Jinekoloji - Obstetrik ve Neonatoloji Tıp Dergisi
The Journal of Gynecology-Obstetrics and Neonatology

ÖZGÜN ARAŞTIRMA / ORIGINAL ARTICLE

DOI: 10.38136/jgon.1362074

Prediction of gestational diabetes by second trimester complete blood count derived inflammatory markers

İkinci trimester tam kan sayımından elde edilen inflamatuar belirteçler ile gestasyonel diyabetin öngörülmesi

Şebnem KARAGÜN[1], Yusuf DAL[1], Sadık KÜKRER[2], Ayhan COŞKUN[1]

[1]Department of Obstetrics and Gynecology, Perinatology Department, Mersin University Faculty of Medicine, Mersin, Turkey
[2]University of Health Sciences Turkey, Adana City Training and Research Hospital, Clinic of Obstetrics and Gynecology, Adana, Turkey

ABSTRACT

Aim: To investigate the predictive ability of routine complete blood count (CBC) derived inflammatory markers on gestational diabetes mellitus (GDM) in the second trimester.

Materials and Methods: A total of 181 patients whose routine CBC was measured between 14 and 24 weeks of gestation were divided into two groups according to a 75 g oral glucose tolerance test (OGTT) results. The first group consisted of 99 women with GDM, while the second group included 82 women with normal glucose tolerance (NGT). The groups were compared with regard to mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT), immature granulocyte count, delta neutrophil index (DNI), neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR) and Systemic Immune-Inflammation Index (SII).

Results: PDW, immature granulocyte count, NLR, PLR and SII were higher in the GDM group. However, no statistically significant difference was identified. Mean values of DNI were lower in women with GDM compared to those with NGT, although not statistically significant (0.84 versus 0.99, p =0.742).

Conclusion: Our findings revealed that utilizing inflammatory CBC markers during the second trimester as a pre-screening test is not a reliable approach for predicting GDM.

Keywords: Complete blood count; Delta Neutrophil Index; gestational diabetes mellitus; inflammatory markers; prediction.

ÖZ

Amaç: Rutin tam kan sayımından (CBC) elde edilen inflamatuar belirteçlerin ikinci trimesterde gestasyonel diabetes mellitus (GDM) üzerindeki prediktif yeteneğini araştırmak.

Gereç ve Yöntem: Rutin tam kan sayımı (CBC) 14 ila 24. gebelik haftaları arasında ölçülen toplam 181 hasta, 75 g OGTT sonuçlarına göre iki gruba ayrıldı. 99 kadın GDM ve 82 kadın normal glukoz toleransına (NGT) sahipti. Gruplar ortalama trombosit hacmi (MPV), trombosit dağılım genişliği (PDW), trombositokrit (PCT), olgunlaşmamış granülosit sayısı, delta nötrofil indeksi (DNI), nötrofil/lenfosit oranı (NLR), trombosit/lenfosit oranı (PLR) ve Sistemik İmmün-İnflamasyon İndeksi (SII) açısından karşılaştırıldı.

Bulgular: GDM grubunda PDW, immatür granülosit sayısı, NLR, PLR ve SII daha yüksekti, ancak istatistiksel olarak anlamlı bir fark gözlenmedi. Ortalama DNI değerleri GDM'li kadınlarda NGT'ye göre daha düşüktü, ancak istatistiksel olarak anlamlı değildi (0,84›e karşı 0,99, p =0,742).

Sonuç: Bulgularımız, tarama testi öncesinde ikinci trimester inflamatuar CBC parametrelerinin kullanılmasının GDM'yi öngörmede doğru bir yöntem olmadığını ortaya koymuştur.

Anahtar Kelimeler: Tam kan sayımı, delta nötrofil index, gestasyonel diyabet öngörüsü

Cite as: Karagün Ş, Dal Y, Kükrer S, Coşkun A. Prediction of gestational diabetes by second trimester complete blood count derived inflammatory markers. Jinekoloji-Obstetrik ve Neonatoloji Tıp Dergisi 2024;21(4):323–328.

Geliş/Received: 20.09.2023 • **Kabul/Accepted:** 20.08.2024

Sorumlu Yazar/Corresponding Author: Şebnem KARAGÜN, Department of Obstetrics and Gynecology, Perinatology Department, Mersin University Faculty of Medicine, TR-33110, Mersin, Türkiye
E-mail: karagunsebnem@gmail.com

Çevrimiçi Erişim/Available online at: https://dergipark.org.tr/tr/pub/jgon

INTRODUCTION

Any degree of glucose intolerance that begins or is first noticed during pregnancy is described as gestational diabetes mellitus (GDM) (1) . GDM affects approximately 7% of all pregnancies worldwide, and the diagnosis of type 2 diabetes mellitus increases by up to 70% during follow-up (2, 3). Long-term complications of diabetes load a serious financial burden and require multidisciplinary teamwork (4). Positive linear associations have been found between glucose exposure and short-term adverse consequences of gestational diabetes, such as cesarean section, induction of labour, macrosomia, and shoulder dystocia (5). Once the diagnosis is confirmed, there is limited time to prevent and manage the complications. Predicting GDM prior to the diagnostic tests will extend this limited time and allow patients with risk factors to modify their lifestyle.

Hyperglycemic and insulin-resistant conditions have been shown to cause the release of a number of maternal inflammatory markers (6). This increase in pro-inflammatory cytokines has been demonstrated even low-intensity hyperglycaemic conditions not qualified as GDM (7). The effect of inflammation on complete blood count (CBC) parameters in the 2nd trimester were also studied (8, 9). Although the platelet/lymphocyte and neutrophil/lymphocyte ratios (PLR and NLR, respectively) are considered indicators of subclinical inflammation and predictive markers in prediabetes and diabetes mellitus, investigations on their predictive value in GDM have yielded conflicting results (10-14). Most researchers have investigated platetalet related markers such as platelet count, mean platelet volume (MPV), platelet distribution width (PDW), plateletcrit (PCT) for early detection of GDM (9, 15, 16). The Systemic Immune-Inflammation Index (SII) as a new inflammatory marker, has been studied in the first trimester in GDM (17). The Delta Neutrophil Index (DNI), which reflects the ratio of circulating immature granulocytes to the total neutrophil count, was observed to be elevated at 37 weeks of gestation (18).

The primary goal of this retrospective study is to determine whether routine CBC derived inflammatory markers measured in the second trimester could predict GDM.

METHODS

This is a retrospective case–control study. Pregnant women who attended the obstetrics outpatient clinic at Mersin University Faculty of Medicine between January 2021 and June 2022 were included in the study. The study protocol was approved by the Ethics Committee of Mersin University (no:2023/41), and was carried out in accordance with the Helsinki Declaration. Informed consent was not obtained as data were analyzed anonymously. Data were collected from 181 pregnancies in women attending for gestational diabetes screening between 24-28 weeks of pregnancy, with 99 women having GDM (54.7%) and 82 women with normal glucose tolerance (NGT, 45.3%). The inclusion criteria were (1) age between 18 and 43 years; (2) singleton pregnancy; (3) having a CBC for routine control in our clinic between the 14th and 24th weeks of pregnancy; (4) basic demographic and clinical data were complete; (5) the embryo size was consistent with the gestational age. Exclusion criteria were as follows: (1) multiple pregnancy; (2) known fetal malformations; (3) preexisting diabetes, thyroid or other endocrine diseases; (4) cardiovascular diseases; (5) acute and chronic inflammatory diseases in pregnancy.

We perform one-step approach for universal screening after overnight fast in all women not previously found to have overt diabetes or GDM during testing earlier in this pregnancy. GDM was diagnosed in according with the International Association of Diabetes and Pregnancy Study Groups (IADPSG) by performing a 75-g oral glucose tolerance test (OGTT) (19). Women were diagnosed with GDM if one of the following was abnormal, including fasting plasma glucose level ≥92 mg/dL, 1-hour value ≥180 mg/dL, or 2-h value ≥153 mg/dL.

In this study, venous blood samples were collected from all pregnant women from 14 weeks to 24 weeks of pregnancy for routine monitoring. Patients with local or active systemic infection were not included in the study. Venous blood samples were drawn into 3-mL EDTA tubes (Samplix®, Greiner Bio One, Austria). Complete blood count was analyzed using an automated haematology analyser (Beckman Coulter Gen-S system device). DNI (%) (the sub-fraction of leukocytes tested by cytochemical reaction in the MPO channel) was calculated by a flow cytometry-based hematological analyzer.

Medical records were retrospectively analysed for clinical data such as maternal age, weight, height, gestational age at diagnosis, neonatal outcomes, maternal white blood cell (WBC) count, neutrophil, lymphocyte, and platelet counts, MPV, PCT, immature granulocytes, and delta neutrophil index (DNI). Neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, SII index [(Platelet counts x Absolute Neutrophil Counts (ANC)/Absolute Lymphocyte Counts (ALC))/1000], Body mass index (BMI) [weight (kg)/height $(m)^2$] were calculated.

SPSS (Statistical Package for the Social Sciences) 25.0 program was used for statistical analysis of the data. Categorical measures were summarised as numbers and percentages, and continuous measurements as mean and standard deviation (median and minimum-maximum where appropriate). The Shapiro-Wilk test

was used to determine whether the variables in the study showed a normal distribution. The Independent Student's t-test was used for normally distributed variables, and the Mann-Whitney U test was used for pairwise group analyzes for non-normally distributed variables. The Pearson correlation test was used to determine the relationship between continuous measurements. A p-value ≤ 0.05 with confidence intervals at 95% was considered as statistically significant in all analyses.

RESULTS

A total of 181 pregnant women (82 with NGT and 99 with GDM) who gave blood for a routine CBC test between 14 and 24 weeks of gestation met the inclusion criteria for this study. There was no statistically significant difference between the two groups in terms of maternal demographics and neonatal outcomes, except for the BMI, which was higher in the GDM group (Table 1).

Hematological parameters are depicted in Table 2. No statistically significant differences were found between the two groups in WBC, neutrophil, lymphocyte, RBC, and platelet counts, hemoglobin concentration, hematocrit and MPV values. PDW, immature granulocyte count, NLR, PLR and SII were higher in the GDM group, but no statistically significant difference was observed. Mean values of DNI were lower in women with GDM than in those with NGT, although not statistically significant (0.84 versus 0.99, p =0.742).

The correlations between DNI and SII values and immature granulocyte count were evaluated in GDM group (Table 3). There was no correlation between DNI, SII and immature granulocytes (p>0.05).

Table 1. Patient characteristics and neonatal results (mean ± SD)

	GDM group (n=99)	NGT group (n=82)	*p* value
Age (years)	33.3 ± 5.6	30.7 ± 5.1	**0.002****,a
Gravida	2.97 ± 1.6	2.79 ± 1.7	0.343[b]
Parity	1.40 ± 1.2	1.21 ± 1.2	0.251[b]
BMI (kg/m^2)	30.8 ± 5.3	23.6 ± 2.9	**<0.001****,b
Gestational age at delivery (weeks)	38.1 ± 1.5	38.4 ± 1.3	0,192[a]
Birthweight of neonate (g)	3294.9 ± 535.4	3240.5 ± 444.7	0.566[a]
1-minute Apgar score	7.81 ± 1.6	7.56 ± 1.5	0.246[b]
5-minute Apgar score	9.19 ± 1.1	9.06 ± 1.1	0.403[b]
Cord blood pH	7.30 ± 0.08	7.32 ± 0.06	0.067[b]

* p<0.,05, **p<0.001, a: Independent student T-test, b: Mann-Whitney U test

Table 2. Comparison of hematological parameters between groups (mean ± SD)

Routine CBC parmeters	GDM group (n=99)	NGT group (n=82)	*p* value
White blood cell count (WBC) (x10^9/L)	9.89 ± 2.4	9.83 ± 2.2	0.860[a]
Neutrophil count (NEUT) (x10^9/L)	7.21 ± 2.1	7.00 ± 1.9	0.487[a]
Lymphocyte count (LYMPH) (x10^9/L)	1.88 ± 0.5	1.99 ± 0.5	0.199[b]
Monocyte count (MONO) (x10^9/L)	0.62 ± 0.2	0.65 ± 0.2	0.210[a]
Red blood cell count (RBC) (x10^{12}/L)	4.07 ± 0.4	3.98 ± 0.4	0.117[a]
Hemoglobin (HGB) g/dL	11.7 ± 1.1	11.5 ± 1.1	0.219[a]
Hematocrit (HCT), %	34.4 ± 2.6	33.9 ± 2.9	0.214[a]
Platelet count (PLT) (x10^9/L)	233.5 ± 67.5	249.3 ± 64.7	0.071[b]
Platelet distribution width (PDW), fL	12.8 ± 2.5	12.3 ± 2.3	0.105[b]
Mean platelet volume (MPV), fL	10.7 ± 0.9	10.7 ± 1.0	0.714[a]
Plateletocrit (PCT), %	0.25 ± 0.07	0.26 ± 0.06	0.503[a]
Immature granulocyte count	0.10 ± 0.12	0.096 ± 0.088	0.906[b]
DNI (%)	0.84 ± 0.51	0.99 ± 0.92	0,742[b]
NLR	4.14 ± 1.9	3.63 ± 1.2	0.071[b]
PLR	131.8 ± 47.4	129.4 ± 38.6	0.991[b]
SII	966.8 ± 572.9	913.3 ± 385.3	0.966[b]

p<0.05 a: Independent t-test b: Mann-Whitney U test

Table 3. Correlation analysis between DNI ,SII and immature granulocytes in the GDM group

GDM (n=99)	DNI		SII	
	r	p	r	p
SII	-0.032	0.750		
Immature granulocyte count	-0.138	0.174	0.166	0.100

Table 4. Effects on SII and DNI on age, BMI and GDM variables: Regression Analysis.

Dependent Variable SII		**Standardized Coefficients**	**p value**	**95.0% Confidence Interval for B**	
		Beta		Lower Bound	Upper Bound
	Age (years)	0,180	**0,019**	-29,697	-2,692
	BMI (kg/m²)	0,034	0,718	-13,542	19,621
	GDM	0,069	0,477	-121,137	257,979
Dependent Variable DNI		**Standardized Coefficients**	**p value**	**95.0% Confidence Interval for B**	
		Beta			B
	Age (years)	0,067	0,396	-,012	,029
	BMI (kg/m²)	0,101	0,303	-,038	,012
	GDM	0,102	0,303	-,136	,435

Significant at the p<0.05 level. Bold p values indicate statistically significant.

Table 4 shows the results of a regression analysis using SII and DNI as dependent variables and age and BMI as independent variables in the GDM group. SII dependent variable only the coefficient of the age variable is significant (p<0.05). The coefficient of age is -16,195, indicating that with an increase in age by one year, SII decreases by an average of 16,195 units. The coefficients of the other variables are not significant (p>0.05).

DISCUSSION

The major findings of the present study demonstrated that routine CBC-derived inflammatory markers measured between 14th and 24th weeks of pregnancy are not effective to predict future development of GDM. To the best of our knowledge, this study is the first to demonstrate that predicting GDM using the CBC inflammatory markers PLR, NLR, and SII is not a reliable strategy.

The results of this study confirm previous reports that raised maternal BMI is a risk factor for the onset of GDM (20). In a meta-analysis with 120 million participants, the risk of GDM increased linearly with advanced maternal age (21). This result was consistent with our findings.

Based on the literature showing that insulin resistance is the main determinant of platelet activation in female obesity (22), platelet indices in the prediction of GDM has received much attention in recent years (23, 24). A meta-analysis from China demonstrated that MPV was significantly increased in GDM (15), but in subgroup analysis, significantly increased MPV was observed in the third trimester, while the difference did not reach statistical significance during the second trimester. In our study, second trimester MPV values were not increased, either. In a study investigating the relationship between maternal age and MPV value in the prediction of GDM, no significant difference was found in the MPV value in pregnant women younger than 28 years old (24). Huang et al. showed that the diagnostic accuracy of PCT in prediction of GDM is low (23). Similar to our findings, Gorar et al. found no significant difference in PDW levels and platelet counts (25). The results of platelet parameters in GDM are inconsistent depending on the gestational week, maternal age and pre-pregnancy inflammatory status.

In a study evaluating the number of immature granulocytes in GDM, no significant difference was found at the time of OGTT (26), while Uysal et al. found significant difference in DNI at the delivery stage (18) DNI and immature granulocyte counts in the second trimester

were not significant in our study. Sargın et al. claimed that NLR and PLR from the CBC results done on the same day as OGTT can not be used to screen for GDM (p=0.911, p=0.416) (12). However, in a relatively small cohort from China, PLR, NLR, and MPV were found to be independent predictors of GDM development (11). In first trimester studies SII value has been shown to be statistically significant in predicting GDM (17, 27). A subclinical inflammation that existed prior to pregnancy may be the cause of first trimester high SII levels. In a larger study, no significant difference was observed in MPV, PLR, NLR and SII values measured simultaneously with OGTT (28).

As demonstrated by the discordant results reported by the studies described above, the results of our study showed that none of the CBC-derived inflammatory parameters made a significant prediction of GDM. GDM is a state of transient hyperglycemia during pregnancy. Soon after delivery, the majority of GDM patients' blood glucose levels return to normal. While GDM and DM share several inflammatory pathways, the intensity of the inflammatory processes in GDM differ. In GDM, the severity of chronic low-grade inflammation is related to advanced maternal age, obesity, and the presence of underlying PCOS (polycystic ovary syndrome). As a result, in low-risk populations, CBC inflammatory markers might have no reliable predictive value for the development of GDM.

There are several limitations in the present study worthy of mention. First, the study was retrospective and included only tertiary center experience. Another limitation was the small number of participants. This might have precluded to discern subtle differences in terms of inflammatory markers in GDM patients. Larger prospective studies are needed for early prediction of GDM. The fact that we did not include patients with impaired pre-pregnancy glucose metabolism by following strict criteria in patient selection, screening with only one-step 75-gr OGTT, and the ethnic composition of the population may be some of the reasons why we found different results in the literature on this topic.

In conclusion, our main objective was to investigate the predictive value of inflammatory markers in routine CBC for the early detection of GDM. According to our study, CBC-derived inflammatory parameters were not sufficiently reliable to predict the future development of GDM.

Ethics Committee Aproval

The study protocol was approved by the Ethics Committee of Mersin University (no:2023/41), and was carried out in accordance with the Helsinki Declaration.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Funding

The authors have not disclosed any funding.

Data Availability

Data availability is supplied up on request.

REFERENCES

1. Diagnosis and classification of diabetes mellitus. American Diabetes Association - Diabetes care. 2010;33(Supplement_1):S62-S9.
2. Eades CE, Cameron DM, Evans JMM. Prevalence of gestational diabetes mellitus in Europe: A meta-analysis. Diabetes research and clinical practice. 2017;129:173-81.
3. Ferrara A. Increasing prevalence of gestational diabetes mellitus: a public health perspective. Diabetes care. 2007;30 Suppl 2:S141-6.
4. Karagun B, Akkus G, Sengoz S, Evran M, Sert M, Tetiker T. Hospitalization costs associated with diabetic foot ulcers treated by a multidisciplinary team in clinical practice. A retrospective study from southern Turkey. Annali italiani di chirurgia. 2021;92:87-91.
5. Farrar D, Simmonds M, Bryant M, Sheldon TA, Tuffnell D, Golder S, et al. Hyperglycaemia and risk of adverse perinatal outcomes: systematic review and meta-analysis. BMJ (Clinical research ed). 2016;354:i4694.
6. McElwain CJ, McCarthy FP, McCarthy CM. Gestational Diabetes Mellitus and Maternal Immune Dysregulation: What We Know So Far. International journal of molecular sciences. 2021;22(8).
7. Corrêa-Silva S, Alencar AP, Moreli JB, Borbely AU, Lima LdS, Scavone C, et al. Hyperglycemia induces inflammatory mediators in the human chorionic villous. 2018;111:41-8.
8. Shaarbaf Eidgahi E, Nasiri M, Kariman N, Safavi Ardebili N, Salehi M, Kazemi M, et al. Diagnostic accuracy of first and early second trimester multiple biomarkers for prediction of gestational diabetes mellitus: a multivariate longitudinal approach. BMC pregnancy and childbirth. 2022;22(1):13.
9. 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? Obstetrics & gynecology science. 2020;63(2):133-40.
10. Mertoglu C, Gunay M. Neutrophil-Lymphocyte ratio and Platelet-Lymphocyte ratio as useful predictive markers of prediabetes and diabetes mellitus. Diabetes & metabolic syndrome. 2017;11 Suppl 1:S127-s31.
11. Liu W, Lou X, Zhang Z, Chai Y, Yu Q. Association of neutrophil to lymphocyte ratio, platelet to lymphocyte ratio, mean platelet volume with the risk of gestational diabetes mellitus. Gynecological endocrinology : the official journal of the International Society of Gynecological Endocrinology. 2021;37(2):105-7.
12. 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? Therapeutics and clinical risk management. 2016;12:657-65.
13. 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 : biochemical indicators of exposure, response, and susceptibility to chemicals. 2021;26(6):491-8.
14. Pratama R, Cristobal RJ. Association of inflammatory and hemogram parameters to gestational diabetes mellitus: Predictive value for early diagnosis during pregnancy. European Journal of Obstetrics Gynecology Reproductive Biology. 2019;234:e61.
15. Zhou Z, Chen H, Sun M, Ju H. Mean Platelet Volume and Gestational Diabetes Mellitus: A Systematic Review and Meta-Analysis. Journal of diabetes research. 2018;2018:1985026.
16. Xiang LL, Chen C, Wang QY, Zhu YT, Chen YJ, Zeng Y. Impact of inflammatory factors, hemoglobin A1c, and platelet parameters in gestational diabetes mellitus. Archives of gynecology and obstetrics. 2023;307(2):439-46.

17. Lyu X, Jia J, Yang H, Deng Y, Wu H, Wang S, et al. Hematological Parameters in the First Trimester and the Risk of Gestational Diabetes Mellitus - Beijing, China, 2017-2020. China CDC weekly. 2023;5(9):194-200.
18. Şahin Uysal N, Eroğlu H, Özcan Ç, Şahin D, Yücel A. Is the serum delta neutrophil index level different in gestational diabetic women? The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet. 2020;33(19):3349-54.
19. Metzger BE, Gabbe SG, Persson B, Buchanan TA, Catalano PA, Damm P, et al. International association of diabetes and pregnancy study groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. Diabetes care. 2010;33(3):676-82.
20. Martin KE, Grivell RM, Yelland LN, Dodd JM. The influence of maternal BMI and gestational diabetes on pregnancy outcome. Diabetes research and clinical practice. 2015;108(3):508-13.
21. Li Y, Ren X, He L, Li J, Zhang S, Chen W. Maternal age and the risk of gestational diabetes mellitus: A systematic review and meta-analysis of over 120 million participants. Diabetes research and clinical practice. 2020;162:108044.
22. Basili S, Pacini G, Guagnano MT, Manigrasso MR, Santilli F, Pettinella C, et al. Insulin resistance as a determinant of platelet activation in obese women. Journal of the American College of Cardiology. 2006;48(12):2531-8.
23. Huang Y, Chen X, You ZS, Gu F, Li L, Wang D, et al. The value of first-trimester platelet parameters in predicting gestational diabetes mellitus. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet. 2022;35(11):2031-5.
24. Colak E, Ozcimen EE, Ceran MU, Tohma YA, Kulaksızoglu S. Role of mean platelet volume in pregnancy to predict gestational diabetes mellitus in the first trimester. The journal of maternal-fetal & neonatal medicine : the official journal of the European Association of Perinatal Medicine, the Federation of Asia and Oceania Perinatal Societies, the International Society of Perinatal Obstet. 2020;33(21):3689-94.
25. Gorar S, Abanonu GB, Uysal A, Erol O, Unal A, Uyar S, et al. Comparison of thyroid function tests and blood count in pregnant women with versus without gestational diabetes mellitus. The journal of obstetrics and gynaecology research. 2017;43(5):848-54.
26. Aytan P, Babuş SB, Sakarya Ö, Çiftçi RS, Aytan H. Can A Simple Complete Blood Count Predict Gestational Diabetes Mellitus? Journal of Contemporary Medicine. 2020;10(3):336-41.
27. Akdulum MFC, DEMİRDAĞ E, SAHİLA S, Erdem M, Erdem A. Predicting Gestational Diabetes Mellitus Using The Systemic Immune-Inflammation Index in The First Trimester. Journal of Contemporary Medicine. 2022;12(5):617-20.
28. Cirakli ZL, Gulec N. Evaluation of White Blood-cell-based Inflammatory Markers in Gestational Diabetes Mellitus. Medical Journal of Bakirkoy. 2022;18(2).