Experimental
&
Clinical Article

Obstetrics; *Maternal Fetal Medicine and Perinatology*

The Role of Systemic Inflammation Response Index for Predicting the Prognosis of Threatened Miscarriage

Gokce GOKKAYA[1], Zehra VURAL YILMAZ[2], Elif YILMAZ,[3]

Duzce, Türkiye

ABSTRACT

OBJECTIVE: To investigate the value of the systemic inflammation response index (SIRI) in predicting prognosis in pregnant women with threatened miscarriage (TM).

STUDY DESIGN: The study included 203 pregnant women (≤12 weeks) who presented and were hospitalized with TM in our hospital. Eighty-three pregnant women with spontaneous abortions comprised the study group, and 120 women with healthy pregnancies comprised the control group. Demographic and laboratory parameters were obtained from the patients' medical records. SIRI was calculated using the formula: neutrophil count × monocyte count/lymphocyte count. SIRI values were compared between groups.

RESULTS: The rate of spontaneous abortion in pregnant women with TM was 40.9% in our study population. The SIRI level was found to be significantly higher in the study group than in the control group ($p<0.001$). The regression analysis showed that the SIRI level is an independent marker for spontaneous abortion, and it was found that when the SIRI level increases by 1 unit, the risk of abortion increases by 25.4% (OR=1.254, p=0.003). We found that, with a cut-off value of 2.11, SIRI predicted spontaneous abortion with 68.7% sensitivity and 65.8% specificity.

CONCLUSION: The SIRI level, a non-invasive, simple, and cheap marker, could be used to assess the spontaneous abortion risk of pregnant women presenting with TM. However, future studies with a larger number of patients and serial measurements of the SIRI level are needed to determine the optimal value for predicting the disease.

Keywords: Abortus; Inflammation; Neutrophil/Lymphocyte ratio; Systemic inflammation response index; Threatened miscarriage;

Gynecol Obstet Reprod Med 2025;31(3):199-205

Introduction

Threatened Miscarriage (TM) is defined as vaginal spotting and/or bleeding without cervical dilatation and effacement before 20 weeks of gestation. It is commonly seen in the first 12 weeks of pregnancy and affects 20-50% of pregnant women (1). Approximately 50% of pregnant women diagnosed with TM experience spontaneous abortion in subsequent periods of their pregnancy. It is also known that pregnancies diagnosed with TM but not resulting in spontaneous abortion also suffer from many adverse pregnancy outcomes, such as low birth weight, preterm delivery, and perinatal death (2).

Although chromosomal abnormalities are the most common cause of spontaneous abortion, many other pathologies may lead to this condition. The exact pathophysiology of TM is still unknown (3). Trophoblast invasion into the maternal decidua during the first trimester is considered a key process for embryonic development and a healthy pregnancy (4), and reduced or impaired vascular invasion results in decreased placental blood flow, leading to placental insufficiency and oxidative stress. Placental ischemia and oxidative stress cause an inflammatory response. They might result in placental developmental abnormalities, which can lead to obstetric complications, such as spontaneous abortion, fetal growth restriction, and later preeclampsia (5,6). One of the hypotheses about

[1] Duzce Ataturk State Hospital, Duzce, Türkiye
[2] Republic of Turkey Ministry of Health Etlik City Hospital, Ankara, Türkiye
[3] Ataturk Sanatoryum Training and Research Hospital, Ankara, Türkiye

Address of Correspondence: *Gokce Gokkaya*
Duzce Ataturk State Hospital, Aziziye, Sht.Ramazan Gel St. No:7, 81010 Duzce Türkiye
eggokkayaa@gmail.com

Submitted for Publication: 18.03.2025 Revised for Publication: 11.05.2025
Accepted for Publication: 09.10.2025 Online Published: 03.11.2025

ORCID IDs of the authors: *GG: 0000-0001-9589-3902*
ZVY: 0000-0002-8719-1879 *EY: 0000-0001-5107-6492*

QR Code	Access this article online
	www.gorm.com.tr • gorm@medicalnetwork.com.tr full magazin: https://mndijital.medicalnetwork.com.tr
	DOI:10.21613/GORM.2025.1590

How to cite this article: *Gokkaya G. Vural Yilmaz Z. Yilmaz E. The Role of Systemic Inflammation Response Index for Predicting the Prognosis of Threatened Miscarriage. Gynecol Obstet Reprod Med. 2025;31(3):199-205*

TM is that a focus of intrauterine hemorrhage may release various uterotonic mediators that cause uterine contractions (4).

In recent years, the determination of blood cell indices calculated from the complete blood count (CBC) has become popular and is associated with the diagnosis and prognosis of various inflammation-related diseases, such as coronary artery disease, autoimmune disorders, and malignancies (7). The neutrophil-to-lymphocyte ratio (NLR) is one of the most studied systemic inflammatory response parameters and is associated with various types of cancer, coronary heart disease, and obstetric complications, such as preeclampsia, gestational diabetes, and intrahepatic cholestasis of pregnancy (8).

The systemic inflammatory response index (SIRI) is a new systemic inflammatory response parameter calculated using neutrophil, monocyte, and lymphocyte counts. Studies have shown that the SIRI level is associated with the prognosis of various cancer types and can be used as a prognostic marker in these diseases (9,10). Although studies have investigated SIRI levels in malignant diseases, little is known about its association with obstetric complications. This study aimed to investigate the role of SIRI and NLR in spontaneous abortion and whether these markers can predict spontaneous abortion in pregnant women presenting with TM at 12 weeks of gestation or earlier.

Material and Method

Study Design and Participants: In this study, we retrospectively analyzed the data of women diagnosed with TM and hospitalized at Dr. Sami Ulus Obstetrics and Gynecology, Pediatrics Training and Research Hospital between July 1, 2019, and December 31, 2022. The study was approved by the ethics committee of our hospital (Approval no: 2012-KAEK-15/2737). The study adhered to the universal principles of the Helsinki Declaration, and informed consent was obtained from all participants.

Pregnant women aged 20-40 years, and in their first pregnancy, were included in the study. Pregnant women who were hospitalized with an TM diagnosis who experienced spontaneous abortion were included in the study group (n=83), while those hospitalized with TM during the same period but who had a healthy pregnancy and delivery constituted the control group (n=120). All patients included in the study were diagnosed with TM at less than 12 weeks of gestation.

Pregnant women with any chronic systemic disease (endocrinological, urogenital, cardiovascular, gastrointestinal, immunological, or oncological) and active infection that may affect the CBC result, with fetal anomalies and chromosomal disease, with uterine anomalies, pregnant with assisted reproductive technology, and multiple gestations were excluded from the study.

Data Collection: Patient information is accessed through our hospital's electronic database. From the patients' electronic medical records, demographic data, including age, parity, gestational week at admission to the hospital, and laboratory data, including routine CBC values taken at the first hospital admission, were retrieved. Peripheral blood samples were taken into tubes containing ethylated diamine tetraacetic acid (EDTA) and analyzed by the Sysmex XN 1000 series hematology analyzer.

Gestational age was calculated using the first day of the last menstrual period (LMP) and the ultrasonographic measurement of crown-rump length (CRL) in the first trimester. If the discrepancy between LMP and ultrasound dating exceeded seven days, the ultrasound measurement was used to determine gestational age (11). TM is defined as vaginal spotting and/or bleeding without cervical dilatation and effacement before 20 weeks of gestation (1). Platelet, neutrophil, lymphocyte, and monocyte counts were obtained from CBC results at hospital admission. NLR was calculated by dividing the neutrophil count by the lymphocyte count, and SIRI was calculated using the formula: neutrophil count × monocyte count/lymphocyte count.

Statistical analysis

Statistical analyses were performed using the SPSS software (IBM SPSS Statistics 27). Frequency tables and descriptive statistics were used to interpret the findings. The Kolmogorov-Smirnov test was used to assess the normality of data distribution. Categorical variables were compared using the Chi-Square and Fisher's exact tests. Parametric continuous variables with a normal distribution were compared using the Student's t-test, while non-normally distributed variables were compared using the Mann-Whitney U test. Binary logistic regression analysis (Backward LR method) was performed to identify factors associated with the risk of spontaneous abortion. Receiver Operating Characteristic (ROC) analysis was performed to determine the optimal cut-off values for SIRI and NLR, and results were evaluated within a 95% confidence interval (CI). A p-value <0.05 was considered statistically significant.

Results

A total of 203 pregnant women, 83 in the abortus group and 120 in the control group, were included in the study. There was no significant difference between the groups in terms of age. All pregnant women were in their first pregnancy. The rate of spontaneous abortion in pregnant women with TM was 40.9% in our study population. Significant bleeding (41.0% vs. 14.2%; $p<0.001$) and pelvic pain (45.8% vs. 15.0%; $p<0.001$) were found to be significantly higher in the study group than the control group. Demographic characteristics and complaints of pregnant women at admission to the hospital are presented in table I.

Table I: *Demographic characteristics and complaints of the study population*

Parameter		Abortus Group (n=83)	Control Group (n=120)	p
Age (mean ±SD) (median)		30.72±6.17 (30.0)	30.19±5.97 (29.0)	0.509
GW at assessment to the study (mean ±SD) (median)		7.58±1.57 (7.6)	7.82±1.49 (7.9)	0.26 0.566
Gravida		2.60±1.72 (2.0)	2.36±1.35 (2.0)	
Parity		0.92±0.97 (1.0)	1.38±0.97 (1.0)	**<0.001**
Smoking (n,%)				
	Yes	5 (6.023%)	8 (6.67%)	0.82
	No	78 (93.97%)	112 (93.33%)	
Type of Bleeding (n) (%)				
	Spotting	67 (80.7%)	98 (81.7%)	0.86
	Significant bleeding	34 (41.0%)	17 (14.2%)	<0.001
Presence of Pelvic pain (n) (%)				
	Yes	38 (45.8%)	18 (15.0)	<0.001
	No	45 (54.2%)	102 (85.0%)	
Presence of Abdominal Cramp (n)(%)				
	Yes	5 (94.0%)	116 (96.7%)	0.36
	No	78 (6.0%)	4 (3.3%)	

**p < 0.05 was considered significant*

The neutrophil count (7.33±2.77 vs. 5.92±2.66; p<0.001) and platelet count (279.72±71.65 vs. 253.43±66.18; p=0.017) were significantly higher in the study group than the control group. NLR was found to be significantly higher in the study group than the control group (4.36±3.12 vs. 3.36±2.89; p<0.001). The mean SIRI level was also found to be increased in the study group than the control group (2.73±3.26 vs. 2.18±3.26; p<0.001). The laboratory results of the study groups are shown in table II.

SIRI level and NLR were found to be important parameters affecting abortus status as a result of Backward: LR logistic regression analyses based on spontaneous abortion and using all significant findings in univariate analyses. It was found that when the SIRI level increases by 1 unit, the risk of abortion increases by 25.4% (OR=1.254, p=0.003), and when the NLR increases by 1 unit, the risk of abortion increases by 12.4% (OR=1.124, p=0.045).

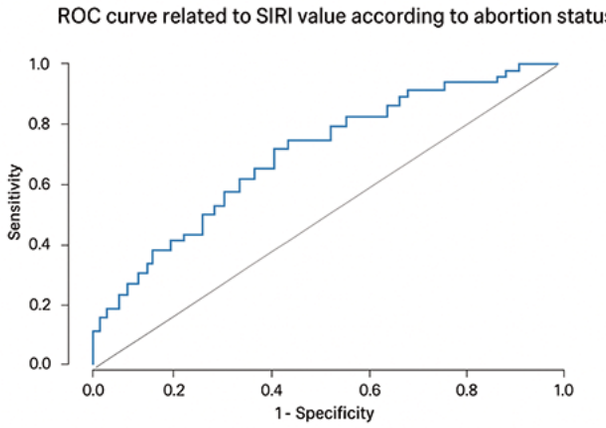
We used ROC analyses to determine the cut-off value for SIRI and NLR for determining spontaneous abortion. The AUC for SIRI was 0.673 (95% CI: 0.59-0.74), with an optimal

Table II: *Laboratory Parameters of Study Population*

Parameter	Abortus Group (n=83) Mean±SD (Median)	Control Group (n=120) Mean±SD (Median)	p
Hb (g/dL)	12.87±1.27 (13.0)	12.59±1.37(12.8)	0304
PLT (×10^9/L)	279.72±71.65 (266.0)	253.43±66.18 (253.0)	**0.017**
Neutrophils (×10^9/L)	7.33±2.77 (6.7)	5.92±2.66 (5.4)	**<0.001**
Monocytes (×10^9/L)	0.60±0.27 (0.56)	0.61±0.46 (0.51)	0.208
Lymphocytes (×10^9/L)	1.97±0.73 (1.9)	2.07±0.63 (2.1)	0.166
NLR Ratio	4.36±3.12 (3.4)	3.36±2.89 (2.78)	**<0.001**
SIRI	2.73±3.26 (2.10)	2.18±3.26 (1.40)	**<0.001**

Data is presented as mean±SD; Hb:Hemoglobin; PLT: Platelets; LMR: Lymphocyte-Monocyte Ratio; NLR: Neutrophil-Lymphocyte Ratio; SIRI: systemic inflammatory response index. p<0.05 was considered significant.

cut-off value of 2.11, corresponding to a sensitivity of 68.7% and a specificity of 65.8%. Regression analyses for the risk of spontaneous abortion in study groups and ROC analyses results were presented in table III. ROC curve for SIRI was presented in figure 1.



Variable	Area	Standard Error	p	95% Confidence Interval (OR) - Lower	95% Confidence Interval (OR) - Upper	Cut-off Value
SIRI	0.673	0.039	<0.001	0.596	0.749	≥2.111

Figure 1: *ROC curve related to SIRI value according to abortion status*
Note: SIRI = Systemic Inflammatory Response Index; ROC Curve = Receiver Operating Characteristic Curve.

Discussion

In this study, we aimed to evaluate the role of SIRI, one of the new serum inflammatory response markers, in predicting spontaneous abortion in pregnant women presented with TM. We found that the SIRI level was significantly higher in pregnant women with spontaneous abortion than in pregnant women with ongoing pregnancy and could be used as a predictive factor with a 2.11 cutoff value, with 68.7% sensitivity and 65.8% specificity. Moreover, in logistic regression analyses, we demonstrated that an increased level of SIRI was an independent risk factor for spontaneous abortion in pregnant women with TM.

Vaginal spotting and/or bleeding in the first trimester of pregnancy are very common complications and are highly likely to be associated with spontaneous abortion. In the literature, the rate of spontaneous abortion in patients diagnosed with TM has been reported to be 14-50% (12,13). The rate of spontaneous abortion in pregnant women with TM was 40.9% in our study population, and significant bleeding and pelvic pain were observed significantly more in the abortus group than in those whose pregnancy progressed to term, in accordance with the literature.

Although many causes have been implicated in the pathophysiology of TM, such as genetic factors, chromosomal abnormalities, very low or high BMI, and smoking, placental dysfunction is also blamed as a causative factor for spontaneous pregnancy loss in the first trimester (5,14,15). Jauniaux et al. showed blood flow changes in the intervillous vessels in the aborted group (16). Therefore, oxidative damage caused by decreased placental blood flow activates the systemic inflammatory response, which in turn may lead to spontaneous miscarriage (6). These changes may also explain adverse pregnancy outcomes in pregnancies that had first-trimester bleeding. The studies have demonstrated the association between activation of the systemic inflammatory response and threatened abortion and early pregnancy loss (17,18).

Recent studies have demonstrated the involvement of the inflammatory cell response in the pathophysiology of chronic diseases, such as hypertension, cardiovascular disorders, rheumatologic diseases, and the majority of cancer types. Numerous biochemical and hematologic markers reflect systemic inflammation. In recent years, determination of complete blood cell indices calculated from complete blood count has become popular and has been found in the literature to be associated with the diagnosis and prognosis of various diseases associated with inflammation (19).

The NLR ratio, an indicator of systemic inflammatory response, is associated with many diseases

Table III: *Regression Analyses for Risk of Spontaneous Abortion in the Study Population and ROC analyses for optimal SIRI and NLR value*

Regression Analyses	**OR**	**95 % CI**	**SD**	**B**	**SE**	**Wald**	**p**
SIRI	1.254	1.076-1.465	1	0.229	0.068	8.493	0.003
NLR	1.124	1.084-1.347	1	1.126	0.063	16.684	0.045
ROC Analyses	**AUC**	**95 % CI**	**SE**	**Sensitivity**	**Specificity**	**Cut-off value**	**p**
SIRI	0.67	0.59-0.74	0.039	68.7%	65.8%	2.11	<0.001
NLR	0.65	0.58-0.73	0.03	61.4%	60%	2.0	<0.01

OR- Odds Ratio; CI: Confidence Interval; ROC: Receiver Operating Characteristic; AUC: Area Under Curve; SE: Standard Error; SIRI: Systemic Inflammatory Response Index; NLR: Neutrophil-Lymphocyte Ratio. p<0.05 was considered significant.

such as coronary artery disease, rheumatologic diseases, and cancer, and also with adverse pregnancy outcomes such as preeclampsia, gestational diabetes, and intrahepatic cholestasis of pregnancy (20,21,22,18). Bas et al. found that NLR and WBC were significantly higher in pregnant women with spontaneous abortion than in healthy pregnant women, and NLR and WBC can be used for the risk assessment of spontaneous abortion in pregnancy (18). However, in their study of pregnant women diagnosed with TM, Feng et al. did not find a statistically significant difference in the prognosis of abortion with other inflammatory markers other than the lymphocyte/monocyte ratio (23). Ata et al. found no significant differences in terms of neutrophil count and NLR between pregnant women with spontaneous abortion, threatened abortion, and healthy pregnant women (17). In our study, platelet and neutrophil count and NLR were found significantly higher in the spontaneous abortion group than the control group, and in logistic regression analyses, we found that when the NLR increases by 1 unit, the risk of abortion increases by 12.4% (OR=1.124).

In recent years, a novel inflammation marker, SIRI, has been found as a new systemic inflammatory response parameter and shown to it can be used as a prognostic marker for various neoplasms, including pancreatic, esophageal, gastric, nasopharyngeal, ovarian, and endometrial cancer. High score was found to be associated with a poorer prognosis and a more advanced stage (9,10-24). Although there are studies about SIRI and cancer, the significance of this index for pregnancy and pregnancy-related complications is not well known. Seyhanli et al. found that SIRI can be used as a marker for predicting the risk of preeclampsia in the first trimester (25), and Ipek et al. found that SIRI level was significantly higher in pregnant women with HELLP syndrome (26). However, the studies investigating the association between SIRI and spontaneous abortions are limited in the literature. Sert et al. reported that the systemic immune index (thrombocyte × neutrophil/lymphocyte) ratio was significantly higher in pregnant women with missed abortions than in healthy pregnant women (27). A study by Agaoglu et al. revealed that the SIRI rate was higher in cases of first pregnancy loss, and that both the SIRI and SII rates were higher in cases of recurrent pregnancy loss compared to the control group (28). However, there is no study about the SIRI level and spontaneous abortion in the literature. In our study of pregnant women presented with TM, we found that pregnant women who ended with spontaneous abortion had a significantly higher mean SIRI score than pregnant women without abortion, and it was found that when the SIRI level increases by 1 unit, the risk of abortion increases by 25.4% (OR=1.254).

The primary strength of our study lies in its ability to predict the risk of abortion in patients diagnosed with abortion imminence, obviating the necessity for additional invasive procedures. This aspect is particularly noteworthy given the paucity of literature addressing this crucial issue. The main limitations of our study were the retrospective design and the small number of patients. In addition, no power analysis was used to determine the sample size, and patients who qualified for inclusion criteria between the indicated years were included in the study. However, future studies with a larger number of pregnant women and serial measurement of SIRI level are needed to confirm our results and to determine the optimal cut-off value for predicting spontaneous abortion.

Despite these limitations, we demonstrated that SIRI, a simple parameter calculated from routine CBC count, could be used for the prediction of spontaneous abortion in pregnant women presented with TM.

Declarations

Ethics approval and consent to participate: All participants signed informed written consent before being enrolled in the study. The study was reviewed and approved by the ethics committee of KAEK (Ethics approval reference number: 2012-KAEK-15/2737date 21.06.2023). All procedures were performed according to the Declaration of Helsinki.

Availability of data and materials: The data supporting this study are available through the corresponding author upon reasonable request. / The datasets and code used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests: The authors declare that they have no competing interests.

Funding: This study was not supported. None.

Authors' contributions: ZVY and EY raised the presented idea. ZVY and GG designed the study. GG conducted the analyses. ZVY and GG developed the first draft of the manuscript. All authors contributed to the writing of the paper, and have read and approved the final manuscript. GG conducted the population study, analyzed and interpreted the data, and drafted the manuscript. ZVY participated in data analysis, interpretation, and draft revision. GG and EY participated in data collection and result interpretation. ZVY, EY, and GG assisted with data collection and analysis. GG designed the study and critically revised the manuscript. All authors read and approved the final manuscript.

Acknowledgment: This manuscript is the result of the MD thesis of Gokce Gokkaya.

Conflict of interest: The authors declare that they have no conflict of interest. The authors declare that no funding or any type of sponsorships were received.

References

1. Simpson JL, Mills JL, Holmes LB, Ober CL, Aarons J, Jovanovic L, et al. Low fetal loss rates after ultrasound-proven viability in early pregnancy. JAMA. 1987;258 (18):2555-7. PMID: 3312659.
2. Weiss JL, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Threatened abortion: A risk factor for

poor pregnancy outcome, a population-based screening study. Am J Obstet Gynecol. 2004;190(3):745-50. Doi: 10.1016/j.ajog.2003.09.023. PMID: 15042008.

3. Kaufmann P, Black S, Huppertz B. Endovascular trophoblast invasion: implications for the pathogenesis of intrauterine growth retardation and preeclampsia. Biol Reprod. 2003;69(1):1-7. Doi: 10.1095/biolreprod.102.014977. PMID: 12620937.
4. Pawelec M, Pałczyński B, Krzemieniewska J, Karmowski M, Koryś J, Lątkowski K, et al. Initiation of preterm labor. Adv Clin Exp Med. 2013;22(2):283-8. PMID: 23709385.
5. Katar-Yildirim C, Tokmak A, Yildirim C, Erel O, Caglar AT. Investigation of serum thiol/disulphide homeostasis in patients with abortus imminens. J Matern Fetal Neonatal Med. 2018;31(18):2457-62. Doi: 10.1080/14767058.2017.1344962. PMID: 28629274.
6. Gupta S, Agarwal A, Banerjee J, Alvarez JG. The role of oxidative stress in spontaneous abortion and recurrent pregnancy loss: a systematic review. Obstet Gynecol Surv. 2007;62(5):335-47; quiz 353-4. Doi: 10.1097/01.ogx.0000261644.89300.df. PMID: 17425812.
7. Tang J, Gao X, Zhi M, Zhou HM, Zhang M, Chen HW, et al. Plateletcrit: a sensitive biomarker for evaluating disease activity in Crohn's disease with low hs-CRP. J Dig Dis. 2015;16(3):118-24. Doi: 10.1111/1751-2980.12225. PMID: 25565427.
8. Wang J, Zhu QW, Cheng XY, Liu JY, Zhang LL, Tao YM, et al. Assessment efficacy of neutrophil-lymphocyte ratio and monocyte-lymphocyte ratio in preeclampsia. J Reprod Immunol. 2019;132:29-34. Doi: 10.1016/j.jri.2019.02.001. PMID: 30861482.
9. Zhu M, Feng M, He F, Han B, Ma K, Zeng X, et al. Pretreatment neutrophil-lymphocyte and platelet-lymphocyte ratio predict clinical outcome and prognosis for cervical Cancer. Clin Chim Acta. 2018;483:296-302. Doi: 10.1016/j.cca.2018.05.025. PMID: 29758203.
10. Chao B, Ju X, Zhang L, Xu X, Zhao Y. A Novel Prognostic Marker Systemic Inflammation Response Index (SIRI) for operable cervical cancer patients. Front Oncol. 2020;10:766. Doi: 10.3389/fonc.2020.00766. PMID: 32477958, PMCID: PMC7237698.
11. Committee opinion no 611: method for estimating due date. Obstet Gynecol. 2014;124(4):863-6. Doi: 10.1097/01.AOG.0000454932.15177.be. PMID: 25244460.
12. Hasan R, Baird DD, Herring AH, Olshan AF, Jonsson Funk ML, Hartmann KE. Association between first-trimester vaginal bleeding and miscarriage. Obstet Gynecol. 2009;114(4):860-7. Doi: 10.1097/AOG.0b013e3181b79796. PMID: 19888046, PMCID: PMC2828396.
13. Basama FM, Crosfill F. The outcome of pregnancies in 182 women with threatened miscarriage. Arch Gynecol Obstet. 2004;270(2):86-90. Doi: 10.1007/s00404-003-0475-z. PMID: 12682847.
14. Benedetto C, Tibaldi C, Marozio L, Marini S, Masuelli G, Pelissetto S, et al. Cervicovaginal infections during pregnancy: epidemiological and microbiological aspects. J Matern Fetal Neonatal Med. 2004;16 Suppl 2:9-12. Doi: 10.1080/14767050410001727107. PMID: 15590426.
15. Giakoumelou S, Wheelhouse N, Cuschieri K, Entrican G, Howie SE, Horne AW. The role of infection in miscarriage. Hum Reprod Update. 2016;22(1):116-33. Doi: 10.1093/humupd/dmv041. PMID: 26386469, PMCID: PMC4664130.
16. Jauniaux E, Gulbis B, Burton GJ. The human first trimester gestational sac limits rather than facilitates oxygen transfer to the foetus--a review. Placenta. 2003;24 Suppl A:S86-93. Doi: 10.1053/plac.2002.0932. PMID: 12852418.
17. Ata N, Kulhan M, Kulhan NG, Turkler C. Can neutrophil-lymphocyte and platelet-lymphocyte ratios predict threatened abortion and early pregnancy loss? Ginekol Pol. 2020;91(4):210-5. Doi: 10.5603/GP.2020.0042. PMID: 32374021.
18. Bas FY, Tola EN, Sak S, Cankaya BA. The role of complete blood inflammation markers in the prediction of spontaneous abortion. Pak J Med Sci. 2018;34(6):1381-5. Doi: 10.12669/pjms.346.15939. PMID: 30559789, PMCID: PMC6290208.
19. Yasar Z, Buyuksirin M, Ucsular FD, Kargı A, Erdem F, Talay F, et al. Is an elevated neutrophil-to-lymphocyte ratio a predictor of metabolic syndrome in patients with chronic obstructive pulmonary disease? Eur Rev Med Pharmacol Sci. 2015;19(6):956-62. PMID: 25855919.
20. Oylumlu M, Ozler A, Yildiz A, Oylumlu M, Acet H, Polat N, et al. New inflammatory markers in pre-eclampsia: echocardiographic epicardial fat thickness and neutrophil to lymphocyte ratio. Clin Exp Hypertens. 2014;36(7):503-7 . Doi: 10.3109/10641963.2013.863324. PMID: 2443 30 91.
21. Tamhane UU, Aneja S, Montgomery D, Rogers EK, Eagle KA, Gurm HS. Association between admission neutrophil to lymphocyte ratio and outcomes in patients with acute coronary syndrome. Am J Cardiol. 2008;102(6):653-7. Doi: 10.1016/j.amjcard.2008.05.006. PMID: 18773982.
22. Celikbilek M, Dogan S, Ozbakır O, Zararsız G, Kücük H, Gürsoy S, et al. Neutrophil-lymphocyte ratio as a predictor of disease severity in ulcerative colitis. J Clin Lab Anal. 2013;27(1):72-6. Doi: 10.1002/jcla.21564. PMID: 23292894, PMCID: PMC6807407.
23. Feng QT, Chen C, Yu QY, Chen SY, Huang X, Zhong YL, et al. The benefits of higher LMR for early threatened abortion: A retrospective cohort study. PLoS One. 2020;15(4):e0231642. Doi: 10.1371/journal.pone.0231642. PMID: 32310980, PMCID: PMC7170252.
24. Cho H, Hur HW, Kim SW, Kim SH, Kim JH, Kim YT, et al. Pre-treatment neutrophil to lymphocyte ratio is elevated in epithelial ovarian cancer and predicts survival

after treatment. Cancer Immunol Immunother. 2009;58 (1):15-23. Doi: 10.1007/s00262-008-0516-3. PMID: 18414853, PMCID: PMC11029845.

25. Seyhanli Z, Bayraktar B, Baysoz OB, Karabay G, Sucu ST, Ulusoy CO, et al. The role of first trimester serum inflammatory indexes (NLR, PLR, MLR, SII, SIRI, and PIV) and the β-hCG to PAPP-A ratio in predicting preeclampsia. J Reprod Immunol. 2024;162:104190. Doi: 10.1016/j.jri.2023.104190. PMID: 38219631.
26. İpek G, Tanaçan A, Ağaoğlu Z, Peker A, Şahin D. Can SIRI or other inflammatory indices predict HELLP syndrome in the first trimester? J Reprod Immunol. 2023; 159:104126. Doi: 10.1016/j.jri.2023.104126. PMID: 37573651.
27. Sert ZS, Bülbül R. Can the systemic Immune-Inflammation Index be a useful marker for the prediction of a missed abortion in the first trimester of pregnancy?. Dubai Med J. 2023;6(1):14-9. Doi: 10.1159/000527888.
28. Agaoglu Z, Tanacan A, Ipek G, Peker A, Ozturk Agaoglu M, Sahin D. Systemic Inflammation Response Index and Systemic Immune-inflammation Index for prediction of pregnancy loss: a case-control study. Reprod Sci. 2024;31(6):1565-72. Doi: 10.1007/s43032-024-01506-x. PMID: 38438777.