Obstetrics; *Maternal Fetal Medicine and Perinatology*

Albumin-Related Inflammatory Indices in the Prediction of Placental Abruption: A Clinical-Laboratory Study

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ABSTRACT

OBJECTIVE: We aimed to evaluate the diagnostic utility of albumin-related inflammatory indices in predicting placental abruption (PA) and to explore their potential advantages over conventional clinical and laboratory parameters. For this purpose, we assessed the neutrophil-to-albumin ratio (NAR), neutrophil percentage-to-albumin ratio (NPAR), blood urea nitrogen-to-albumin ratio (BAR), and serum albumin-to-creatinine ratio (sACR), and examined their associations with neonatal outcomes.

STUDY DESIGN: This retrospective cohort study included 179 singleton pregnancies, comprising 64 patients diagnosed with PA and 115 healthy controls. Maternal demographic and clinical characteristics were recorded, including age, gravidity, parity, pre-pregnancy body mass index (BMI, kg/m²), history of preterm birth, previous cesarean delivery, use of low-molecular-weight heparin (LMWH), need for blood transfusion, and length of hospital stay. Neonatal outcomes included gestational age at birth, birth weight, 1- and 5-minute Apgar scores below 7, and neonatal intensive care unit (NICU) admission. Receiver operating characteristic (ROC) curve analysis was used to evaluate the diagnostic performance of the indices, while multivariate logistic regression and analysis of covariance (ANCOVA) were performed to adjust for gestational age.

RESULTS: NPAR and BAR levels were significantly higher in the PA group compared to controls. These indices demonstrated moderate discriminatory ability and remained statistically significant after adjustment for gestational age. Although NAR and sACR were also associated with PA, their diagnostic utility appeared more limited.

CONCLUSION: Among the albumin-associated inflammatory indices evaluated, NPAR and BAR demonstrated the strongest associations with placental abruption and may serve as useful adjunctive markers in clinical evaluation. Although NAR and sACR also showed statistically significant associations, their limited diagnostic performance suggests the need for further investigation before clinical implementation.

Keywords: Biomarkers; Inflammation mediators; Placental abruption

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Introduction

Placental abruption (PA) is an obstetric emergency associated with significant maternal and fetal morbidity and mortality, affecting approximately 1% of pregnancies. Several risk factors, including advanced maternal age, hypertensive disorders, prior preterm birth, and multiple gestation, have been identified; however, the underlying pathophysiological mechanisms remain incompletely understood (1,2). As with many pregnancy-related complications, impaired maternal–fetal adaptation and inflammatory pathways are increasingly recognized as major contributors to the development of PA (3). Several obstetric complications, such as chorioamnionitis and preterm rupture of membranes (PROM), have been implicated in the pathogenesis of PA, primarily through mechanisms involving cytokine release, increased vascular permeability, and endothelial injury (4,5). Supporting this hypothesis, histopathological studies have demonstrated enhanced infiltration of neutrophils and macrophages in placental tissues from affected pregnancies, further underscoring the role of inflammation in the development of PA (6).

Despite its clinical significance, antenatal diagnosis of PA remains challenging. Ultrasonography often fails to detect placental separation in early stages or cases without overt symptoms such as vaginal bleeding or uterine tenderness (7). When clinical or sonographic signs are present, the condition can deteriorate within minutes and is often associated with worse outcomes, including an increased risk of maternal morbidity and fetal mortality (8,9). Approximately half of PA cases occur before 37 weeks of gestation, and a recognizable risk factor cannot be identified in most cases (10). In this context, the absence of a widely accepted biochemical test for PA represents a critical gap in obstetric care, underscoring the need to explore novel, accessible biomarkers that could facilitate earlier detection and improve clinical decision-making.

Among the biomarkers most applicable in clinical practice, inflammation-related markers have gained attention due to their feasibility and widespread use. These include parameters that are routinely assessed in most clinical settings, such as neutrophils, blood urea nitrogen (BUN), creatinine, and albumin. Neutrophils are key components of the innate immune system and serve as early indicators of systemic inflammation (11). BUN may also rise in response to acute inflammatory stress, reflecting increased protein catabolism and metabolic demand (12). Creatinine, another widely used laboratory parameter, may indicate systemic metabolic stress and renal perfusion status (13). In contrast, albumin is a negative acute-phase reactant, with levels that decline during inflammation due to suppressed hepatic synthesis and increased vascular permeability (14).

Based on these mechanisms, several composite indices that combine inflammatory markers with albumin have been developed to offer a more integrated assessment of systemic inflammation and nutritional status. Among the most studied are the neutrophil-to-albumin ratio (NAR), neutrophil percentage-to-albumin ratio (NPAR), blood urea nitrogen-to-albumin ratio (BAR), and serum albumin-to-creatinine ratio (sACR), which have shown promise in various clinical settings, including sepsis, malignancies, and cardiovascular diseases (15-18). Multiple studies have reported their potential role in obstetric complications such as preeclampsia and gestational diabetes (19,20). Moreover, recent evidence suggests that elevated neutrophil counts may be linked to an increased risk of PA, supporting the potential value of inflammation-based hematological parameters in this context (21).

In light of these considerations, this study aimed to evaluate the diagnostic value of albumin-associated inflammatory indices-including NAR, NPAR, BAR, and sACR-in pregnancies complicated by PA. We hypothesized that these indices could serve as valuable adjuncts in the early detection of PA, particularly when clinical or sonographic indicators are absent.

Material and Method

This retrospective cohort study included singleton pregnancies diagnosed with PA at a tertiary care center. The study protocol was approved by the local ethics committee (Approval No: AESH-BADEK1-2024-723) and conducted in accordance with the principles outlined in the Declaration of Helsinki. Given the retrospective design, the requirement for written informed consent for the use of patient data was waived by the ethics committee. Eligible cases were identified through a review of electronic medical records between September 2022 and July 2024.

Given the potential ambiguity of clinical and sonographic findings in PA, diagnoses were confirmed through intraoperative visualization of localized placental separation and, in most cases, subsequent histopathological examination of the placental tissue. To avoid diagnostic uncertainty, pregnancies complicated by placenta previa were excluded, as physiologic placental separation may occur in such cases. To minimize confounding due to chronic placental insufficiency, pregnancies affected by fetal growth restriction, oligohydramnios, or abnormal Doppler velocimetry were also excluded. Additional exclusion criteria included pregnancies conceived via in vitro fertilization (IVF); those complicated by maternal autoimmune disorders, bleeding diatheses, chronic renal or hepatic disease, or confirmed infections. To reduce confounding influences on neonatal outcomes, pregnancies with multiple gestations, fetal congenital anomalies, or premature rupture of membranes were also excluded. A control group consisted of healthy singleton pregnancies without any maternal comorbidities or fetal anomalies.

Maternal characteristics, including age, gravidity, parity, body mass index (BMI; kg/m^2), previous cesarean delivery, gestational age at delivery, number of transfused blood products, and length of hospitalization, were recorded. Neonatal outcomes included birth weight, APGAR scores at 1 and 5 minutes, and neonatal intensive care unit (NICU) admission.

Laboratory parameters for the PA group were obtained at the time of diagnosis, whereas in the control group, data were derived from routine laboratory evaluations performed within one week prior to delivery. These data were used to calculate inflammatory indices as follows:

- NAR = neutrophil count (×10/L)/albumin (g/dL)
- NPAR = neutrophil percentage/albumin (g/dL)
- BAR = blood urea nitrogen (mg/dL)/albumin (g/dL)
- sACR = albumin (g/dL)/creatinine (mg/dL)

Statistical analyses were performed using IBM SPSS Statistics version 27.0. Descriptive statistics and frequency tables were used for data summarization. Normality of distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For normally distributed variables, independent samples t-tests were applied, with results expressed as

mean ± standard deviation (SD); for non-normally distributed variables, the Mann-Whitney U test was employed, and data were presented as median (Q1-Q3). Categorical variables were compared using Pearson's chi-square test. Associations between non-normally distributed variables were evaluated using Spearman correlation analysis. A p-value <0.05 was considered statistically significant.

The diagnostic performance of NAR, NPAR, BAR, and sACR in predicting PA was evaluated using receiver operating characteristic (ROC) curve analysis. The primary threshold for each index was determined by the shortest Euclidean distance to the ideal ROC point (0, 1), calculated as: $\sqrt{((1- \text{Specificity})^2 + (1 - \text{Sensitivity})^2)}$. The threshold minimizing this distance was selected. As a sensitivity analysis, we also examined Youden's J index (sensitivity + specificity - 1); however, in our dataset, the Youden-maximizing cut-offs yielded a high-specificity/low-sensitivity profile judged clinically suboptimal for case detection. For each selected threshold, sensitivity, specificity, positive and negative likelihood ratios (LR+, LR-), and predictive values (PPV, NPV) were calculated. Univariate and backward stepwise multivariate logistic regression analyses were used to identify predictors of PA.

Additionally, analysis of covariance (ANCOVA) was performed to compare NPAR and sACR values between groups after adjusting for gestational age. To address heteroscedasticity, HC3 robust standard errors were applied. Estimated marginal means and standard errors were calculated at the mean gestational age, and partial eta squared (η^2) values were reported as measures of effect size.

Results

This retrospective study included 64 patients diagnosed with PA and a control group of 115 healthy singleton pregnancies. Baseline maternal characteristics such as age, gravidity, parity, pre-pregnancy BMI, history of preterm birth, prior cesarean delivery, and use of low-molecular-weight heparin (LMWH) were evaluated. Gravidity, parity, history of preterm birth, and prior cesarean delivery were significantly more common in the PA group ($p<0.05$ for all). Additionally, the PA group had a higher rate of blood product transfusion and longer hospitalization duration compared to controls ($p< 0.001$ for both). Neonatal outcomes - including gestational age at delivery, birth weight, Apgar scores at 1 and 5 minutes, and NICU admission - were significantly less favorable in the PA group ($p<0.001$ for all). Detailed maternal and perinatal characteristics are presented in Table I.

Hematological, biochemical, and inflammatory profiles were compared between the PA and control groups. Hemoglobin, leukocyte, neutrophil, lymphocyte, and platelet counts did not differ significantly between the groups. However, albumin and fibrinogen levels were significantly lower in the PA group ($p<0.001$ for both), suggesting an acute-phase response. Among liver and renal function parameters, AST and BUN levels were significantly elevated in the PA group ($p= 0.002$ and $p= 0.028$, respectively), whereas ALT and creatinine levels showed no significant difference. In terms of composite inflammatory indices, NAR, NPAR, and BAR were significantly higher in the PA group ($p= 0.008$, <0.001, and <0.001, respectively), while sACR was significantly lower ($p= 0.003$). For NPAR, the effect size calculated using Cohen's d was 0.764 (95% CI: 0.448-1.079) (Table II).

ROC analysis demonstrated that NAR, NPAR, BAR, and sACR had varying degrees of discriminatory power for identifying PA (Table III). Among these indices, NPAR and BAR showed the highest diagnostic performance, with moderate sensitivity and specificity.

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

Variable	PA group (n=64)	Control group (n=115)	p
Maternal age (years)*	29.3 ± 6.0	27.7 ± 5.3	0.077
Gravidity*	2 (1-4)	2 (1-3)	0.007
Parity*	1 (0-2)	1 (0-2)	0.021
Maternal BMI (kg/m²)*	28.0 (25.5-30.0)	29.0 (26.0-32.6)	0.084
History of preterm birth†	30 (46.9%)	7 (6.1%)	<0.001
History of cesarean delivery†	59 (92.2%)	29 (25.2%)	<0.001
Using LMWH†	4 (6.3%)	3 (2.6%)	0.228
Patients requiring blood product transfusion†	15 (23.4%)	7 (6.1%)	<0.001
Length of hospital stay (days)*	3.5 (3-5)	2.0 (2-3)	<0.001
Perinatal outcomes†			
Gestational age at delivery (weeks)	37 (32-39)	39 (38 - 40)	<0.001
Birthweight (g)	2507 ± 999	3319 ± 435	<0.001
Apgar score ≤7 at 1 minute	36 (56.3%)	7 (6.1%)	<0.001
Apgar score ≤7 at 5 minutes	24 (37.5%)	2 (1.7%)	<0.001
NICU admission	31 (53.4%)	7 (6.1%)	<0.001

**: Values are presented as mean ± standard deviation or median (IQR) as appropriate.*
†: Neonatal outcomes are presented as number (%).
BMI: Body mass index; LMWH: Low molecular weight heparin; NICU: Neonatal intensive care unit.

Table II: *Comparison of hematological, biochemical, and coagulation parameters between the PA and control groups.*

	PA group (n=64)	Control group (n=115)	p
Hb (g/dL)	11.9 (11.3 - 13.0)	11.8 (10.8 - 12.9)	0.355
WBC (10^3/μL)	11140 (9010 - 14140)	10800 (9270 - 12430)	0.244
Thrombocyte (10^3/μL)	229 (194 - 274)	247 (206 - 285)	0.273
Albumin (g/L)	34.0 (32.0 - 37.0)	37.3 (36.2 - 38.4)	<0.001
Fibrinogen (mg/dL)	428 (367 - 489)	483 (436 - 541)	<0.001
ALT (U/L)	11.0 (9.0 - 14.0)	10.0 (8.0 - 14.0)	0.280
AST (U/L)	20.0 (18.0 - 26.0)	18.0 (16.0 - 21.0)	0.002
BUN (mg/dL)	16.0 (12.5 - 21.5)	14.5 (11.9 - 17.2)	0.028
Creatinine (mg/dL)	0.535 (0.455 - 0.630)	0.510 (0.460 - 0.600)	0.280
Neutrophil count (10^9/L)	8.050 (6.085 - 10.735)	7.980 (6.650 - 8.930)	0.413
Lymphocyte count (10^9/L)	2.175 (1.795 - 2.865)	2.060 (1.590 - 2.480)	0.095
Neutrophil percentage (%)	70 (67 - 79)	72 (68 - 76)	0.620
NAR	0.237 (0.188 - 0.319)	0.207 (0.176 - 0.245)	0.008
NPAR	21.237 ± 3.071	19.396 ± 1.949	<0.001
BAR	4.605 (3.750 - 6.621)	3.913 (3.111 - 4.651)	<0.001
sACR	6.622 ± 1.793	7.386 ± 1.505	0.003

Hb: Hemoglobin, WBC: White blood cells, PT: Prothrombin time, aPTT: Activated partial thromboplastin time, INR: International normalized ratio, ALT: Alanine aminotransferase, AST: Aspartate aminotransferase, BUN: Blood urea nitrogen, NAR: Neutrophil-to-albumin ratio, NPAR: Neutrophil percentage-to-albumin ratio, BAR, Blood urea nitrogen-to-albumin ratio, sACR: Serum albumin-to-creatinine ratio.

Table III: *ROC analysis of albumin-related indices for the diagnosis of placental abruption*

Index	Cut-off	AUC (95% CI)	Sensitivity (%)	Specificity (%)	LR+	LR-	p
NAR	≥0.227	0.619 (0.544-0.691)	57.8	62.6	1.55	0.67	0.010
NPAR	≥19.839	0.681 (0.607-0.748)	65.6	65.2	1.89	0.53	<0.001
BAR	≥4.155	0.660 (0.586-0.729)	64.1	60.0	1.60	0.60	<0.001
sACR	≤6.655	0.638 (0.563-0.708)	53.1	68.7	1.70	0.68	0.002

ROC analyses were performed, and the results were interpreted with a 95% confidence interval. Statistical significance was set at p<0.05
ROC: Receiver operating characteristic, AUC: Area under the curve, LR: Likelihood ratio

In the multivariable logistic regression analyses, each index was entered into a separate model adjusted for maternal age, pre-pregnancy BMI, and history of preterm birth to avoid potential multicollinearity due to the shared albumin component. Lower NAR values were significantly associated with an increased risk of placental abruption (aOR = 0.011, 95% CI: 0.000 - 0.251, p= 0.002). Similarly, lower NPAR (aOR = 0.715, 95% CI: 0.604-0.847, p<0.001) and lower BAR (aOR = 0.662, 95% CI: 0.507 - 0.865, p= 0.002) values were also independently associated with placental abruption. In contrast, higher sACR values were associated with increased odds of placental abruption (aOR = 1.350, 95% CI: 1.069-1.705, p= 0.012) (Table IV).

ANCOVA revealed a statistically significant difference in NPAR levels between the PA and control groups after adjusting for gestational age at delivery ($F(1,176) = 12.549$, $p< 0.001$, partial $\eta^2 = 0.067$; Table 5). The estimated marginal mean was significantly higher in the PA group (21.040 ± 0.331) than in the control group (19.505 ± 0.237). Gestational age at delivery did not significantly affect NPAR levels (p= 0.261).

Table IV: *Multivariable logistic regression of albumin-related indices for predicting placental abruption*

Index	aOR	95% CI	p
NAR	0.011	0.000 - 0.251	0.002
NPAR	0.715	0.604 - 0.847	<0.001
BAR	0.662	0.507 - 0.865	0.002
sACR	1.350	1.069 - 1.705	0.012

Each index was analyzed in a separate multivariable logistic regression model adjusted for maternal age, pre-pregnancy BMI, and history of preterm birth to avoid potential multicollinearity due to the shared albumin component.
aOR: Adjusted odds ratio, CI: Confidence interval

Table V: *ANCOVA results comparing NPAR and sACR between the PA and control groups, adjusted for gestational age*

Dependent Variable	Source	Mean Square	F	p	Partial η²	Estimated Marginal Means (Mean ± SE)	Mean Difference (95% CI)
NPAR	PA vs. Control	72.413	12.549	0.001	0.067	PA: 21.040 ± 0.331 Control: 19.505 ± 0.237	1.536 (0.680 to 2.391)
	GA (covariate)	1.350	1.967	0.261	0.007		
sACR	PA vs. Control	0.183	5.454	0.021	0.030	PA: 6.676 ± 0.223 Control: 7.357 ± 0.160	-0.681 (-1.257 to -0.106)
	GA (covariate)	0.011	0.314	0.640	0.001		

ANCOVA models were adjusted using HC3 robust standard errors due to variance heterogeneity. Estimated marginal means are reported at the covariate mean gestational age (GA) of 37.7 weeks.
ANCOVA: Analysis of covariance, SE: Standard error, CI: Confidence Interval

Discussion

Pregnancy represents a dynamic equilibrium between maternal and fetal inflammatory mediators, and disruption of this balance has been implicated in abnormal placentation processes (22). Histopathological evidence has shown increased neutrophilic infiltration and inflammatory alterations in placental tissues. For instance, Kovo et al. identified acute histologic chorioamnionitis in 22% of patients with PA, while Nath et al. reported enhanced neutrophil infiltration in PA cases complicated by histologic chorioamnionitis (23,24). These findings support the hypothesis that inflammation contributes to decidual vasculopathy, trophoblastic dysfunction, and placental infarction, key mechanisms underlying the pathophysiology of PA (25).

When evaluated alongside markers such as neutrophil count and BUN, albumin may offer a more comprehensive perspective on systemic inflammation and metabolic stress (26,27). Hypoalbuminemia may reflect both systemic inflammation and increased vascular permeability. Inflammatory cytokines such as interleukin (IL)-6 and vascular endothelial growth factor (VEGF) can suppress hepatic albumin synthesis in acute inflammatory states, while concomitant endothelial activation and vascular leakage contribute to extravascular albumin loss (28). Based on this rationale, we hypothesized that albumin-related inflammatory indices may more comprehensively reflect the underlying inflammatory processes of PA.

In this study, we evaluated several composite indices that combine immune cell activity with albumin levels to reflect systemic inflammation, nutritional status, and metabolic burden. NPAR, first introduced by Hehe Cui in 2019, was initially reported as a predictor of mortality in cardiovascular disease (29). Since then, it has been investigated in various clinical contexts, including its potential to predict neonatal outcomes in preeclamptic pregnancies (19,30). Although BAR has demonstrated prognostic value in several medical conditions, its utility in obstetric populations remains underexplored (31).

Among the indices examined, NPAR and BAR emerged as the most reliable and clinically informative predictors of PA. Both demonstrated moderate diagnostic accuracy in ROC analysis and retained independent associations in multivariate models. These findings suggest that NPAR and BAR may serve as valuable tools for obstetric risk stratification.

In addition to NPAR and BAR, our analysis also investigated the potential relevance of other albumin-associated indices, including NAR and sACR. Although NAR has been proposed as a useful inflammatory marker in various clinical settings, its role in obstetric complications remains unclear (32,33). NAR is calculated using the absolute neutrophil count, whereas NPAR is based on the neutrophil percentage relative to the total leukocyte count. This distinction may carry clinical significance, as NPAR may better capture the dynamic shifts in immune activity, particularly relevant in acute conditions such as PA. Consistent with this, the discriminatory capacity of NAR appeared more limited when compared to the more integrative indices, NPAR and BAR.

However, its clinical utility in obstetric populations, particularly under acute hemodynamic disturbances such as those seen in PA, remains uncertain. Physiological alterations in glomerular filtration during pregnancy may reduce the sensitivity of creatinine-based indices like sACR for detecting early renal dysfunction (34). This may account for its relatively weaker predictive performance in our study compared to NPAR and BAR.

Overall, among the evaluated indices, NPAR and BAR consistently demonstrated superior performance in identifying pregnancies complicated by PA. Higher values of both indices were independently associated with a reduced risk of PA after adjustment for maternal age, pre-pregnancy BMI, and history of preterm birth. Specifically, each 1-point increase in NPAR was associated with a 22% reduction in the odds of PA, whereas each 1-point increase in BAR corresponded to a 29.5% reduction in risk. These findings suggest that NPAR and BAR may serve as supportive tools in obstetric risk as-

sessment. While NAR and sACR also demonstrated statistically significant associations, their comparatively lower diagnostic performance warrants further investigation.

This study has several strengths, including the evaluation of novel albumin-based inflammatory indices within a well-defined obstetric cohort and the use of rigorous inclusion and exclusion criteria to minimize confounding. However, certain limitations should be acknowledged. The retrospective, single-center design and relatively small sample size may limit the generalizability of the findings, while the absence of long-term follow-up could introduce potential selection bias and preclude causal inference. Additionally, unmeasured variables, such as subclinical infections, may have influenced biomarker levels. Although the observed sensitivity and specificity values for NPAR and BAR were statistically significant, their relatively modest magnitude may limit their standalone diagnostic value. These indices may have greater clinical applicability when combined with other laboratory or clinical parameters to improve predictive accuracy. Larger, multicenter prospective studies are warranted to validate these findings and improve the generalizability of the results.

Conclusion

In conclusion, our results suggest that albumin-associated inflammatory indices, particularly NPAR and BAR, may serve as valuable tools for the early identification of PA. Their integration into routine laboratory panels could improve diagnostic accuracy and facilitate timely clinical decision-making, with the potential to enhance maternal and neonatal outcomes. Prospective, multicenter studies are warranted to validate these findings across broader populations and diverse clinical settings.

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Ethics Approval and Consent to Participate: The study protocol was approved by the local ethics committee (Approval No: AESH-BADEK1-2024-723, dated July 31, 2024) and conducted in accordance with the principles of the Declaration of Helsinki. Given the retrospective design, the requirement for written informed consent for the use of patient data was waived by the ethics committee.

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Authors' Contributions: ACB: Conception and manuscript writing; DSK: Data analysis; BS: Data collection; KYY: Supervision

Conflict of Interest Statement: The authors declare no conflict of interest.

References

1. Oyelese Y, Ananth CV. Placental abruption. Obstet Gynecol. 2006;108(4):1005-16. Doi: 10.1097/01.AOG.0000239439.04364.9a. PMID: 17012465.
2. Ananth CV, Oyelese Y, Yeo L, Pradhan A, Vintzileos AM. Placental abruption in the United States, 1979 through 2001: temporal trends and potential determinants. Am J Obstet Gynecol. 2005;192(1):191-8. Doi: 10. 1016/j.ajog.2004.05.087. PMID: 15672024.
3. Ananth CV, Getahun D, Peltier MR, Smulian JC. Placental abruption in term and preterm gestations: evidence for heterogeneity in clinical pathways. Obstet Gynecol. 2006; 107(4):785-92. Doi: 10.1097/01.AOG.0000207560.41604.19. PMID: 16582113..
4. Ananth CV, Oyelese Y, Srinivas N, Yeo L, Vintzileos AM. Preterm premature rupture of membranes, intrauterine infection, and oligohydramnios: risk factors for placental abruption. Obstet Gynecol. 2004;104(1):71-7. Doi: 10.1097/01.AOG.0000128172.71408.a0. PMID: 15229003.
5. Steinborn A, Seidl C, Sayehli C, Sohn C, Seifried E, Kaufmann M, et al. Anti-fetal immune response mechanisms may be involved in the pathogenesis of placental abruption. Clin Immunol. 2004;110(1):45-54. Doi: 10.1016/j.clim.2003.09.004. PMID: 14962795.
6. Redline RW. Placental inflammation. Semin Neonatol. 2004;9(4):265-74. Doi: 10.1016/j.siny.2003.09.005. PMID: 15251143.
7. Glantz C, Purnell L. Clinical utility of sonography in the diagnosis and treatment of placental abruption. J Ultrasound Med. 2002;21(8):837-40. Doi: 10.7863/jum.2002.21.8.837. PMID: 12164566.
8. Bodelon C, Bernabe-Ortiz A, Schiff MA, Reed SD. Factors associated with peripartum hysterectomy. Obstet Gynecol. 2009;114(1):115-23. Doi: 10.1097/AOG.0b01 3e3181a81cdd. PMID: 19546767, PMCID: PMC2714 706.
9. Tikkanen M, Gissler M, Metsäranta M, Luukkaala T, Hiilesmaa V, Andersson S, et al. Maternal deaths in Finland: focus on placental abruption. Acta Obstet Gynecol Scand. 2009;88(10):1124-7. Doi: 10.1080/00016340903214940. PMID: 19707898.
10. Ananth CV, Berkowitz GS, Savitz DA, Lapinski RH. Placental abruption and adverse perinatal outcomes. JAMA. 1999;282(17):1646-51. Doi: 10.1001/jama.282.17.1646. PMID: 10553791.
11. Kaufmann SH. Immunology's foundation: the 100-year anniversary of the Nobel Prize to Paul Ehrlich and Elie Metchnikoff. Nat Immunol. 2008;9(7):705-12. Doi: 10.1038/ni0708-705. PMID: 18563076.
12. Schutz Y. Protein turnover, ureagenesis and gluconeogenesis. Int J Vitam Nutr Res. 2011;81(2-3):101-7. Doi: 10.1024/0300-9831/a000064. PMID: 22139560.
13. Kashani K, Rosner MH, Ostermann M. Creatinine: from

physiology to clinical application. Eur J Intern Med. 2020;72:9-14. Doi: 10.1016/j.ejim.2019.10.025. Erratum in: Eur J Intern Med. 2023 Oct;116:168-9. Doi: 10. 1016/j.ejim.2023.07.025. PMID: 31708357.

14. Moshage HJ, Janssen JA, Franssen JH, Hafkenscheid JC, Yap SH. Study of the molecular mechanism of decreased liver synthesis of albumin in inflammation. J Clin Invest. 1987;79(6):1635-41. Doi: 10.1172/JCI113000. PMID: 3584463, PMCID: PMC424488.

15. Wang X, Zhang Y, Wang Y, Liu J, Xu X, Liu J, et al. The neutrophil percentage-to-albumin ratio is associated with all-cause mortality in patients with chronic heart failure. BMC Cardiovasc Disord. 2023;23(1):568. Doi: 10.1186/s12872-023-03472-9. PMID: 37980510, PMCID: PMC10657562.

16. Xie H, Jia P, Wei L, Ruan G, Zhang H, Ge Y, et al. Evaluation and validation of neutrophil to albumin ratio as a promising prognostic marker for all-cause mortality in patients with cancer: a multicenter cohort study. Nutrition. 2024;121:112365. Doi: 10.1016/j.nut.2024.112365. PMID: 38377700.

17. Wang Y, Gao S, Hong L, Hou T, Liu H, Li M, et al. Prognostic impact of blood urea nitrogen to albumin ratio on patients with sepsis: a retrospective cohort study. Sci Rep. 2023;13(1):10013. Doi: 10.1038/s41598-023-37127-8. PMID: 37340147, PMCID: PMC10282077.

18. Mahemuti N, Zou J, Liu C, Xiao Z, Liang F, Yang X. Urinary Albumin-to-Creatinine Ratio in Normal Range, Cardiovascular Health, and All-Cause Mortality. JAMA Netw Open. 2023;6(12):e2348333. Doi: 10.1001/jamanetworkopen.2023.48333. PMID: 38113044, PMCID: PMC10731498.

19. Biçer Ç, Akkuş F, Dal Y. First-trimester neutrophil percentage-to-albumin ratio: a novel predictor for preeclampsia. Biomark Med. 2025;19(11):415-23. Doi: 10.1080/17520363.2025.2511468. PMID: 40415382, PMCID: PMC12140476.

20. Li L, Zhu Q, Wang Z, Tao Y, Liu H, Tang F, et al. Establishment and validation of a predictive nomogram for gestational diabetes mellitus during early pregnancy term: A retrospective study. Front Endocrinol (Lausanne). 2023;14:1087994. Doi: 10.3389/fendo.2023.1087994. PMID: 36909340, PMCID: PMC9998988.

21. Ozkan S, Firatligil FB, Sucu S, Dereli ML, Kurt D, Yigit A, et al. Can inflammatory biomarkers based on first trimester complete blood count parameters predict placental abruption ?: A case-control study. J Reprod Immunol. 2024;164:104279. Doi: 10.1016/j.jri.2024.104279. PMID: 38924810.

22. Challis JR, Lockwood CJ, Myatt L, Norman JE, Strauss JF 3rd, Petraglia F. Inflammation and pregnancy. Reprod Sci. 2009;16(2):206-15. Doi: 10.1177/1933719108329095. PMID: 19208789.

23. Kovo M, Gonen N, Schreiber L, Hochman R, Noy LK, Levy M, et al. Histologic chorioamnionitis concomitant placental abruption and its effects on pregnancy outcome. Placenta. 2020 May;94:39-43. Doi: 10.1016/j.placenta.2020.03.012. PMID: 32421533.

24. Nath CA, Ananth CV, Smulian JC, Shen-Schwarz S, Kaminsky L; New Jersey-Placental Abruption Study Investigators. Histologic evidence of inflammation and risk of placental abruption. Am J Obstet Gynecol. 2007;197(3):319.e1-6. Doi: 10.1016/j.ajog.2007.06.012. PMID: 17826437.

25. Tikkanen M. Placental abruption: epidemiology, risk factors and consequences. Acta Obstet Gynecol Scand. 2011;90(2):140-9. Doi: 10.1111/j.1600-0412.2010.01030.x. PMID: 21241259.

26. Abbasi B, Hayat A, Lyons M, Gupta A, Gupta S. Serum protein and electrolyte imbalances are associated with chemotherapy induced neutropenia. Heliyon. 2022;8(7):e09949. Doi: 10.1016/j.heliyon.2022.e09949. PMID: 35865973, PMCID: PMC9293742.

27. Don BR, Kaysen G. Serum albumin: relationship to inflammation and nutrition. Semin Dial. 2004 Nov-Dec;17(6):432-7. Doi: 10.1111/j.0894-0959.2004.17603.x. PMI D: 15660573.

28. Soeters PB, Wolfe RR, Shenkin A. Hypoalbuminemia: pathogenesis and cinical significance. JPEN J Parenter Enteral Nutr. 2019;43(2):181-93. Doi: 10.1002/jpen.1451. PMID: 30288759, PMCID: PMC7379941.

29. Cui H, Ding X, Li W, Chen H, Li H. The neutrophil percentage to albumin ratio as a new predictor of in-hospital mortality in patients with ST-segment elevation myocardial infarction. Med Sci Monit. 2019;25:7845-52. Doi: 10.12659/MSM.917987. PMID: 31628741, PMCID: PMC6820334.

30. Wu CC, Wu CH, Lee CH, Cheng CI. Association between neutrophil percentage-to-albumin ratio (NPAR), neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR) and long-term mortality in community-dwelling adults with heart failure: evidence from US NHANES 2005-2016. BMC Cardiovasc Disord. 2023;23(1):312. Doi: 10.1186/s12872-023-03316-6. PMID: 37344786, PMCID: PMC10286403.

31. Dundar ZD, Kucukceran K, Ayranci MK. Blood urea nitrogen to albumin ratio is a predictor of in-hospital mortality in older emergency department patients. Am J Emerg Med. 2021;46:349-54. Doi: 10.1016/j.ajem. 2020.10.008. PMID: 33069540.

32. Huang X, Li A, Long P, Liu Y, Zhou Z, Pan Y. The neutrophil-to-albumin ratio (NAR): a novel index in relation to clinical symptoms, quality of life, and psychological status in diarrhea-predominant irritable bowel syndrome (IBS-D). J Inflamm Res. 2024;17:3685-95. Doi: 10.2147/JIR.S458363. PMID: 38882187, PMCID: PMC11177865.

33. Varim C, Yaylaci S, Demirci T, Kaya T, Nalbant A, Dheir H, et al. Neutrophil count to albumin ratio as a new pre-

dictor of mortality in patients with COVID-19 infection. Rev Assoc Med Bras (1992). 2020;66Suppl 2(Suppl 2):77-81. Doi: 10.1590/1806-9282.66.S2.77. PMID: 32965361.

34. Lopes van Balen VA, van Gansewinkel TAG, de Haas S, Spaan JJ, Ghossein-Doha C, van Kuijk SMJ, et al. Maternal kidney function during pregnancy: systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2019;54(3):297-307. Doi: 10.1002/uog.20137. PMID: 30288811, PMCID: PMC6772153.