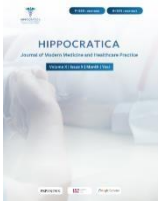

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Overview of Serum Albumin Levels in Post-Sc Mothers With Preeclampsia at Bendan Regional General Hospital in Pekalongan City in 2025

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Abstract

Preeclampsia remains a major cause of maternal morbidity and mortality and is frequently managed by cesarean section. Altered vascular permeability, proteinuria, and perioperative stress may contribute to reduced serum albumin concentrations. This study aimed to describe serum albumin levels among post-cesarean mothers with preeclampsia at Bendan Regional General Hospital, Pekalongan City, in 2025. A descriptive observational design with a retrospective approach was used. Secondary data were obtained from medical records and laboratory information systems and analyzed descriptively. Previous evidence indicates that hypoalbuminemia is common in preeclampsia and cesarean populations, with lower albumin concentrations associated with severe disease, proteinuria, fluid-related complications, and impaired postoperative recovery. Indonesian multicenter studies further demonstrate a high burden of severe preeclampsia and cesarean delivery. Serum albumin is a clinically relevant complementary laboratory parameter for evaluating post-cesarean mothers with preeclampsia. Its interpretation should be integrated with blood pressure, proteinuria, renal and hepatic function, fluid balance, and postoperative findings, rather than serving as an isolated marker of severity or postoperative prognosis in routine practice. These findings support hospital-based monitoring and further analytical research.

Keywords: *serum albumin, preeclampsia, cesarean section, maternal health, hypoalbuminemia.*

INTRODUCTION

Preeclampsia remains a major complication of pregnancy and continues to contribute substantially to maternal and perinatal morbidity and mortality worldwide. The condition generally develops after 20 weeks of gestation and is characterized by hypertension that may be accompanied by proteinuria and various manifestations of maternal organ dysfunction (World Health Organization [WHO], 2025). The WHO estimates that preeclampsia affects approximately 3–8% of women giving birth globally and may progress to eclampsia if it is not detected and managed appropriately. Hypertensive disorders of pregnancy also account for approximately 16% of maternal deaths worldwide, highlighting the importance of identifying clinical and laboratory parameters associated with preeclampsia to improve maternal safety (WHO, 2025).

Preeclampsia also remains highly relevant to maternal health services in Indonesia. The Indonesian Health Profile reported that hypertensive disorders of pregnancy were the leading cause of maternal death in 2023, accounting for 412 cases, exceeding the 360 deaths attributed to obstetric hemorrhage (Ministry of Health of the Republic of Indonesia [MoH RI], 2024). The multicenter Indonesia Pre-eclampsia Study involving 6,763 pregnancies complicated by preeclampsia found that 69% of cases were classified as severe preeclampsia, with a maternal mortality rate of 1.6% (Akbar et al., 2025). These findings indicate that preeclampsia continues to require comprehensive clinical surveillance supported by laboratory assessment to provide a more complete evaluation of maternal physiological status.

Preeclampsia is associated with endothelial dysfunction, increased vascular permeability, and multiorgan disturbances that may disrupt fluid and protein homeostasis in pregnant women. Endothelial injury and renal involvement may increase urinary protein loss, while enhanced capillary permeability facilitates the movement of fluid and plasma proteins from the intravascular

compartment into the interstitial space (MoH RI, 2024). These pathological changes may contribute to reduced plasma protein concentrations, including serum albumin, and may subsequently decrease plasma oncotic pressure and promote edema formation. Serum albumin therefore represents a relevant biochemical parameter for describing physiological alterations in women with preeclampsia (MoH RI, 2024).

Albumin is the most abundant plasma protein and plays an essential role in maintaining oncotic pressure, intravascular fluid distribution, and the transport of various endogenous and exogenous substances. Reduced albumin concentrations or hypoalbuminemia in women with preeclampsia may be associated with proteinuria, altered vascular permeability, and disturbances in fluid balance resulting from the disease process. Previous Indonesian research involving patients with severe preeclampsia and eclampsia has also evaluated serum albumin as a potential parameter related to maternal morbidity and mortality, although statistically significant associations have not always been demonstrated (Jurnal Kesehatan Andalas, 2015). These inconsistent findings indicate that serum albumin profiles in women with preeclampsia remain relevant for investigation across different populations and healthcare settings.

Cesarean section is frequently performed in pregnancies complicated by preeclampsia when maternal or fetal indications require termination of pregnancy. The INAPRES study reported that 72.4% of pregnancies complicated by preeclampsia in an Indonesian national cohort were delivered by cesarean section, demonstrating the frequent use of this mode of delivery among affected women (Akbar et al., 2025). Surgical procedures may induce inflammatory responses, fluid redistribution, blood loss, and alterations in protein metabolism that can influence serum albumin concentrations during the postoperative period. Postoperative reductions in albumin have also been associated with surgical stress responses and several postoperative complications, suggesting that albumin monitoring may have clinical relevance in the evaluation of patients following surgery (Labgaa et al., 2017).

The role of serum albumin in women after cesarean section is particularly important because protein status may influence postoperative recovery and wound healing. Siddiqui et al. (2026) reported that hypoalbuminemia, defined as a serum albumin concentration below 3.5 g/dL, was observed among women undergoing cesarean delivery and was evaluated in relation to postoperative wound complications. Yagur et al. (2022) also identified an association between maternal albumin concentrations before cesarean delivery and postoperative outcomes, although the observed relationship indicated that albumin should not be interpreted as an isolated risk factor. These findings suggest that serum albumin levels in women undergoing cesarean section should be assessed in conjunction with the underlying clinical condition, including the presence of preeclampsia (Yagur et al., 2022; Siddiqui et al., 2026).

Post-cesarean women with preeclampsia constitute a high-risk population requiring close monitoring because they experience both the pathophysiological consequences of hypertensive disorders of pregnancy and the systemic response to surgical intervention. Preeclampsia may result in serious complications, including pulmonary edema, renal impairment, HELLP syndrome, neurological disturbances, and the need for intensive care in severe cases (Akbar et al., 2025). National evidence from Indonesia has demonstrated that pulmonary edema and intensive care unit admission are strongly associated with an increased risk of maternal mortality among women with preeclampsia (Akbar et al., 2025). Measurement of serum albumin during the post-cesarean period may therefore provide additional information regarding protein status and physiological changes during maternal recovery.

Characterization of serum albumin levels among post-cesarean women with preeclampsia is important because patient characteristics, disease severity, nutritional status, protein loss, and responses to surgical intervention may result in considerable variation in albumin concentrations. Hospital-based data on this biochemical parameter may provide useful baseline information for understanding the laboratory profile of affected women and may support the evaluation of maternal care following cesarean delivery. The need for context-specific evidence is particularly relevant because maternal outcomes associated with preeclampsia in Indonesia may vary across regions and healthcare facilities (Akbar et al., 2025). Therefore, this study aims to describe serum albumin levels among post-cesarean section mothers with preeclampsia at Bendan Regional General Hospital, Pekalongan City, in 2025, thereby providing empirical evidence that may support subsequent clinical evaluation and further research.

RESEARCH METHODS

This study employed a descriptive observational design with a retrospective approach to characterize serum albumin levels among post-cesarean section mothers diagnosed with preeclampsia at Bendan Regional General Hospital, Pekalongan City, during 2025. The study population consisted of all post-cesarean section mothers with preeclampsia who underwent serum albumin examination and had medical records available during the study period. Secondary data were obtained from medical records and laboratory information systems, including maternal characteristics and serum albumin examination results. Patients with incomplete medical records or unavailable serum albumin results were excluded from the analysis to ensure the completeness and reliability of the study data.

Data were collected using a structured data collection sheet and subsequently checked for completeness, consistency, and eligibility before statistical analysis. Serum albumin levels were treated as the primary study variable and were categorized according to the reference values applied by the hospital laboratory, while relevant maternal characteristics were summarized to describe the study population. Descriptive statistical analysis was performed using frequencies and percentages for categorical variables, whereas numerical variables were presented as mean and standard deviation or median and interquartile range, depending on the distribution of the data. The findings were subsequently presented in tables and descriptive narratives to provide a comprehensive overview of serum albumin levels among post-cesarean section mothers with preeclampsia at Bendan Regional General Hospital during the study period.

RESULTS AND DISCUSSION

Serum Albunim Profile in Preeclampsia and Cesarean Populations

Serum albumin abnormalities are frequently observed in pregnancies complicated by preeclampsia, although the magnitude of reduction differs substantially across populations and clinical settings. Preeclampsia is characterized by endothelial dysfunction, increased vascular permeability, and renal protein loss, all of which may contribute to declining circulating albumin concentrations. The World Health Organization reported that preeclampsia affects approximately 3–8% of women giving birth worldwide, while hypertensive disorders accounted for approximately 16% of global maternal deaths in 2023. These epidemiological data demonstrate the importance of biochemical assessment, including serum albumin measurement, in populations at increased maternal risk (WHO, 2025).

Large-scale Indonesian evidence further demonstrates the substantial clinical burden of preeclampsia among hospitalized pregnant women. The Indonesia Pre-eclampsia Study evaluated 6,763 pregnancies with preeclampsia from 30 hospitals and reported that 69.0% had severe preeclampsia, 35.5% had preterm preeclampsia, and 72.4% underwent cesarean delivery. The same study documented maternal mortality of 1.6%, eclampsia in 7.4%, HELLP syndrome in 8.9%, and intensive care unit admission in 12.6% of cases. These findings are particularly relevant to research involving post-cesarean mothers with preeclampsia because operative delivery represents a major component of contemporary preeclampsia management in Indonesia (Akbar et al., 2026).

Direct evidence concerning serum albumin concentrations has demonstrated lower values among women with more severe preeclampsia. Benoit and Rey (2011) analyzed 459 women with preeclampsia, of whom 62.7% fulfilled criteria for severe disease. Mean plasma albumin was significantly lower in women with severe preeclampsia at 23.5 ± 3.7 g/L, equivalent to approximately 2.35 ± 0.37 g/dL, compared with 25.9 ± 2.8 g/L or approximately 2.59 ± 0.28 g/dL among women with non-severe disease. The difference remained significant after adjustment for gestational age and number of fetuses, supporting an association between decreasing albumin concentrations and greater disease severity (Benoit & Rey, 2011).

More recent Indonesian data provide further support for this relationship. Marlina et al. (2026) conducted a multicenter retrospective study involving 245 pregnant women with preeclampsia at Dr. Hasan Sadikin General Hospital and Prof. Dr. Margono Soekarjo Regional General Hospital between 2022 and 2024. Severe hypoalbuminemia was associated with a 4.4-fold greater risk of preeclampsia with severe features compared with mild-to-moderate hypoalbuminemia, and receiver operating characteristic analysis identified a serum albumin cut-off of 2.51 g/dL for predicting severe features. The significant association between hypoalbuminemia and preeclampsia severity ($p < 0.001$)

strengthens the relevance of serum albumin assessment in Indonesian obstetric populations (Marlina et al., 2026).

Serum albumin concentrations are also relevant in women undergoing cesarean section because pregnancy physiology and operative stress may influence circulating protein levels. Yagur et al. (2022) evaluated 537 women undergoing elective cesarean delivery and reported serum albumin concentrations ranging from 2.4 to 4.3 g/dL, with both the mean and median values being 3.3 g/dL. A total of 250 women, representing 46.6% of the cohort, had serum albumin concentrations below 3.3 g/dL, whereas 287 women or 53.4% had concentrations of at least 3.3 g/dL. These data illustrate that relatively low albumin concentrations are common even among cesarean populations not exclusively selected for preeclampsia (Yagur et al., 2022).

Table 1. Comparative Evidence on Serum Albumin Levels and Clinical Outcomes in Preeclampsia and Cesarean Delivery

Study	Population	Albumin Findings / Cut-off	Major Numerical Findings
Benoit & Rey (2011)	459 women with preeclampsia	Severe PE: 2.35 ± 0.37 g/dL; non-severe PE: 2.59 ± 0.28 g/dL	62.7% had severe PE; 44 women had albumin <2.0 g/dL
Veronika et al. (2015)	133 severe PE/eclampsia cases	Hypoalbuminemia identified in the cohort	Hypoalbuminemia 3.8%; maternal morbidity 33.8%; mortality 3.8%
Yagur et al. (2022)	537 elective cesarean deliveries	Cut-off 3.3 g/dL; range 2.4–4.3 g/dL	<3.3 g/dL: 250 (46.6%); ≥3.3 g/dL: 287 (53.4%)
Siddiqui et al. (2026)	500 cesarean deliveries	Hypoalbuminemia <3.5 g/dL	95 (19.0%) hypoalbuminemic; 405 (81.0%) non-hypoalbuminemic
Marlina et al. (2026)	245 women with preeclampsia	Severe hypoalbuminemia ≤2.5 g/dL; ROC cut-off 2.51 g/dL	Severe hypoalbuminemia associated with 4.4-fold greater risk of PE with severe features
Akbar et al. (2026)	6,763 Indonesian PE pregnancies	Albumin not the primary variable	Severe PE 69.0%; cesarean section 72.4%; maternal mortality 1.6%

PE: preeclampsia; ROC: receiver operating characteristic.

The comparative data presented in Table 1 demonstrate considerable heterogeneity in serum albumin profiles across preeclampsia and cesarean populations. Yagur et al. (2022) identified albumin levels below 3.3 g/dL in 46.6% of women undergoing elective cesarean delivery, whereas Siddiqui et al. (2026) identified hypoalbuminemia below 3.5 g/dL in 95 of 500 women, corresponding to 19.0%. The difference between these proportions should not be interpreted as contradictory because the studies employed different albumin thresholds, populations, inclusion criteria, and clinical settings. Nevertheless, both investigations indicate that reduced serum albumin represents a clinically observable biochemical condition among women undergoing cesarean section (Yagur et al., 2022; Siddiqui et al., 2026).

The findings reported by Siddiqui et al. (2026) are particularly relevant when serum albumin is considered in the postoperative context. Among women with albumin concentrations below 3.5 g/dL, 44.2% developed wound infection, compared with only 8.1% among women with albumin concentrations of at least 3.5 g/dL. Hypoalbuminemia was associated with an 8.93-fold increase in the odds of wound infection, with a 95% confidence interval of 5.04–15.89, while an albumin threshold below 3.35 g/dL predicted wound infection with 95% sensitivity and 89% specificity. These results suggest that identifying reduced albumin concentrations may provide additional information for postoperative surveillance among cesarean patients, although clinical decisions should not be based on albumin alone (Siddiqui et al., 2026).

Earlier Indonesian evidence provides a somewhat different perspective and illustrates why albumin must be interpreted cautiously. Veronika et al. (2015) analyzed 133 patients with severe preeclampsia and eclampsia at Dr. M. Djamil Hospital, Padang, and reported maternal morbidity in

33.8%, maternal mortality in 3.8%, and hypoalbuminemia in 3.8% of patients. Serum albumin was not significantly associated with maternal morbidity ($p = 1.000$) or mortality ($p = 0.177$) in that study. The findings indicate that although serum albumin may reflect physiological alterations associated with preeclampsia, it cannot consistently function as an independent predictor of severe maternal outcomes (Veronika et al., 2015).

A similar caution was reported by Benoit and Rey (2011), despite their observation of significantly lower albumin levels among patients with severe preeclampsia. Forty-four of the 459 women in their study had plasma albumin concentrations below 20 g/L or 2.0 g/dL, and these women more frequently exhibited thrombocytopenia, elevated alanine aminotransferase, severe proteinuria, and the need for platelet transfusion. However, an albumin concentration below 20 g/L was not considered an independent criterion of severe preeclampsia because affected women also presented with other adverse clinical abnormalities. Serum albumin should therefore be incorporated into a multidimensional clinical assessment rather than used as an isolated severity marker (Benoit & Rey, 2011).

The postoperative period may further modify serum albumin concentrations through inflammatory responses, capillary leakage, hemodilution, blood loss, and redistribution of albumin between intravascular and extravascular compartments. Evidence from surgical populations has shown that an acute decrease in serum albumin after surgery can reflect the magnitude of surgical stress and systemic inflammatory responses (Labgaa et al., 2017). In women with preeclampsia, such postoperative mechanisms may occur simultaneously with pre-existing endothelial dysfunction and urinary protein loss, theoretically producing a greater tendency toward hypoalbuminemia. This combined pathophysiological context provides a strong rationale for specifically investigating serum albumin levels among post-cesarean mothers with preeclampsia rather than extrapolating exclusively from general obstetric or surgical populations.

Collectively, available evidence demonstrates that serum albumin concentrations vary considerably among women with preeclampsia and those undergoing cesarean delivery, with reported values and prevalence depending strongly on the definition and clinical population examined. Albumin concentrations around 2.35 g/dL have been reported in severe preeclampsia, a threshold of approximately 2.51 g/dL has recently demonstrated predictive value for severe preeclampsia in Indonesia, and 19.0–46.6% of cesarean populations have been classified as having relatively low albumin depending on the cut-off employed (Benoit & Rey, 2011; Yagur et al., 2022; Marlina et al., 2026; Siddiqui et al., 2026). These findings provide an empirical basis for interpreting serum albumin data among post-cesarean mothers with preeclampsia at Bendan Regional General Hospital. Hospital-specific findings should ultimately be compared with these literature values once the actual 2025 patient dataset is available, allowing the study to determine whether the local serum albumin profile is consistent with or differs from previously reported populations.

Serum Albumin Levels in Relation to Clinical Characteristics and Preeclampsia Severity

Serum albumin concentrations in women with preeclampsia appear to vary according to the severity of maternal disease and the extent of systemic involvement. A recent Indonesian multicenter study by Marlina et al. (2026) included 245 women with preeclampsia and demonstrated a significant relationship between hypoalbuminemia and preeclampsia severity. Hypoalbuminemia was most frequently observed among women aged 31–40 years, while most participants were multiparous, obese, and diagnosed with preeclampsia without severe features. Women with severe hypoalbuminemia nevertheless had a 4.4-fold higher risk of developing preeclampsia with severe features than those with mild-to-moderate hypoalbuminemia (Marlina et al., 2026).

The clinical characteristics described by Marlina et al. are consistent with broader Indonesian epidemiological evidence showing considerable heterogeneity among women affected by preeclampsia. The Indonesia Pre-eclampsia Study analyzed 6,763 pregnancies from 30 hospitals and reported a mean maternal age of 31.55 ± 6.7 years and a mean body mass index of 30.2 ± 11.9 kg/m². Obesity was identified in 50.4% of patients, primiparity in 27.5%, and chronic hypertension in 20.5%, indicating that several maternal characteristics coexist with preeclampsia in routine clinical practice. Severe preeclampsia occurred in approximately 69% of the cohort, emphasizing the substantial burden of advanced disease in Indonesian hospitals (Akbar et al., 2026).

Disease severity has been repeatedly associated with lower circulating albumin concentrations. Benoit and Rey (2011) evaluated 459 women with preeclampsia and found that 62.7% fulfilled diagnostic criteria for severe preeclampsia. Mean albumin was significantly lower among women with severe disease at 23.5 ± 3.7 g/L, equivalent to 2.35 ± 0.37 g/dL, compared with 25.9 ± 2.8 g/L or 2.59 ± 0.28 g/dL in the non-severe group. This difference remained significant after adjustment for gestational age and number of fetuses, suggesting that the decline in albumin was not solely attributable to these variables (Benoit & Rey, 2011).

The association between hypoalbuminemia and severe preeclampsia may be explained by the progressive impairment of vascular and renal function. Endothelial dysfunction increases capillary permeability, while glomerular injury increases urinary protein loss and consequently reduces circulating albumin concentrations. These changes may become more pronounced in women with extensive proteinuria, edema, hepatic abnormalities, thrombocytopenia, or other manifestations of multiorgan involvement. Accordingly, albumin concentration can provide complementary biochemical information regarding the physiological consequences of preeclampsia, although it should not be interpreted independently of other severity indicators.

A clinically relevant albumin threshold has recently been proposed in the Indonesian population. Marlina et al. (2026) reported that receiver operating characteristic analysis identified a serum albumin concentration of 2.51 g/dL as a cut-off for predicting preeclampsia with severe features. The association between hypoalbuminemia and severity was statistically significant at $p < 0.001$, supporting the potential value of albumin as a severity-related biomarker. However, this threshold should be regarded as a research-based predictive value rather than a universal diagnostic criterion applicable to every hospital population (Marlina et al., 2026).

Table 2. Comparative Evidence Linking Serum Albumin with Clinical Characteristics and Severity of Preeclampsia

Study	Population	Clinical Characteristic / Severity Indicator	Serum Albumin Findings	Main Numerical Result
Benoit & Rey (2011)	459 women with PE	Severe vs non-severe PE	2.35 ± 0.37 vs 2.59 ± 0.28 g/dL	Severe PE: 62.7%; $p < 0.05$
Morikawa et al. (2025)	721 women with PE	Severe proteinuria and pulmonary edema/pleural effusion	Median 2.6 vs 2.8 g/dL in selected comparison groups	Pulmonary edema/pleural effusion: 15.0% vs 5.8%; $p = 0.041$
Marlina et al. (2026)	245 Indonesian women with PE	Hypoalbuminemia and PE with severe features	ROC cut-off: 2.51 g/dL	Severe hypoalbuminemia: 4.4-fold higher risk; $p < 0.001$
Akbar et al. (2026)	6,763 Indonesian PE pregnancies	National clinical severity profile	Albumin not primary variable	Severe PE 69.0%; obesity 50.4%; primiparity 27.5%; chronic hypertension 20.5%
Akbar et al. (2026)	6,763 Indonesian PE pregnancies	Major maternal complications	Albumin not primary variable	HELLP 8.9%; eclampsia 7.4%; ICU admission 12.6%

PE: preeclampsia; ROC: receiver operating characteristic; HELLP: hemolysis, elevated liver enzymes, and low platelet count; ICU: intensive care unit.

The data summarized in Table 2 indicate that decreasing albumin concentrations tend to accompany more severe clinical manifestations of preeclampsia. Morikawa et al. (2025) evaluated 721 women with preeclampsia from 11 institutions and demonstrated that severe proteinuria was associated with important maternal complications. Among women with non-severe hypertension and

severe proteinuria, pulmonary edema or pleural effusion occurred in 15.0%, compared with 5.8% among women with severe hypertension but non-severe proteinuria, while median albumin was 2.6 versus 2.8 g/dL, respectively. These findings suggest that low albumin may be particularly relevant to fluid-related complications rather than simply reflecting the degree of hypertension (Morikawa et al., 2025).

Proteinuria provides an important mechanistic link between albumin depletion and preeclampsia severity. Morikawa et al. (2025) found that serum albumin demonstrated the strongest laboratory relationship with the urine protein-to-creatinine ratio at delivery, and women with severe hypoalbuminemia had a significantly greater risk of severe proteinuria and pulmonary edema or pleural effusion. Severe proteinuria was also associated with higher preterm-delivery rates, reaching 72.3% versus 49.9% among women with severe hypertension and 57.5% versus 24.8% among women with non-severe hypertension. These results reinforce the concept that albumin reduction reflects renal protein loss and altered fluid homeostasis, both of which can contribute to maternal deterioration.

Nevertheless, albumin concentration alone does not provide a complete measure of preeclampsia severity. Benoit and Rey (2011) identified 44 women with albumin concentrations below 20 g/L or 2.0 g/dL and found that thrombocytopenia, elevated alanine aminotransferase, severe proteinuria, and platelet transfusion were more frequent in this group. Despite these associations, albumin below 2.0 g/dL was not considered an independent marker of severe preeclampsia because other adverse clinical conditions were simultaneously present. Therefore, albumin should be interpreted together with blood pressure, proteinuria, platelet count, renal function, liver enzymes, neurological manifestations, and pulmonary findings (Benoit & Rey, 2011).

The Indonesian clinical context further strengthens the need for multidimensional assessment. In the INAPRES cohort, HELLP syndrome occurred in 8.9% of cases, eclampsia in 7.4%, and ICU admission in 12.6%, while severe preeclampsia affected approximately 69% of all participants. Cesarean delivery was also recorded in approximately 72.4% of cases, demonstrating that severe hypertensive disease frequently coexists with operative delivery and intensive maternal management. These figures support the relevance of assessing serum albumin in post-cesarean mothers with preeclampsia, particularly when low albumin occurs alongside other indicators of organ dysfunction (Akbar et al., 2026).

Differences in albumin concentrations across age, parity, obesity status, and clinical severity should also be interpreted cautiously because these factors may interact with disease progression rather than act as independent determinants of serum albumin. Marlina et al. (2026) observed that hypoalbuminemia was most commonly found among women aged 31–40 years and that most participants were multiparous and obese, but the most clinically important finding was the association between the degree of hypoalbuminemia and severe preeclampsia. The INAPRES study similarly demonstrated that maternal demographic and risk characteristics varied widely across Indonesian regions and hospitals. Consequently, local albumin data from Bendan Regional General Hospital should ideally be interpreted in relation to both maternal characteristics and clinical disease severity rather than compared using a single universal threshold (Marlina et al., 2026; Akbar et al., 2026).

Overall, current evidence consistently supports an association between lower serum albumin concentrations and greater clinical complexity in preeclampsia, although albumin is not an independent diagnostic criterion for severe disease. Mean values of approximately 2.35 g/dL have been reported in severe preeclampsia, a cut-off of 2.51 g/dL has demonstrated predictive value in an Indonesian multicenter study, and median levels around 2.6 g/dL have been associated with severe proteinuria and fluid-related complications (Benoit & Rey, 2011; Morikawa et al., 2025; Marlina et al., 2026). The combined evidence suggests that serum albumin is most appropriately viewed as a complementary marker reflecting protein loss, endothelial dysfunction, and altered fluid balance. These findings provide a strong scientific basis for interpreting albumin concentrations among post-cesarean mothers with preeclampsia at Bendan Regional General Hospital in relation to their broader clinical characteristics and disease severity.

Relationship between Knowledge Level and Appropriate Gout Medication Use

Serum albumin abnormalities have important clinical implications in women recovering from cesarean section, particularly when operative delivery occurs in the presence of preeclampsia. Preeclampsia is characterized by systemic endothelial dysfunction, renal protein loss, increased

capillary permeability, and disturbances in intravascular fluid homeostasis, which may contribute to reduced circulating albumin concentrations. The World Health Organization estimates that preeclampsia affects approximately 3–8% of women giving birth worldwide and that hypertensive disorders were responsible for approximately 16% of maternal deaths globally in 2023. These findings emphasize the importance of comprehensive biochemical and clinical monitoring in high-risk obstetric populations rather than relying solely on blood pressure measurements (WHO, 2025).

The clinical relevance of this issue is particularly evident in Indonesia, where cesarean delivery is common among pregnancies complicated by preeclampsia. The INAPRES multicenter study evaluated 6,763 pregnancies with preeclampsia across 30 Indonesian hospitals and reported that 69.0% involved severe preeclampsia and 72.4% were delivered by cesarean section. Major maternal complications included pulmonary edema in 3.8%, HELLP syndrome in 8.9%, eclampsia in 7.4%, acute kidney injury in 1.6%, and intensive care unit admission in 12.6%, while maternal mortality reached 1.6%. The coexistence of severe hypertensive disease and operative delivery therefore provides a strong rationale for evaluating serum albumin as part of the broader postoperative assessment of affected women (Akbar et al., 2026).

Evidence specific to cesarean section suggests that hypoalbuminemia may have implications for postoperative wound recovery. Siddiqui et al. (2026) investigated 500 women undergoing cesarean delivery and identified serum albumin concentrations below 3.5 g/dL in 95 women, representing 19.0% of the study population, whereas 405 women or 81.0% had albumin levels of at least 3.5 g/dL. Surgical-site infection occurred in 44.2% of hypoalbuminemic women compared with only 8.1% of women without hypoalbuminemia, and albumin below 3.5 g/dL was associated with an 8.93-fold increase in the odds of wound infection. An albumin cut-off below 3.35 g/dL demonstrated 95% sensitivity and 89% specificity for predicting wound infection, indicating that low albumin may identify women requiring closer postoperative surveillance (Siddiqui et al., 2026).

Postoperative albumin changes may also reflect the magnitude of the physiological stress response induced by surgery. Labgaa et al. (2017) prospectively evaluated 138 patients undergoing major abdominal surgery and demonstrated that serum albumin decreased rapidly during the early postoperative period. A reduction of at least 10 g/L, equivalent to approximately 1.0 g/dL, on the first postoperative day predicted complications with a sensitivity of 77.1%, specificity of 67.2%, and an area under the curve of 78.3%. Patients experiencing this degree of albumin decline had approximately a threefold higher risk of postoperative complications, supporting the concept that albumin reduction can reflect inflammatory activation, capillary leakage, blood loss, hemodilution, and redistribution of plasma proteins following surgery (Labgaa et al., 2017).

Albumin depletion may have additional importance in preeclampsia because it can interact with severe proteinuria and altered fluid balance. Morikawa et al. (2025) studied 721 women with preeclampsia and reported that women with non-severe hypertension but severe proteinuria had a higher frequency of pulmonary edema or pleural effusion than women with severe hypertension but non-severe proteinuria, at 15.0% versus 5.8%, respectively. Median serum albumin was also significantly lower in the former group at 2.6 g/dL compared with 2.8 g/dL, and serum albumin showed the strongest laboratory relationship with the urine protein-to-creatinine ratio at delivery. These findings indicate that hypoalbuminemia may be particularly relevant to fluid-related complications in preeclampsia and may provide complementary information beyond the degree of hypertension alone (Morikawa et al., 2025).

Table 3. Comparative Evidence on the Clinical Implications of Serum Albumin in Preeclampsia and Cesarean Delivery

Study	Population	Albumin Indicator	Clinical Outcome	Key Numerical Finding
Siddiqui et al. (2026)	500 cesarean deliveries	<3.5 g/dL	Surgical-site infection	44.2% vs 8.1%; OR 8.93 (95% CI 5.04–15.89)
Siddiqui et al. (2026)	500 cesarean deliveries	Cut-off <3.35 g/dL	Prediction of wound infection	Sensitivity 95%; specificity 89%
Yagur et	537 elective	<3.3 vs ≥3.3 g/dL	Postoperative	SSI 1.6% vs 5.6%;

al. (2022)	cesarean deliveries		complications	rehospitalization 0.4% vs 5.2%
Labgaa et al. (2017)	138 major abdominal surgery patients	Postoperative decline ≥1.0 g/dL	Overall complications	Sensitivity 77.1%; specificity 67.2%; approximately threefold increased risk
Morikawa et al. (2025)	721 women with preeclampsia	Median 2.6 vs 2.8 g/dL	Pulmonary edema/pleural effusion	15.0% vs 5.8%; p = 0.041
Marlina et al. (2026)	245 women with preeclampsia	ROC cut-off 2.51 g/dL	PE with severe features	Severe hypoalbuminemia associated with 4.4-fold higher risk
Akbar et al. (2026)	6,763 Indonesian PE pregnancies	Albumin not primary exposure	Overall maternal disease burden	Pulmonary edema 3.8%; ICU 12.6%; maternal death 1.6%
Veronika et al. (2015)	133 severe PE/eclampsia cases	Hypoalbuminemia	Maternal morbidity/mortality	Morbidity 33.8%; mortality 3.8%; no significant albumin association

PE: preeclampsia; SSI: surgical-site infection; ICU: intensive care unit; ROC: receiver operating characteristic; OR: odds ratio; CI: confidence interval.

The comparative evidence summarized in Table 3 demonstrates that the clinical significance of serum albumin depends substantially on the population, timing of measurement, and clinical outcome assessed. Siddiqui et al. (2026) identified a strong relationship between low albumin and impaired wound outcomes after cesarean delivery, whereas Labgaa et al. (2017) demonstrated that the magnitude of early postoperative albumin decline was associated with complications after major abdominal surgery. Morikawa et al. (2025), in contrast, highlighted the relationship between hypoalbuminemia, severe proteinuria, and pulmonary fluid complications among women with preeclampsia. Collectively, these findings indicate that albumin may reflect several different physiological processes, including protein depletion, vascular leakage, inflammation, renal protein loss, and surgical stress, rather than representing a single disease mechanism.

The relationship between albumin and postoperative outcomes is nevertheless not uniformly linear across obstetric populations. Yagur et al. (2022) evaluated 537 women undergoing elective cesarean delivery and found that 250 women or 46.6% had albumin concentrations below 3.3 g/dL, while 287 or 53.4% had concentrations of at least 3.3 g/dL. Unexpectedly, the higher-albumin group demonstrated greater rates of surgical-site infection at 5.6% versus 1.6%, postpartum antibiotic administration at 10.8% versus 3.2%, and rehospitalization at 5.2% versus 0.4%. The study excluded women with preeclampsia and therefore should not be directly extrapolated to the present population, but its findings demonstrate that serum albumin should not be interpreted using a simplistic assumption that lower concentrations invariably predict worse postoperative outcomes (Yagur et al., 2022).

The potential usefulness of albumin in preeclampsia is more strongly supported when disease severity and systemic involvement are considered simultaneously. Marlina et al. (2026) demonstrated a significant relationship between hypoalbuminemia and preeclampsia severity in 245 Indonesian women, with severe hypoalbuminemia associated with a 4.4-fold greater risk of preeclampsia with severe features. Receiver operating characteristic analysis identified 2.51 g/dL as a potential albumin threshold for identifying severe features, although this value should be interpreted as a study-specific predictive cut-off rather than a universal diagnostic criterion. These results support using serum albumin as a complementary marker alongside blood pressure, proteinuria, platelet counts, liver enzymes, renal function, neurological manifestations, and respiratory findings (Marlina et al., 2026).

Clinical interpretation should remain cautious because not all studies have demonstrated an independent relationship between albumin and adverse maternal outcomes. Veronika et al. (2015) examined 133 patients with severe preeclampsia and eclampsia at Dr. M. Djamil Hospital in Padang

and reported maternal morbidity of 33.8%, maternal mortality of 3.8%, and hypoalbuminemia in 3.8% of cases. Serum albumin was not significantly associated with maternal morbidity ($p = 1.000$) or maternal mortality ($p = 0.177$), suggesting that albumin alone cannot reliably determine maternal prognosis. Differences between this result and more recent studies may reflect variations in sample size, albumin definitions, disease characteristics, timing of measurement, and availability of contemporary obstetric management (Veronika et al., 2015).

The clinical implications of hypoalbuminemia are particularly important in post-cesarean women because wound healing requires adequate protein availability for fibroblast proliferation, collagen synthesis, tissue remodeling, and immune responses. Reduced circulating albumin may coexist with inflammatory activation, edema, renal protein loss, and other systemic abnormalities that potentially interfere with recovery after operative delivery. Evidence from Siddiqui et al. (2026) demonstrates a strong association between hypoalbuminemia and wound infection, whereas postoperative surgical evidence indicates that rapid albumin decline may serve as an early marker of physiological stress and subsequent complications (Labgaa et al., 2017). Serum albumin measurement may therefore contribute to risk stratification when interpreted alongside wound condition, vital signs, fluid balance, renal function, nutritional status, and established postoperative indicators rather than being used as an isolated decision-making parameter.

Available evidence indicates that serum albumin has potential value as a complementary laboratory parameter in post-cesarean mothers with preeclampsia because it integrates information related to protein loss, endothelial dysfunction, fluid redistribution, inflammatory stress, and postoperative recovery. The high cesarean rate of 72.4% and substantial prevalence of severe preeclampsia reported in the Indonesian INAPRES cohort reinforce the clinical relevance of evaluating biochemical abnormalities in this population. However, the contrasting findings across Siddiqui et al. (2026), Yagur et al. (2022), Veronika et al. (2015), and other studies demonstrate that albumin should not be considered an independent prognostic marker. The literature therefore supports the assessment of serum albumin as part of a comprehensive maternal monitoring strategy and provides an appropriate comparative framework for interpreting serum albumin levels among post-cesarean mothers with preeclampsia at Bendan Regional General Hospital, Pekalongan City (Akbar et al., 2026; Siddiqui et al., 2026; Veronika et al., 2015).

CONCLUSION

Serum albumin represents an important biochemical parameter in the assessment of mothers with preeclampsia following cesarean section because its concentration may reflect protein loss, endothelial dysfunction, increased vascular permeability, and perioperative physiological stress. Evidence from previous studies consistently demonstrates that lower serum albumin concentrations are frequently associated with severe preeclampsia, substantial proteinuria, fluid-related complications, and postoperative disturbances, although the strength of these associations varies across populations and clinical settings. Serum albumin should therefore be interpreted as a complementary laboratory indicator rather than as an independent diagnostic or prognostic marker. Its evaluation is particularly relevant in post-cesarean mothers with preeclampsia who require comprehensive maternal monitoring during the postoperative period.

The available evidence also indicates that serum albumin abnormalities may have implications for postoperative recovery, including wound healing and the occurrence of surgical complications. Nevertheless, albumin concentrations are influenced by multiple factors, including disease severity, renal protein loss, nutritional status, inflammatory responses, intravenous fluid administration, blood loss, and the timing of laboratory examination. Assessment of serum albumin should consequently be integrated with blood pressure, proteinuria, renal and hepatic function, hematological parameters, fluid balance, wound condition, and other maternal clinical findings. Hospital-specific serum albumin data from Bendan Regional General Hospital may provide valuable local evidence for improving clinical evaluation and supporting future analytical studies on maternal outcomes among post-cesarean women with preeclampsia.

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