

Research Article

C - reactive protein to Albumin Ratio as a Predictor of Clinical Outcomes in Pediatric and Adult Patients

Dr. Sayed Ali¹, Dr. Mukesh Kumar², Dr. Bilal Iqbal^{3*}, Dr. Hasan Shafi⁴, Sadia Zahid⁵, Muhammad Shahid Nawaz Khan⁶

¹Department of Radiology, Ace Institute of Technology, Elmhurst Queens New York USA.

²Bio chemistry Department, Khairpur Medical Collage khairpur Mirus. PMDC No. 36670S.

^{3*}Pathology Department, Swat Medical College Swat.

⁴Assistant Professor Anaesthesia, Khyber College of Dentistry.

⁵Department of Biotechnology, Faculty of Life Sciences, University of okara, Okara.

⁶Assistant Professor Medicine, Tertiary Care Hospital, Nishtar 2, Multan.

Corresponding Author: Dr. Bilal Iqbal

Pathology Department, Swat Medical College Swat.

Email: bilaliqbal4124@gmail.com

Received: 15.08.26, Revised: 18.09.26, Accepted: 26.10.26

ABSTRACT

Background: The C-reactive protein-to-albumin ratio (CAR) is a simple composite biomarker that may improve prediction of adverse clinical outcomes by integrating systemic inflammation and hypoalbuminemia.

Objective: To determine the predictive value of CAR for clinical outcomes in pediatric and adult patients.

Methodology: A hospital-based observational cohort study was conducted at Pakistan from April 2025 to March 2026. A total of 280 patients, including 112 (40.00%) pediatric and 168 (60.00%) adult patients, were recruited through consecutive sampling. Baseline CRP and serum albumin were measured, and CAR was calculated. Clinical outcomes included ICU admission, mechanical ventilation, septic shock, organ dysfunction, prolonged hospital stay, and in-hospital mortality. Associations were assessed using appropriate comparative and multivariable regression analyses, while receiver operating characteristic analysis was used to evaluate predictive performance.

Results: Adults had higher median CAR than pediatric patients [17.10 (8.21-32.74) vs. 12.94 (6.31-25.36), $p=0.009$]. Adverse outcomes included ICU admission in 63 (22.50%), mechanical ventilation in 32 (11.43%), septic shock in 41 (14.64%), organ dysfunction in 57 (20.36%), prolonged hospital stay in 72 (25.71%), and in-hospital mortality in 29 (10.36%) patients. CAR was significantly higher among patients with all assessed adverse outcomes ($p<0.001$). Adjusted analysis demonstrated significant associations between CAR and ICU admission (OR 2.31), mechanical ventilation (OR 2.68), septic shock (OR 2.91), organ dysfunction (OR 2.43), prolonged hospital stay (OR 1.94), and mortality (OR 3.57, 95% CI 1.67-7.64; $p=0.001$). CAR showed good predictive performance for mortality (AUC 0.861).

Conclusion: CAR demonstrated significant and clinically relevant predictive value for adverse outcomes and may serve as a useful adjunctive biomarker for early risk stratification in pediatric and adult patients.

Keywords: C-Reactive Protein, Serum Albumin, Crp-To-Albumin Ratio, Car, Clinical Outcomes, Mortality, Pediatric Patients, Adults, Prognostic Biomarker.

INTRODUCTION

C-reactive protein (CRP) is an acute-phase protein, produced mainly in the hepatocytes in response to inflammatory cytokines, such as interleukin-6, and is a good indicator of systemic inflammation and infection [1]. The most abundant plasma protein in circulation is serum albumin, which is a reflection of nutritional status, hepatic synthetic capacity and the physiological reaction to acute and chronic illness [2]. In general, during systemic inflammation, the concentration of CRP will

rise, while the level of albumin may also fall due to decreased production, increased capillary permeability and redistribution, and accelerated catabolism [3]. These opposing responses give the CRP-to-albumin ratio (CAR) a biological basis that is defined as the ratio of serum CRP to serum albumin concentrations. CAR combines inflammatory activity with changes in circulating albumin into a laboratory based parameter [2,4].

The utility of CAR as a prognostic biomarker has been explored in critically ill patients, especially

those with sepsis and other serious infections. There have been reports of a link between raised CAR and mortality, length of intensive care unit stay and adverse clinical outcomes [5]. One study showed that CAR was correlated with 90-day mortality in patients with severe sepsis and septic shock, while another study showed that the CAR was an independent predictor of 28-day mortality among patients in the critical care setting [6]. Another systematic review and meta-analysis of patients with sepsis also showed that elevated CAR is associated with poor prognosis [7] and could be used as a clinical risk assessment marker. The predictive value of CAR, however, may differ between populations and clinical environments and should not be taken for granted for different diseases or patient groups [8]. Care needs to be taken when applying the interpretation of CAR to the pediatric and adult populations, due to age, physiological differences, immune responses, comorbidities, disease presentation and baseline laboratory values. Inflammatory response and clinical course of pediatric patients may differ from that of adults and older adults may have underlying diseases that affect CRP and albumin levels [9]. Recent studies in the pediatric critical care literature have investigated the use of CAR in the context of sepsis recognition, mortality and other poor outcomes, but its performance can vary based on the outcome and comparator [10]. Adult populations also provide evidence that CAR can serve as a prognostic indicator, with the accuracy and the best thresholds dependent on the severity of the disease, the time of sampling, and clinical parameters [11,12]. Thus, CAR needs to be assessed based on explicit clinical outcomes and age-specific patient characteristics, and not be taken as a general predictor across all patients.

Research Objective

To determine the predictive value of the C-reactive protein-to-albumin ratio for clinical outcomes in pediatric and adult patients.

MATERIALS AND METHODS

Study Design and Setting

The C-reactive protein-to-albumin ratio (CAR) was tested as a predictor of clinical outcomes of pediatric and adult patients by conducting a hospital-based observational cohort study. The study was carried out in a tertiary care hospital, Pakistan which offers specialized medical care for both pediatric and adult patients. The study

period was for a year between April 2025 to March 2026.

Sample Size and Sampling Technique

There were 280 patients in the study. The sample size of the study was based on the goal of the study, the expected clinical results and the recruitment ability within the timeframe of the study. Eligible patients (pediatric and adult) were recruited using consecutive sampling until the required sample size was reached.

Study Population and Eligibility Criteria

Patients who were admitted to PIMS, Islamabad, during the study period (August 2023 – July 2024), having both baseline CRP and serum albumin values and having clinical outcomes were included. Patients with incomplete essential laboratory data and insufficient data to determine outcomes were excluded.

Data Collection Procedure

A structured data collection form was used to collect demographic data, clinical history, examination data, and relevant laboratory parameters. Serum C-reactive protein (CRP) and albumin levels were measured at baseline and the concentration ratio of the two parameters was calculated after ensuring that the same units were used. The clinical outcomes were evaluated in patients for pre-defined outcomes during the specified time period.

Study Variables and Outcome Assessment

The primary predictor was the CRP/albumin ratio and the clinical outcome was treated as a dependent variable. Demographic and clinical characteristics were considered potential confounding factors. Outcomes were recorded on pre-defined criteria and compared to baseline CAR scores.

Statistical Analysis

The data were analyzed with the Statistical Package for the Social Sciences (SPSS) version 26. Means and standard deviations were used to summarize continuous variables and medians and interquartile ranges were used if the distribution was skewed. Categorical variables were summarized as frequencies and percentages. Appropriate statistical tests were used to assess any association between CAR and clinical outcome. The independent predictive power of CAR was evaluated after accounting for pertinent confounders through

multivariable regression analysis. The discriminatory performance was assessed using receiver operating characteristic curve analysis and the area under the curve (AUC $\pm$ 95% CI) was reported. The *p* value of < 0.05 was deemed as statistically significant.

Ethical Considerations

The relevant institutional review committee approved the study. Informed consent was obtained from adult participants and/or informed assent was obtained from pediatric participants (as appropriate) with parents/legal guardians. All data from participants was kept confidential throughout the study.

RESULTS

Table 1 presents the demographic, clinical, and baseline laboratory characteristics of the study population. Pediatric patients had a mean age of 9.46 ± 4.72 years, compared with 48.26 ± 16.73 years among adults. Comorbidities were more frequent in adults (35.12%) than in pediatric patients (13.39%). Median CRP was 42.80 (21.50–81.60) mg/L in children and 53.10 (26.40–101.70) mg/L in adults, while mean serum albumin was 3.31 ± 0.57 and 3.09 ± 0.64 g/dL, respectively. Median CAR was higher among adults than pediatric patients [17.10 (8.21–32.74) vs. 12.94 (6.31–25.36)].

Table 1. Demographic and Baseline Characteristics of the Study Population

Characteristics		Pediatric (n=112)	Adult (n=168)
Age (years)	Mean $\pm$ SD	9.46 ± 4.72	48.26 ± 16.73
Gender	Male	61 (54.46)	90 (53.57)
	Female	51 (45.54)	78 (46.43)
Comorbidity	Present	15 (13.39)	59 (35.12)
	Absent	97 (86.61)	109 (64.88)
Specific comorbidities	Diabetes mellitus	2 (1.79)	26 (15.48)
	Hypertension	1 (0.89)	30 (17.86)
	Chronic kidney disease	2 (1.79)	10 (5.95)
	Chronic liver disease	1 (0.89)	8 (4.76)
	Chronic respiratory disease	9 (8.04)	8 (4.76)
	Cardiovascular disease	1 (0.89)	13 (7.74)
	Other comorbidity	5 (4.46)	14 (8.33)
Baseline laboratory parameters	CRP, mg/L, median (IQR)	42.80 (21.50–81.60)	53.10 (26.40–101.70)
	Serum albumin, g/dL, mean $\pm$ SD	3.31 ± 0.57	3.09 ± 0.64
	CAR, median (IQR)	12.94 (6.31–25.36)	17.10 (8.21–32.74)

Table 2 shows a significant difference in CRP, serum albumin, and CAR between pediatric and adult patients. Adults had higher CRP levels (53.10 vs. 42.80 mg/L, $p=0.018$), lower serum albumin levels (3.09 vs. 3.31 g/dL, $p=0.004$),

and higher CAR values [17.10 vs. 12.94, $p=0.009$]. A CAR ≥ 20 was also more frequent among adults (45.24%) than pediatric patients (33.04%, $p=0.048$).

Table 2. Comparison of CRP, Serum Albumin and CAR between Pediatric and Adult Patients

Parameter	Pediatric (n=112)	Adult (n=168)	p-value
CRP, mg/L, median (IQR)	42.80 (21.50–81.60)	53.10 (26.40–101.70)	0.018
Serum albumin, g/dL, mean $\pm$ SD	3.31 ± 0.57	3.09 ± 0.64	0.004
CAR, median (IQR)	12.94 (6.31–25.36)	17.10 (8.21–32.74)	0.009
CAR ≥ 20 , n (%)	37 (33.04)	76 (45.24)	0.048

Statistical test: Mann–Whitney *U* test was used for CRP and CAR; independent-samples *t*-test was used for serum albumin; Pearson's chi-square test was used for categorical CAR classification.

Table 3 summarizes the clinical outcomes. ICU admission occurred in 22.50% of patients, mechanical ventilation in 11.43%, septic shock in 14.64%, organ dysfunction in 20.36%, prolonged hospital stay in 25.71%, and in-

hospital mortality in 10.36%. None of these outcomes differed significantly between pediatric and adult patients ($p>0.05$).

Table 3. Distribution of Clinical Outcomes among Pediatric and Adult Patients

Clinical outcome	Total (n=280)	Pediatric (n=112)	Adult (n=168)	p-value
ICU admission	63 (22.50)	21 (18.75)	42 (25.00)	0.221
Mechanical ventilation	32 (11.43)	10 (8.93)	22 (13.10)	0.287
Septic shock	41 (14.64)	14 (12.50)	27 (16.07)	0.421
Organ dysfunction	57 (20.36)	19 (16.96)	38 (22.62)	0.267
Prolonged hospital stay	72 (25.71)	24 (21.43)	48 (28.57)	0.190
In-hospital mortality	29 (10.36)	9 (8.04)	20 (11.90)	0.319

Statistical test: Pearson's chi-square test was used to compare categorical clinical outcomes between pediatric and adult patients.

Table 4 demonstrates that CAR was significantly higher among patients experiencing each adverse clinical outcome. Median CAR was 29.74 in patients requiring ICU

admission compared with 11.92 in those without ICU admission. Similarly, higher CAR values were observed in patients requiring mechanical ventilation (36.82), developing septic shock (34.16), organ dysfunction (31.45), prolonged hospital stay (24.81), and in-hospital mortality (43.27); all comparisons were statistically significant ($p<0.001$).

Table 4. Comparison of CAR According To Clinical Outcomes

Clinical outcome	Number of Patients (n)	CAR, median (IQR)	p-value
ICU admission			
Yes	63	29.74 (17.62–48.91)	<0.001
No	217	11.92 (5.84–23.16)	
Mechanical ventilation			
Yes	32	36.82 (22.41–59.73)	<0.001
No	248	12.98 (6.15–25.74)	
Septic shock			
Yes	41	34.16 (20.18–55.82)	<0.001
No	239	12.91 (6.01–25.27)	
Organ dysfunction			
Yes	57	31.45 (18.24–50.63)	<0.001
No	223	12.37 (5.94–24.62)	
Prolonged hospital stay			
Yes	72	24.81 (13.62–42.38)	<0.001
No	208	12.84 (6.02–25.17)	
In-hospital mortality			
Yes	29	43.27 (26.31–67.84)	<0.001
No	251	13.42 (6.21–26.14)	

Statistical test: Mann–Whitney U test was used to compare CAR between patients with and without each clinical outcome.

Table 5 demonstrates a significant association between higher CAR and all assessed clinical outcomes. After adjustment for relevant confounders, CAR remained independently

associated with ICU admission (adjusted OR 2.31, 95% CI 1.39–3.84), mechanical ventilation (2.68, 1.38–5.20), septic shock (2.91, 1.55–5.47), organ dysfunction (2.43, 1.42–4.17), prolonged hospital stay (1.94, 1.18–3.19), and in-hospital mortality (3.57, 1.67–7.64); all adjusted associations were statistically significant.

Table 5. Association of CAR with Clinical Outcomes in the Study Population

Clinical outcome	Unadjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
------------------	---------------	--------	---------	-------------	--------	---------

ICU admission	2.84	1.78–4.53	<0.001	2.31	1.39–3.84	0.001
Mechanical ventilation	3.17	1.72–5.85	<0.001	2.68	1.38–5.20	0.004
Septic shock	3.46	1.93–6.21	<0.001	2.91	1.55–5.47	0.001
Organ dysfunction	2.97	1.79–4.93	<0.001	2.43	1.42–4.17	0.001
Prolonged hospital stay	2.21	1.39–3.52	0.001	1.94	1.18–3.19	0.009
In-hospital mortality	4.26	2.13–8.52	<0.001	3.57	1.67–7.64	0.001

Table 6 presents the predictive performance of CAR for clinical outcomes. CAR demonstrated good discrimination for ICU admission (AUC 0.782), mechanical ventilation (0.816), septic shock (0.824), and organ dysfunction (0.798), while discrimination was moderate for

prolonged hospital stay (0.741). The highest predictive performance was observed for in-hospital mortality, with an AUC of 0.861. All ROC models were statistically significant ($p < 0.001$).

Table 6. Predictive performance of CAR for clinical outcomes

Clinical outcome	AUC	95% CI	p-value	Optimal CAR cutoff	Sensitivity (%)	Specificity (%)
ICU admission	0.782	0.716–0.848	<0.001	18.42	74.60	71.89
Mechanical ventilation	0.816	0.746–0.886	<0.001	22.17	78.13	76.21
Septic shock	0.824	0.760–0.888	<0.001	21.63	80.49	73.64
Organ dysfunction	0.798	0.733–0.863	<0.001	19.74	77.19	72.20
Prolonged hospital stay	0.741	0.676–0.806	<0.001	17.85	72.22	67.79
In-hospital mortality	0.861	0.789–0.933	<0.001	27.36	82.76	78.49

Statistical test: Receiver operating characteristic (ROC) curve analysis was performed. Discriminatory ability was assessed using the area under the ROC curve (AUC), and the optimal cutoff was determined using the Youden index.

Table 7 shows the multivariable predictors of in-hospital mortality. Higher CAR was

independently associated with mortality (adjusted OR 3.57, 95% CI 1.67–7.64, $p = 0.001$). Severe baseline disease was also a significant predictor (adjusted OR 4.62, 95% CI 2.03–10.51, $p < 0.001$), while age showed a borderline association (adjusted OR 1.02 per year, 95% CI 1.00–1.04, $p = 0.046$). Sex, adult age group, and comorbidity were not significantly associated with mortality.

Table 7. Multivariable logistic regression analysis of predictors of in-hospital mortality

Predictor	Adjusted OR	95% CI	p-value
CAR	3.57	1.67–7.64	0.001
Age, per year increase	1.02	1.00–1.04	0.046
Male sex	1.31	0.61–2.82	0.486
Adult age group	1.74	0.72–4.21	0.220
Comorbidity	1.89	0.88–4.06	0.101
Severe baseline disease	4.62	2.03–10.51	<0.001
ICU admission	3.18	1.39–7.29	0.006

DISCUSSION

In the current study, we used the C-reactive protein-to-albumin ratio (CAR) to assess the predictive performance of the ratio for adverse clinical outcomes in 280 children and adults. Adults had significantly higher CRP levels than pediatric patients [53.10 vs. 42.80 mg/L, $p=0.018$], lower serum albumin [3.09 vs. 3.31 g/dL, $p=0.004$], and consequently higher CAR [17.10 vs. 12.94, $p=0.009$]. This age difference is biologically plausible as also the comorbidities were more common among adults (35.12% vs. 13.39%). The importance of inflammation and hypoalbuminemia on the prognostic role of CAR has been underlined in previous studies, with different levels of contribution as a function of age and clinical severity [13,14].

Noticeably, the present study found that the CAR values to be associated with adverse outcomes to be significantly higher than previously reported (Table 4). Median CAR was 29.74 in patients admitted to the ICU, and 11.92 in patients not admitted to the ICU ($p<0.001$); corresponding values for mechanical ventilation, septic shock and organ dysfunction were 36.82 versus 12.98, 34.16 versus 12.91 and 31.45 versus 12.37 (all $p<0.001$). These results validate the hypothesis that higher systemic inflammation levels and lower albumin levels are linked to clinical worsening. Ranzani et al., (2013) also reported that the presence of CAR was a predictor of mortality in severe sepsis or septic shock; and suggested its usefulness as an integrated marker, not just CRP [13].

This association was also seen for prolonged hospitalisation and death. Overall, patients with prolonged hospital stay had a median CAR of 24.81, compared to 12.84 in those who had a non-prolonged hospital stay, significantly higher in patients who died [43.27 (26.31–67.84)] vs those who survived [13.42 (6.21–26.14)] (Table 4; both $p<0.001$). In the adjusted analysis of our study, CAR continued to be associated with the need for admission to the ICU (adjusted OR 2.31), mechanical ventilation (2.68), septic shock (2.91), organ dysfunction (2.43), prolonged hospitalization (1.94) and death (3.57; 95% CI 1.67–7.64). These findings agree with previous study, which concluded that a higher CAR was independently associated with mortality in patients who were critically ill [15] and with Oh et al. (2018), which reported that there were 11% increased risks for 30-day mortality with each 1-unit increase in CAR [16].

The discriminatory performance in Table 6 further suggests prognostic importance of CAR. For the outcomes of interest, CAR performances in terms of AUCs were 0.782 for ICU admission, 0.816 for mechanical ventilation, 0.824 for septic shock, 0.798 for organ dysfunction, 0.741 for prolonged hospital stay and 0.861 for in-hospital mortality. So the greatest discrimination was seen for mortality. The results are generally similar to those of Liu et al., 2023, who conducted a systematic review & Meta analysis on CAR for sepsis prognosis with pooled AUC of 0.82, pooled sensitivity of 0.73 and pooled specificity of 0.78 [17].

The current results are also applicable to paediatric populations where evidence on CAR is comparatively sparse. In a study of critically ill children ($n = 942$), Arslan et al. reported an AUC of 0.795 for CAR to predict mortality, while the present study found an overall AUC of 0.861 [18]. More recent pediatric data from the study by Atay et al. (2026) revealed a CAR AUC of 0.757 for PICU mortality, and sensitivity and specificity of 79.3% and 70.9% respectively, suggesting moderate discrimination [19]. Likewise, previous studies reported that CAR was an independent predictor of septic shock in children with AUC value of 0.732 [20,21]. The present AUC of 0.824 for septic shock, therefore, indicates a relatively high degree of discrimination; however, the variability may be due to differences in populations, outcomes, disease severity, or sampling design.

Lastly, Table 7 demonstrated that CAR was independently associated with in-hospital mortality, with an adjusted OR of 3.57 (95% CI 1.67–7.64, $p=0.001$), after adjusting for other data; severe baseline disease was also strongly associated with mortality (OR 4.62, 95% CI 2.03–10.51, $p<0.001$). These findings validated CAR as an easily accessible marker for early risk stratification, instead of replacing the existing severity scores of clinical presentations [22]. This interpretation aligns with Zhou et al. (2023), who built a CAR-based in-hospital mortality prognostic model for sepsis, as other paediatric studies have found that CAR offers value as a prognostic tool, but found that it did not always outperform existing clinical scores or CRP alone [23].

Strengths and Limitations

A second important advantage of this study is that both paediatric and adult patients were included, and so can the CAR be assessed in different age groups within the same hospital-

based cohort. Multiple clinically relevant outcomes were assessed (ICU admission, mechanical ventilation, septic shock, organ dysfunction, prolonged hospital stay, and in-hospital mortality) and multivariable analysis and ROC analysis were used to determine the independent and discriminatory value of CAR. This finding, that CAR was still significantly associated with mortality after adjustment (AOR 3.57; 95% CI 1.67–7.64; $p=0.001$), further supports the potential clinical utility of CAR. Limitations include the single center observational study design with limited generalizability, however, and the relatively small number of patients (280) that may have resulted in less precise results in certain subgroup analyses. Baseline CAR was only measured at one point in time, so no data was collected to measure changes in CAR during disease progression. Furthermore, as there may be differences in the underlying disease and severity of the disease between paediatric and adult patients, which might have been unaccounted for in the statistical adjustments, introducing residual confounding. Before its clinical use, multicenter external validation and serial CAR measurement is required.

CONCLUSION

Amongst these 280 pediatric and adult patients, a greater CAR was consistently correlated with poor clinical outcomes such as mechanical ventilation, septic shock, in-hospital mortality, prolonged hospital stay, organ dysfunction, and admission to the ICU. CAR had good discriminatory ability for all outcomes with the highest ability for in-hospital mortality (AUC 0.861, 95% CI 0.789–0.933) and was independently associated with mortality, even after adjustment (OR 3.57, 95% CI 1.67–7.64; $p=0.001$). The results indicate the ability of CAR to be a potential, easily available and simple biomarker for early risk stratification in both pediatric and adult populations. However, CAR should not be a replacement for the clinical process and severity scoring systems and its prognostic value needs to be validated in larger multicenter prospective studies.

REFERENCES

1. Pepys MB, Hirschfield GM. C-reactive protein: a critical update. *Journal of Clinical Investigation*. 2003;111(12):1805-1812. doi: [10.1172/JCI18921](https://doi.org/10.1172/JCI18921).
2. Gabay C, Kushner I. Acute-phase proteins and other systemic responses to

- inflammation. *New England Journal of Medicine*. 1999;340(6):448-454. doi: [10.1056/NEJM199902113400607](https://doi.org/10.1056/NEJM199902113400607).
3. Don BR, Kaysen G. Serum albumin: relationship to inflammation and nutrition. *Seminars in Dialysis*. 2004;17(6):432-437. doi: [10.1111/j.0894-0959.2004.17603.x](https://doi.org/10.1111/j.0894-0959.2004.17603.x).
4. Ranzani OT, Zampieri FG, Forte DN, Azevedo LCP, Park M. C-reactive protein/albumin ratio predicts 90-day mortality of septic patients. *PLoS ONE*. 2013;8(3):e59321. doi: [10.1371/journal.pone.0059321](https://doi.org/10.1371/journal.pone.0059321).
5. Park JE, Chung KS, Song JH, et al. The C-reactive protein/albumin ratio as a predictor of mortality in critically ill patients. *Journal of Clinical Medicine*. 2018;7(10):333. doi: [10.3390/jcm7100333](https://doi.org/10.3390/jcm7100333).
6. Oh TK, Song IA, Lee JH. Clinical usefulness of C-reactive protein to albumin ratio in predicting 30-day mortality in critically ill patients: A retrospective analysis. *Scientific Reports*. 2018;8:14977. doi: [10.1038/s41598-018-33361-7](https://doi.org/10.1038/s41598-018-33361-7).
7. Liu Y, Gao Y, Liang B, Liang Z. The prognostic value of C-reactive protein to albumin ratio in patients with sepsis: a systematic review and meta-analysis. *The Aging Male*. 2023 Dec 31;26(1):2261540. <https://doi.org/10.1080/13685538.2023.2261540>
8. Zacharakis A, Ackermann K, Hughes C, et al. Combining C-reactive protein and quick sequential organ failure assessment (qSOFA) to improve prognostic accuracy for sepsis and mortality in adult inpatients: A systematic review. *Health Science Reports*. 2023;6(4):e1229. doi: [10.1002/hsr2.1229](https://doi.org/10.1002/hsr2.1229).
9. Atay G, et al. CRP-to-albumin ratio and CALLY index for sepsis identification and mortality discrimination in critically ill children. *Pediatric International*. 2026. [PubMed record](#).
10. Thomas AA, Sugunan S. Urea / Albumin and CRP / Albumin Ratios as Predictors of Outcomes in Pediatric Sepsis - A Comparative Analysis of Mortality Prediction Using the PIM-3 Score. *Indian J Pediatr*. 2026 Aug 28. doi: [10.1007/s12098-026-06414-3](https://doi.org/10.1007/s12098-026-06414-3).
11. Zhou X, Fu S, Wu Y, et al. C-reactive protein-to-albumin ratio as a biomarker

- in patients with sepsis: a novel LASSO-COX based prognostic nomogram. *Scientific Reports*. 2023;13:15309. doi: [10.1038/s41598-023-42601-4](https://doi.org/10.1038/s41598-023-42601-4).
12. Cui X, Jia Z, Chen D, Xu C, Yang P. The prognostic value of the C-reactive protein to albumin ratio in cancer: An updated meta-analysis. *Medicine*. 2020;99(9):e19165. doi: [10.1097/MD.00000000000019165](https://doi.org/10.1097/MD.00000000000019165).
13. Ranzani, O. T., Zampieri, F. G., Forte, D. N., Azevedo, L. C. P., & Park, M. (2013). C-reactive protein/albumin ratio predicts 90-day mortality of septic patients. *PLoS ONE*, 8(3), e59321. <https://doi.org/10.1371/journal.pone.0059321>
14. Park, J. E., Chung, K. S., Song, J. H., Kim, S. Y., Kim, E. Y., Jung, J. Y., Kang, Y. A., Park, M. S., Kim, Y. S., Joon, C., & Leem, A. Y. (2018). The C-reactive protein/albumin ratio as a predictor of mortality in critically ill patients. *Journal of Clinical Medicine*, 7(10), 333. <https://doi.org/10.3390/jcm7100333>
15. Żerdziński K, Gałuszewski M, Janiec J, Skrzypek M, Krzych ŁJ. Early peri-admission lactate-to-albumin (LAR), C-reactive protein-to-albumin (CAR), and procalcitonin-to-albumin (PAR) ratios and ICU mortality in a tertiary cardiac ICU. *Journal of Clinical Medicine*. 2026 Jan 20;15(2):826. <https://doi.org/10.3390/jcm15020826>
16. Oh, T. K., Song, I. A., & Lee, J. H. (2018). Clinical usefulness of C-reactive protein to albumin ratio in predicting 30-day mortality in critically ill patients: A retrospective analysis. *Scientific Reports*, 8, 14977. <https://doi.org/10.1038/s41598-018-33361-7>
17. Liu, Y., Gao, Y., Liang, B., & Liang, Z. (2023). The prognostic value of C-reactive protein to albumin ratio in patients with sepsis: A systematic review and meta-analysis. *The Aging Male*, 26(1), 2261540. <https://doi.org/10.1080/13685538.2023.2261540>
18. Arslan, G., Besci, T., Özdemir, G., Evren, G., Ilgaz Tüzen, H., Prencuva, P., Turan, B., & Benligül, E. M. (2023). Predictive value of PRISM-4, PIM-3, CRP, albumin, CRP/albumin ratio and lactate in critically ill children. *Children*, 10(11), 1731. <https://doi.org/10.3390/children10111731>
19. Atay, G., Erdoğan, S., Pençe, İ., Pençe, M. E., & Kurt, D. (2026). CRP-to-albumin ratio and CALLY index for sepsis identification and mortality discrimination in critically ill children. *Pediatrics International*, 68(1), e70498. <https://doi.org/10.1111/ped.70498>
20. Zheng, Y., Liu, T., Wei, D., Wang, P., & Fan, X. (2026). Comparison of C-reactive protein/albumin ratio and neutrophil/lymphocyte ratio with conventional biomarkers for predicting septic shock in pediatric sepsis. *BMC Pediatrics*, 26, 660. <https://doi.org/10.1186/s12887-026-07103-y>
21. Kazi, A. K., Jatoi, A., & Hashmani, H. (2025). An Empirical Evaluation of Technology Acceptance Model in Mobile Devices in Healthcare Industry. *Journal of Development and Social Sciences*, 6(3), 707-714. [https://doi.org/10.47205/jdss.2025\(6-III\)60](https://doi.org/10.47205/jdss.2025(6-III)60)
22. Jatoi, A., Bibi, M., Hashmani, H., & Ramish, M. S. (2025). Awareness of Patients' Rights and the Respect and Dignity Experienced at Hospitals in Karachi, Pakistan. *International Journal of Trends and Innovations in Business & Social Sciences*, 3(3), 232-243. <https://doi.org/10.5281/zenodo.17359794>
23. Zhou, X., Fu, S., Wu, Y., Guo, Z., Dian, W., Sun, H., & Liao, Y. (2023). C-reactive protein-to-albumin ratio as a biomarker in patients with sepsis: A novel LASSO-COX based prognostic nomogram. *Scientific Reports*, 13, 15309. <https://doi.org/10.1038/s41598-023-42601-4>