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ARAŞTIRMA / RESEARCH

Predictive value of systemic immune-inflammation index in patients with preterm labor

Erken doğum yapan kadınlarda sistemik immün-inflamasyon indeksinin prediktif değeri

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Abstract

Purpose: The aim of this study was to investigate whether the systemic immune-inflammatory index (SII) could predict the development of preterm labor in pregnant women.

Materials and Methods: Pregnant women aged 18 years and over who presented to our clinic with spontaneous labor between January 1, 2018, and December 31, 2021, had intact membranes, and had a single living fetus were retrospectively evaluated. The women were divided into two groups, preterm and term delivery, according to the week of delivery. The clinical and laboratory characteristics of the women were assessed. The patients' platelet-to-lymphocyte ratio (PLR), neutrophil-to-lymphocyte ratio (NLR), and SII (neutrophil count x platelet count/lymphocyte count) were calculated.

Results: The study included 171 women with preterm labor and 173 women with healthy term labor. The PLR, NLR, and SII values were statistically significantly higher in the preterm group than in the term group. The multivariate logistic regression analysis showed that SII (odds ratio [OR]: 3.65, 95% confidence interval [CI]: 2.21–10.07) was an independent predictor of the development of preterm labor. We found that the power of SII to predict preterm labor (area under the curve [AUC]: 0.792) was higher than that of NLR (AUC: 0.725) or PLR (AUC: 0.716) alone. SII values higher than 789.3 predicted preterm labor with 68.4% sensitivity and 81.5% specificity.

Conclusion: We found that SII was more valuable than NLR and PLR in the early detection of preterm labor. SII can help identify pregnant women at risk of developing preterm labor in the early stages of pregnancy.

Keywords:. Systemic immune-inflammation index; preterm labor; pregnancy

Öz

Amaç: Bu çalışmada sistemik immün-inflamatuar indeksin (SII) hamile kadınlarda erken doğum gelişimini tahmin edip edemeyeceği araştırılmıştır.

Gereç ve Yöntem: 1 Ocak 2018-31 Aralık 2021 tarihleri arasında kliniğimize spontan doğum eylemi ile başvuran, membranları intakt olan ve tek canlı fetüsü olan 18 yaş ve üstü gebeler retrospektif olarak değerlendirildi. Kadınlar doğum haftasına göre preterm ve term doğum olmak üzere iki gruba ayrıldı. Kadınların klinik ve laboratuvar özellikleri değerlendirildi. Hastaların trombosit-lenfosit oranı (PLR), nötrofil-lenfosit oranı (NLR) ve SII (nötrofil sayısı x trombosit sayısı/lenfosit sayısı) hesaplandı.

Bulgular: Çalışmaya erken doğum yapan 171 kadın ve sağlıklı term doğum yapan 173 kadın dahil edildi. PLR, NLR ve SII değerleri preterm grupta term grubuna göre istatistiksel olarak anlamlı derecede yüksekti. Çok değişkenli lojistik regresyon analizi, SII'nin (olasılık oranı [OR]: 3.65, %95 güven aralığı [GA]: 2.21–10.07) erken doğum gelişiminin bağımsız bir prediktör olduğunu gösterdi. SII'nin erken doğumu (eğrinin altındaki alan [AUC]: 0.792) tahmin etme gücünün, tek başına NLR (AUC: 0.725) veya PLR'den (AUC: 0.716) daha yüksek olduğunu bulduk. 789.3'ün üzerindeki SII değerleri, %68,4 duyarlılık ve %81.5 özgüllük ile erken doğumu öngördü.

Sonuç: Preterm doğumun erken tespitinde SII'nın NLR ve PLR'den daha değerli olduğunu bulduk. SII, preterm doğum gelişme riski taşıyan gebelerin erken dönemde belirlenmesine yardımcı olabilir.

Anahtar kelimeler: Sistemik immün-inflamatuar indeks; preterm doğum; gebelik

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INTRODUCTION

Preterm birth occurs in 5–18% of all births and is the leading cause of neonatal mortality[1]. According to World Health Organization data, at least one out of 10 infants is born preterm every year, and this number is increasing day by day[2]. Preterm birth is one of the important clinical problems in obstetrics because it causes neonatal complications, prolongation of hospital stay, and undesirable negative consequences, such as morbidity and mortality. Therefore, it is crucial to predict which patients will experience preterm labor in clinical follow-up decision-making and treatment planning.

Inflammatory response plays an important role in spontaneous preterm labor[3]. Any situation that causes stress to the fetus can trigger the inflammatory response, leading to preterm labor Similarly, inflammation itself causes stress in the fetus, which in turn results in an increase in fetal cortisol levels, inducing the fetal hypothalamo–pituitary–adrenal axis and causing preterm labor[4].

In addition, intrauterine and genitourinary infections in the mother cause a maternal systemic inflammatory response, also leading to stress and inflammatory response in the fetus. In patients with spontaneous preterm labor without a known infectious pattern, there is an increase in the neutrophil count and a decrease in the lymphocyte count[5].

Inflammation, which is involved in the etiology of preterm labor, has also been shown to cause platelet activation[6]. It has been reported that the platelet-to-lymphocyte ratio (PLR) or neutrophil-to-lymphocyte ratio (NLR) can be used as potential inflammatory markers[7-9], and studies have shown that both parameters can be useful in predicting preterm labor[10,11]. The systemic immune–inflammatory index (SII) is a new-generation inflammatory biomarker obtained using whole blood parameters[12]. SII is calculated by multiplying the neutrophil count by the platelet count and dividing the result by the lymphocyte count, and it is likely to be a predictive factor of preterm labor.

The aim of this study was to evaluate whether SII could be used to predict preterm labor in pregnant women. In addition, we investigated whether SII was a better predictive marker than NLR or PLR alone in women with preterm labor.

MATERIALS AND METHODS

Study design and participants

This retrospective study was performed between January 1, 2018, and December 31, 2021 at the Aksaray University Training and Research Hospital, Gynecology and Obstetrics Department. Ethical approval was obtained from Aksaray University Faculty of Medicine, Ethics Committee with the decision no: 2022/02-10 dated 27.01.2022 and performed in accordance with the Helsinki Declaration. Data were collected by researchers and the study included retrospectively collected data, therefore, informed consent was waived.

The study population consisted of women who gave preterm birth in our hospital. Pregnant women aged 18 years and older who presented to our clinic with spontaneous labor, had intact membranes, and had a single live fetus delivered by cesarean section or vaginally were analyzed in the study. The study group included women with preterm (20–37 weeks) labor and the control group included women with healthy term (37–42 weeks) labor. We retrospectively evaluated 280 women who gave preterm labor in our hospital. Women with incomplete records (n=46), a history of acute or chronic inflammatory disease (n=3), a history of hematopoietic system disease (n=2), pregestational and gestational diabetes (n=5), multiple pregnancy (n=1), fetal anomaly (n=1), uterine anomaly (n=1), placental abruption (n=4), placenta previa (n=2), short cervix (n=10), intrauterine growth retardation (n=17), fetal tachycardia (n=6), premature rupture of membranes (n=4), chorioamnionitis (n=1), or fever of unknown origin (n=6) were excluded from the study. The final study group consisted of 171 women.

Data collection

Clinical data were obtained from the hospital's electronic medical database and patient files. The patients' age, gravida, parity, gestational week at birth, mode of delivery, maternal diseases, single or multiple pregnancy history, fetal birth weight, Apgar score, and laboratory results were recorded. Regarding laboratory measurements, the first hemogram parameters measured at the time when prenatal patients were admitted to the hospital were used. Hematological parameters were analyzed using an automatic analyzer (Mindray BC-6000). The investigated parameters were calculated using the

following formulas: SII = (neutrophil count x platelet count) / lymphocyte count[12], PLR = platelet count/lymphocyte count and NLR = neutrophil count/lymphocyte count.

Definitions

Preterm labor was defined as giving birth between 20 and 37 weeks of gestation. The term group was composed of healthy pregnant women who delivered their infants between 37 and 42 weeks of gestation in our clinic without any complications from follow-up until delivery. Spontaneous labor was defined as the detection of regular uterine contractions (more than four contractions in 20 minutes or more than six contractions in 1 hour) and cervical dilation > 2 cm, cervical effacement over 80%, or increased cervical dilation or effacement in the process with intact membranes[13].

Statistical snalysis

According to similar studies (1,5), the rate of developing preterm birth was estimated as 12% and power analysis was performed by calculating the estimated rate as 5% lower and 5% higher than the actual population rate. The sample size was found to be at least 148 with 80% power, 95% confidence interval and α=0.05 margin of error. Data analyses was performed using SPSS version 22 (SPSS Inc., Chicago, IL, USA). Descriptive data were given as number (n), percentage (%), mean (standard deviation), and median values. The Kolmogorov–Smirnov test was used to determine whether or not the variables were distributed normally.

Continuous data with normal distribution were compared using Student's t test (Age, gravida, parity, birth weight, Apgar score, white blood cell, hemoglobin, hematocrit, platelet, neutrophil, neutrophil, lymphocyte, lymphocyte, monocyte, monocyte, MLR, NLR, PLR and SII). Non-normally distributed data were compared using Mann-Whitney U test (Gestational age at delivery). The Chi-square test was used to compare categorical data (Cesarean delivery and normal spontaneous delivery).

The possible association of preterm labor and laboratory parameters was analyzed through univariate and multivariate logistic regression analyses. Statistically insignificant parameters were not included in the regression model. The power of the parameters that were significant in the multivariate logistic regression analysis to predict preterm labor was evaluated by plotting the receiver operating characteristic (ROC) curves. The analysis was used to determine the area under the curve (AUC) and optimal cut-off values. The AUC values were compared with the DeLong test, and the optimal parameter cut-off levels were calculated using the Youden's index. The sensitivity, specificity, positive (PPV), and negative (NPV) predictive values of the optimal cut-off values of PLR, NLR, and SII were calculated in the prediction of preterm labor. A P-value < 0.05 was considered to statistically significant.

RESULTS

A total of 171 women with preterm labor and 173 women with healthy term labor were included in the study. The mean age of the preterm group was 26.0 ± 6.0 years, and that of the term group was 26.4 ± 5.6 years. The distribution of the demographic data of the preterm and term groups is shown in Table 1. The PLR, NLR, and SII values were 131.26 ± 54.71, 4.86 ± 2.66, and 1218.0 ± 681.1, respectively, in the preterm group and 96.66 ± 32.84, 3.36 ± 1.23, and 709.8 ± 294.2, respectively, in the term group. The PLR, NLR, and SII values were statistically significantly higher in the preterm group than in the term group ($p < 0.001$, $p < 0.001$, and $p < 0.001$, respectively).

The multiple logistic regression analysis was conducted between white blood cell, NLR, PLR, MLR, and SII, which were determined to be statistically significant variables in the univariate analysis. The multivariate logistic regression analysis revealed that NLR (OR = 2.43, 95% CI: 1.67–3.85, $p < 0.001$), PLR (OR = 1.78, 95% CI: 1.28–5.96, $p = 0.029$), and SII (OR = 3.65, 95% CI: 2.21–10.07, $p < 0.001$) were independent predictors of the development of preterm labor (Table 2).

We performed an ROC analysis to determine the power of NLR, PLR, and SII to predict preterm labor (Figure 1) and determined the cut-off values of these parameters as 3.9 (56.1% sensitivity, 75.4% specificity), 119.7% (51.4% sensitivity, 70.3% specificity), and 789.3% (68.4% sensitivity, 81.5% specificity), respectively. The AUC value of SII was found to be 0.792. We found that that the power of SII to predict preterm labor was higher than that of NLR (AUC: 0.725) or PLR (AUC: 0.716) alone (Table 3).

Table 1. Demographic features and hematologic parameters of groups

Variables	Preterm (n=171)	Term (n=173)	P-value
Age, (years)	26.0±6.0	26.4±5.6	0.366
Gravida	2.2±1.3	2.6±1.6	0.114
Parity	1.1±1.2	1.2±1.3	0.671
Gestational age at delivery	35 (33-36)	39 (38-40)	<0.001*
Mode of delivery			<0.001*
NSD	85 (49.7%)	125 (72.3%)	
C/S	86 (50.3%)	48 (27.3%)	
Birth weight, (g)	2450±525	3375±450	<0.001*
Apgar score	8.2±1.6	9.0±0.4	<0.001*
White blood cell, (x10^9/L)	11.9±3.0	11.1±2.7	0.017*
Hemoglobin, (g/dL)	12.1±1.4	12.4±1.4	0.100
Hematocrit, (%)	36.4±3.7	37.2±3.3	0.053
Platelet, (x10^9/L)	257.2±87.6	214.4±58.3	<0.001*
Neutrophil, (x10^9/L)	9.25±2.93	7.38±1.90	<0.001*
Neutrophil, (%)	77.6 ± 6.5	74.0±7.0	0.825
Lymphocyte, (x10^9/L)	2.09±0.57	2.34±0.59	<0.001*
Lymphocyte (%)	17.9±5.4	18.6±5.5	0.241
Monocyte, (x10^9/L)	0.75±0.25	0.64±0.19	0.003*
Monocyte, (%)	6.38±1.73	5.72±1.76	<0.001*
MLR	0.38±0.14	0.29±0.12	<0.001*
NLR	4.86±2.66	3.36±1.23	<0.001*
PLR	131.26±54.71	96.66±32.84	<0.001*
SII	1218.0±681.1	709.8±294.2	<0.001*

Data are presented as mean ± standard deviation, median (25%–75% quartiles) or n (%); C/S: Cesarean delivery; NSD: Normal spontaneous delivery; NLR: neutrophil to lymphocyte ratio; PLR: platelet to lymphocyte ratio; MLR: Monocyte to lymphocyte ratio; SII: systemic immune-inflammation index, *p-value <0.05.

Table 2. Predictors of preterm birth as determined by univariate and multivariate logistic regression analysis

Variables	Univariate logistic regression		Multivariate logistic regression	
	OR (95% CI)	P-value	OR (95% CI)	P-value
White blood cell	1.72 (1.05–3.16)	0.017	1.32 (0.67–3.84)	0.116
NLR	2.86 (1.58–3.88)	<0.001	2.43 (1.67–3.85)	<0.001*
PLR	2.25 (1.76–4.91)	<0.001	1.78 (1.28–5.96)	0.029*
MLR	1.64 (1.14–2.28)	<0.001	1.88 (0.84–2.44)	0.093
SII	5.38 (3.18–8.45)	<0.001	3.65 (2.21–10.07)	<0.001*

OR: odds ratio; CI: confidence interval; NLR: neutrophil to lymphocyte ratio; PLR: platelet to lymphocyte ratio; MLR: Monocyte to lymphocyte ratio; SII: systemic immune-inflammation index, *p-value <0.05.

Table 3. Analysis of the area under the ROC curve for preterm birth

Variables	AUC (95 % CI)	Cut-off value	Sensitivity (%)	Specificity (%)	+LR	-LR	PPV (%)	NPV (%)	P value
NLR	0.725 (0.675-0.772)	> 3.9	56.14	75.47	3.04	0.54	75.0	64.3	0.006[a]
PLR	0.716 (0.665-0.763)	>119.7	51.46	70.32	2.78	0.60	73.3	59.9	0,754[b]
SII	0.792 (0.745-0.834)	>789.3	68.44	81.52	4.16	0.35	76.7	70.4	<0.001[c]

ROC: receiver operating characteristic curve; AUC: area under the ROC curve; CI: Confidence interval, +LR: positive likelihood ratio; -LR: negative likelihood ratio; PPV: positive predictive value; NPV: negative predictive value, CI: confidence interval; NLR: neutrophil to lymphocyte ratio; PLR: platelet to lymphocyte ratio; SII: systemic immune-inflammation index.

[a]P values obtained fromthe paired comparison of the AUC values between of SII and NLR.

[b]P values obtained from the paired comparison of the AUC values between the NLR and PLR.

[c]P values obtained from the paired comparison of the AUC values between the SII ratio and PLR.

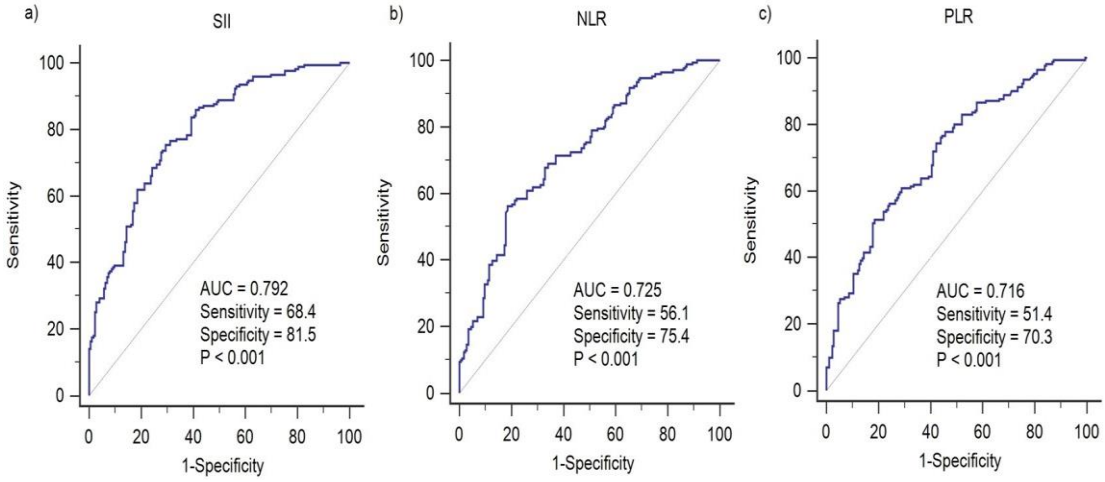

Figure 1. Receiver operating characteristic (ROC) curves for a. the relationship between systemic immune-inflammatory index (SII) and preterm birth, b. the relationship between neutrophil-to-lymphocyte ratio (NLR) and preterm birth, and c. the relationship between platelet-to-lymphocyte ratio (PLR) and preterm birth (AUC: area under the curve).

DISCUSSION

Preterm labor, which has a significant impact on perinatal mortality and morbidity, is an important public health problem. Mortality and morbidity outcomes in preterm infants than in term infants, and the risk of poor outcomes generally decreases with advanced gestational age [14]. The early recognition and proper management of pregnant women at risk of preterm labor are crucial for reducing negative perinatal outcomes associated with prematurity [15]. However, the precise prediction of preterm labor remains an important problem for clinicians. Therefore, in this study, we investigated the efficacy of SII in the early diagnosis of preterm labor. To the best of our knowledge, this is the first study to examine SII as a predictor of the development of preterm labor. In our study, the AUC and OR values obtained for SII in predicting preterm birth were higher than those obtained from NLR or PLR alone. We showed that patients with an SII level higher than 789.3 had a 3.6-times higher risk of having a preterm labor in the future than patients with lower SII levels. In the ROC analysis, SII had a specificity of 81.5% and sensitivity of 68.4% in predicting preterm labor (AUC = 0.792, 95% CI: 0.745–0.834). These findings suggest that SII is a useful diagnostic and predictive marker for preterm labor.

Inflammation is an important factor in the etiology of spontaneous preterm labor[3]. Previous studies have shown that inflammatory C-reactive protein, tumor necrosis factor-α, cytokines, interleukin-1, and interleukin-6 play an important role in preterm labor[16, 17]. Recently, next-generation inflammation markers have been increasingly used in the determination of systemic inflammation due to their easy calculation with whole-blood parameters, low cost, accessibility, rapid results, and non-invasive nature. The primary examples of these parameters are NLR, PLR, and SII. Studies have shown that increased NLR levels can be used to predict preterm labor[13,18]. In addition, studies have shown that PLR may be useful in predicting preterm labor. Similarly, in a retrospective study of 138 patients, Kurban et al.[5] reported that the NLR value was 6.1 ± 3 in the early preterm patient group, 4.5 ± 2.5 in the late preterm patient group, and 3.9 ± 1.9 in the term patient group. The authors found a negative correlation between gestational week and NLR. In another study, it was shown that the PLR value was higher in patients with premature membrane rupture, and it was suggested that this parameter could be used as a new marker of inflammation[19]. In the current study, we found that PLR and NLR values were higher in women with preterm labor than in those with term labor.

SII has been demonstrated as a new systemic inflammatory index based on platelet, neutrophil, and lymphocyte counts. It has been found to be a predictor of malignancies[20,21], premature rupture of membranes[12], coronary artery disease[22], and acute ischemic stroke[23]. Although cervical length and effacement measurement by transvaginal ultrasonography and screening for bacterial vaginosis or fetal fibronectin have been recommended for the prediction and diagnosis of preterm labor, none of these assessments has been shown to improve perinatal outcomes[13]. In addition, these clinical assessments are costly and time-consuming. According to the results of our study, SII is a more valuable parameter than NLR and PLR for the early detection of preterm labor. Neutrophil, platelet, and lymphocyte parameters are easily accessible hematological parameters for clinicians. We determined that SII, in which all these parameters are used together, is more valuable than evaluation of the individual parameters.

This study has certain limitations. The first is related to the single-center design. Second, the sample size was small. Third, the retrospective nature of the study limited the data to those that are routinely collected. Finally, the PLR, NLR, and SII values were calculated from a single blood sample of pregnant women at the time of presentation to the hospital before delivery. Therefore, we were not able to examine the relationship between changes in hematological parameters and preterm labor.

In conclusion, we determined that SII was an independent predictor of the development of preterm labor in pregnant women. SII is a promising parameter suitable for routine use due to its easy-to-calculate nature and low cost. Predicting which patients are at high risk of preterm labor is important in clinical practice in terms of follow-up decisions and treatment planning. SII may be a promising indicator to aid in the prediction of preterm labor. If SII is supported by more comprehensive studies, it can be used to predict preterm labor. We recommend further studies to confirm this possibility.

Yazar Katkıları: Çalışma konsepti/Tasarımı: ZSS, RB; Veri toplama: ZSS; Veri analizi ve yorumlama: ZSS, RB; Yazı taslağı: ZSS, RB; İçeriğin eleştirel incelenmesi: ZSS; Son onay ve sorumluluk: ZSS, RB; Teknik ve malzeme desteği:ZSS, RB; Süpervizyon: ZSS, RB; Fon sağlama (mevcut ise): yok.
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REFERENCES

1. Georgiou HM, Di Quinzio MK, Permezel M, Brennecke SP. Predicting preterm labour: current status and future prospects. Dis Markers. 2015;2015:435014.
2. World Health Organisation (WHO). Preterm birth. February 2018 (cited 2019 December3). Availablefrom: URL: https://www.who. int/news-room/fact-sheets/detail/preterm-birth.
3. Cappelletti M, Presicce P, Lawson MJ, Chaturvedi V, Stankiewicz TE, Vanoni S et al. Type I interferons regulate susceptibility to inflammation-induced preterm birth. JCI Insight. 2017;2:e91288.
4. Buhimschi CS, Turan OM, Funai EF, Azpurua H, Bahtiyar MO, Turan S et al. Fetal adrenal gland volume and cortisol/dehydroepiandrosterone sulfate ratio in inflammation-associated preterm birth. Obstet Gynecol. 2008;111:715-22.
5. Kurban Y, Alan Y, Uyar İ, Atak Z, Aydemir Ö, Öktem A. Investigation of neutrophil/lymphocyte ratio and mean platelet volume in patients diagnosed with preterm labor. Paediatr Respir Rev. 2021;40:39-43.
6. Dundar O, Yoruk P, Tutuncu L, Erikci AA, Muhcu M, Ergur AR et al. Longitudinal study of platelet size changes in gestation and predictive power of elevated MPV in development of pre-eclampsia. Prenat Diagn. 2008;28:1052-6.
7. Bozoklu Akkar O, Sancakdar E, Karakus S, Yildiz C, Akkar I, Arslan M et al. Evaluation of maternal serum 25-hydroxyvitamin D, paraoxonase 1 levels, and neutrophil-to-lymphocyte ratio in spontaneous preterm birth. Med Sci Monit. 2016;22:1238-43.
8. Kokulu K, Günaydın YK, Akıllı NB, Köylü R, Sert ET, Köylü Ö et al. The Relationship between the neutrophil-to-lymphocyte ratio in acute pancreatitis and the severity and systemic complications of the disease. Turk J Gastroenterol. 2018;29:684-91.
9. Kim DS, Shin D, Lee MS, Kim HJ, Kim DY, Kim SM et al. Assessments of neutrophil to lymphocyte ratio and platelet to lymphocyte ratio in Korean patients with psoriasis vulgaris and psoriatic arthritis. J Dermatol. 2016;43:305-10.
10. Daglar H, Kirbas A, Kaya B, Kilincoglu F. The value of complete blood count parameters in predicting

preterm delivery. Eur Rev Med Pharmacol Sci. 2016;20:801-5.
11. Kim MA, Lee YS, Seo K. Assessment of predictive markers for placental inflammatory response in preterm births. PLoS One. 2014;9:e107880.
12. Tanacan A, Uyanik E, Unal C, Beksac MS. A cut-off value for systemic immune-inflammation index in the prediction of adverse neonatal outcomes in preterm premature rupture of the membranes. J Obstet Gynaecol Res. 2020;46:1333-41.
13. Farzaneh F, Ghobadi S, Absalan A. The accuracy of selected hematology and inflammatory indices for predicting preterm labor; a cross-sectional study. Immunopathol Persa. 2019;5:e05.
14. Teune MJ, Bakhuizen S, Gyamfi Bannerman C, Opmeer BC, van Kaam AH, van Wassenaer AG et al. A systematic review of severe morbidity in infants born late preterm. Am J Obstet Gynecol. 2011;205:374.e1-9.
15. Aktepe T, Büyükkayacı Duman N. Preterm doğum riski olan gebeliklerin yönetiminde kanıta dayalı yaklaşımlar. Jinekoloji-Obstetrik ve Neonatoloji Tıp Dergisi. 2020;17:309-14.
16. Nadeau-Vallée M, Obari D, Quiniou C, Lubell WD, Olson DM, Girard S et al. A critical role of interleukin-1 in preterm labor. Cytokine Growth Factor Rev. 2016;28:37-51.
17. Dixon CL, Richardson L, Sheller-Miller S, Saade G, Menon R. A distinct mechanism of senescence activation in amnion epithelial cells by infection, inflammation, and oxidative stress. Am J Reprod Immunol. 2018;79:10.1111/aji.12790.
18. Ma M, Zhu M, Zhuo B, Li L, Chen H, Xu L et al. Use of complete blood count for predicting preterm birth in asymptomatic pregnant women: A propensity score-matched analysis. J Clin Lab Anal. 2020;34:e23313.
19. Toprak E, Bozkurt M, Dinçgez Çakmak B, Özçimen EE, Silahlı M, Ender Yumru A et al. Platelet-to-lymphocyte ratio: A new inflammatory marker for the diagnosis of preterm premature rupture of membranes. J Turk Ger Gynecol Assoc. 2017;18:122-26.
20. Hu B, Yang XR, Xu Y, Sun YF, Sun C, Guo W et al. Systemic immune-inflammation index predicts prognosis of patients after curative resection for hepatocellular carcinoma. Clin Cancer Res. 2014;20:6212-22.
21. Ustundag Y, Huysal K, Gecgel SK, Unal D. Relationship between C-reactive protein, systemic immune-inflammation index, and routine hemogram-related inflammatory markers in low-grade inflammation. Int J Med Biochem. 2018;1:24-28.
22. Yang YL, Wu CH, Hsu PF, Chen SC, Huang SS, Chan WL et al. Systemic immune-inflammation index (SII) predicted clinical outcome in patients with coronary artery disease. Eur J Clin Invest. 2020;50:e13230.
23. Hou D, Wang C, Luo Y, Ye X, Han X, Feng Y et al. Systemic immune-inflammation index (SII) but not platelet-albumin-bilirubin (PALBI) grade is associated with severity of acute ischemic stroke (AIS). Int J Neurosci. 2021;131:1203-08.