameter can be used in the diagnosis of GDM.

CONCLUSION

According to logistic regression analyses, advanced age, Hct, Ba, and MCHC levels could be used for predicting GDM. Additionally, high Hb, RBC, WBC, and neutrophil concentrations seem to be associated with GDM. However, none of these parameters appear to be useful for clinical practice.

Statement

Acknowledgments: We want thank to dear Associate Prof. Dr. Mehmet KIVRAK to statistical evaluations.

Ethics Committee Approval: The Recep Tayyip Erdoğan University Non-invasive Clinical Research Ethics Committee granted approval for this study (date: 14.09.2023, number: 2023/41).

Author Contributions: Concept – MK, NK, DDD, ŞŞ; Design – MK, NK, DDD, ŞŞ; Supervision – MK, ŞŞ; Resource – MK, NK, DDD, ŞŞ; Materials – MK, NK, DDD, ŞŞ; Data Collection and/or Processing – MK, NK, DDD, ŞŞ; Analysis and/or Interpretation – MK, ŞŞ; Literature Search – MK, NK, DDD, ŞŞ; Writing – MK; Critical Reviews – MK, NK, DDD, ŞŞ.

Conflict of Interest: The authors have no conflict of interest to declare.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Use of AI for Writing Assistance: Not declared.

Financial Disclosure: The authors declared that this study has received no financial support.

Peer-review: Externally peer-reviewed.

REFERENCES

1. Chiefari E, Arcidiacono B, Foti D, Brunetti A. Gestational diabetes mellitus: An updated overview. J Endocrinol Invest 2017;40:899–909.
2. Zhu Y, Zhang C. Prevalence of gestational diabetes and risk of progression to type 2 diabetes: A global perspective. Curr Diab Rep 2016;16:7.
3. ACOG Practice Bulletin No. 190: Gestational diabetes mellitus. Obstet Gynecol 2018;131:e49–64.
4. Barut B, Gönültaş F, Gök AFK, Şahin TT. Management of acute cholecystitis during pregnancy: A single center experience. Ulus Travma Acil Cerrahi Derg 2019;25:154–8.
5. Çınar H, Aygün A, Derebey M, Tarım İA, Akalın Ç, Büyükakıncak S, et al. Significance of hemogram on diagnosis of acute appendicitis during pregnancy. Ulus Travma Acil Cerrahi Derg 2018;24:423–8.
6. Fashami MA, Hajian S, Afrakhteh M, Khoob MK. Is there an association between platelet and blood inflammatory indices and the risk of gestational diabetes mellitus? Obstet Gynecol Sci 2020;63:133–40.
7. Plows JF, Stanley JL, Baker PN, Reynolds CM, Vickers MH. The pathophysiology of gestational diabetes mellitus. Int J Mol Sci 2018;19:3342.
8. Wang L, Li W, Zhang S, Liu H, Li W, Hu T, et al. Association of leukocyte counts in the first trimester with glucose intolerance during pregnancy. J Diabetes Investig 2022;13:191–200.
9. Sargın MA, Yassa M, Taymur BD, Celik A, Ergun E, Tug N. Neutrophil-to-lymphocyte and platelet-to-lymphocyte ratios: Are they useful for predicting gestational diabetes mellitus during pregnancy? Ther Clin Risk Manag 2016;12:657–65.
10. Atak B, Aktas G, Duman TT, Erkus E, Kocak MZ, Savli H. Diabetes control could through platelet-to-lymphocyte ratio in hemograms. Rev Assoc Med Bras (1992) 2019;65:38–42.
11. Hassan B, Rayis DA, Musa IR, Eltayeb R, ALhabardi N, Adam I. Blood groups and hematological parameters do not associate with first trimester gestational diabetes Mellitus (Institutional Experience). Ann Clin Lab Sci 2021;51:97–101.
12. Hessami K, Tabrizi R, Homayoon N, Hashemi A, Heydari ST, Pourhoseini SA. Gestational diabetes mellitus and inflammatory biomarkers of neutrophil-lymphocyte ratio and platelet-lymphocyte ratio: A systematic review and meta-analysis. Biomarkers 2021;26:491–8.
13. Wu K, Ke HH, Gong W, Hu H, Chen L. Impact of pre-pregnancy hemoglobin level on the association between pre-pregnancy body mass index and gestational diabetes mellitus: A retrospective cohort study in a single center in China. Diabetes Metab Syndr Obes 2022;15:3767–75.
14. Young MF, Oaks BM, Tandon S, Martorell R, Dewey KG, Wendt AS. Maternal hemoglobin concentrations across pregnancy and maternal and child health: A systematic review and meta-analysis. Ann N Y Acad Sci 2019;1450:47–68.
15. Lao TT, Ho LF. Impact of iron deficiency anemia on prevalence of gestational diabetes mellitus. Diabetes Care 2004;27:650–6.
16. Zhang Y, Lu Y, Jin L. Iron metabolism and ferroptosis in physiological and pathological pregnancy. Int J Mol Sci 2022;23:9395.
17. Tang D, Chen X, Kang R, Kroemer G. Ferroptosis: Molecular mechanisms and health implications. Cell Res 2021;31:107–25.
18. Beyene FY, Kassa BG, Mihretie GN, Ayele AD. Gestational diabetes mellitus and its associated factors in Ethiopia: A systematic review and meta-analysis. Eur J Med Res 2023;28:125.
19. Zhang Y, Zhang Y, Zhao L, Shang Y, He D, Chen J. Distribution of complete blood count constituents in gestational diabetes mellitus. Medicine (Baltimore) 2021;100:e26301.
20. Abrar S, Lodhi FS, Aman T, Hanif M, Shujaat N, Abas H, et al. Variation in haematological profile of pregnant women attending combined military hospital quetta. J Ayub Med Coll Abbottabad 2019;31:196–200.