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A retrospective analysis of the correlation between the glucose-to-albumin ratio and 28-day mortality in sepsis patients

Zhengting Liu[1†], Xianchun Chen[1†] and Liqin Zhang[1*]

Abstract

Background The Glucose to Albumin Ratio (GAR) is considered a novel biomarker for predicting the risk of mortality following intracerebral hemorrhage. Despite the absence of existing research examining the association between the GAR and mortality in sepsis, this study is designed to delineate the relationship between the GAR and the risk of all-cause mortality within a 28-day period in patients diagnosed with sepsis.

Methods This study is a retrospective cohort study, primarily based on data from the Medical Information Mart for Intensive Care (MIMIC, version 2.2). This study targeted the circumstances of adult sepsis patients admitted to intensive care units. The primary investigation was centered on the correlation between the GAR and the mortality from all causes within a 28-day period post-admission for sepsis.

Results This study included a total of 6731 patients with sepsis, with an all-cause mortality rate of 24.7% within 28 days after admission. Multivariate Cox regression analysis showed that, after adjusting for all confounding factors, the GAR is an independent risk factor for 28-day all-cause mortality in sepsis patients (HR:1.11, 95% CI: 1.04–1.19). Curve fitting revealed a J-shaped relationship between GAR and 28-day mortality rates in sepsis patients, and further analysis of the inflection point showed a critical value of GAR at 27.93. Finally, subgroup analysis indicated no interaction effect of GAR across different subgroups ($P > 0.05$).

Conclusion The GAR is significantly correlated with the all-cause mortality rate within 28 days for patients with sepsis, a finding that holds substantial clinical significance. Therefore, prospective studies are needed in the future to further validate this relationship.

Keywords Glucose-albumin ratio, Sepsis, 28-day mortality

Introduction

Sepsis is a condition of dysregulated host response to infection, leading to life-threatening organ dysfunction, and has become a significant global public health issue [1]. Although a deeper understanding of the pathophysiology of sepsis and advances in treatment methods have reduced its mortality rate, it remains the leading cause of death among patients in the intensive care unit (ICU), imposing a substantial economic burden on patients and their families [2]. The latest meta-analysis indicates that the in-hospital mortality rate for sepsis patients is 26.7%, with an even higher rate of 41.9% for ICU patients [2]. Consequently, prompt recognition and intervention in sepsis are essential for enhancing patient prognoses.At present, various scoring systems are widely used to assess the severity of sepsis [3]. However, these methods rely on multiple indicators and may not be

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convenient for use in clinical practice. There is a pressing requirement to develop a predictive tool that is both uncomplicated and swift, offering a cost-efficient solution for the preemptive identification of sepsis.

Glucose and albumin are key biomarkers for assessing the metabolic profile and inflammatory activity in sepsis. The incidence of dysregulated glucose metabolism significantly increases in patients with sepsis and rises with the severity of the condition [4]. This metabolic disorder not only reflects the abnormal hormone secretion and disease severity within the patient's body but is also positively correlated with the patient's mortality rate and the incidence of complications [5]. It should be acknowledged that multiple elements, such as dietary intake, psychological stress, hepatic disorders, pharmaceutical interventions, and nutritional status, can affect blood glucose levels. Consequently, an exclusive reliance on these levels might not yield consistently accurate outcomes.

Albumin, as a crucial negative acute-phase protein, plays an essential role in responding to inflammatory reactions [6]. It can bind with various inflammatory mediators, thereby regulating both systemic and local inflammatory responses and reducing the damage caused by inflammation to the body [7]. In severe inflammatory diseases such as sepsis, albumin levels often significantly decrease due to the suppression of liver synthesis and the redistribution of serum albumin caused by increased vascular permeability [6]. Research has shown that in adult patients, hypoalbuminemia is associated with a higher mortality rate in critical illness [8, 9]. The research conducted by Adem Keskin and colleagues also supports this viewpoint [10]. Furthermore, in pediatric patients, monitoring albumin levels is equally important for assessing their nutritional status and inflammatory response. The study by Hatice Feray Ari et al. indicates that patients with lower protein levels tend to have longer hospital stays, and an albumin level below 3.785 g/dl upon admission is a sensitive and specific indicator for predicting mortality and prognosis [11].

The GAR, as an emerging biomarker, integrates the measurements of blood glucose and plasma albumin levels, providing more comprehensive information for assessing physiological status. Current research has shown that GAR is correlated with non-alcoholic fatty liver disease (NAFLD) and the risk of mortality in patients with cerebral hemorrhage [12, 13]. Nevertheless, the correlation between the GAR and mortality among sepsis patients has yet to be fully elucidated. Therefore, the present study is designed to investigate the association between GAR and the all-cause 28-day mortality in sepsis patients, utilizing data from the MIMIC-IV (version 2.2) database.

Methods

Database introduction

The Medical Information Mart for Intensive Care IV (MIMIC-IV-2.2) is an open-access clinical database that contains clinical data for more than 50,000 patients from the Intensive Care Units at Beth Israel Deaconess Medical Center in Boston, spanning from 2008 to 2019. The database encompasses a wide range of patient information, including demographic data, vital signs, laboratory test results, and medication information, among others. The database is open to everyone, allowing anyone to access and utilize its data freely. To gain access to the database, our lead author, Liu Zhengting, passed the Collaborative Institutional Training Initiative (CITI) exam and obtained the necessary certification to extract data relevant to our study (ID:48,255,890). As all patient data in the database is anonymized, there is no requirement for patients to provide informed consent. The Guidelines for Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) are strictly adhered to in this study.

Selection of participants

In this study, patients diagnosed with sepsis according to the Sepsis-3.0 criteria were associated with infection and had a Sequential Organ Failure Assessment (SOFA) score of at least 2. After screening, we excluded the following categories of patients: (1) patients who were not admitted to the hospital for the first time; (2) patients who were not admitted to the ICU for the first time; (3) patients who were admitted to the ICU for less than 24 h; (4) patients who did not have serum albumin and blood glucose levels tested within 24 h of admission. Consequently, a total of 6731 patients were included in our study (Fig. 1).

Variable extraction

In this study, we utilized PostgreSQL software (version 13.7.2) and Navicat Premium (version 16) to extract data. We executed Structured Query Language (SQL) queries to collect information, including demographic data (age, gender), vital signs (respiratory rate, mean arterial pressure, oxygen saturation, body temperature), and laboratory results (anion gap, albumin, blood urea nitrogen, creatinine, glucose,blood culture,white blood cell). Additionally, we gathered data on comorbidities (myocardial infarction, heart failure, chronic pulmonary disease, renal disease, diabetes), SOFA scores, and the durations of ICU stay and hospitalization. All lab parameters were recorded within the first 24 h following admission. The primary interest of our study centered on the GAR.

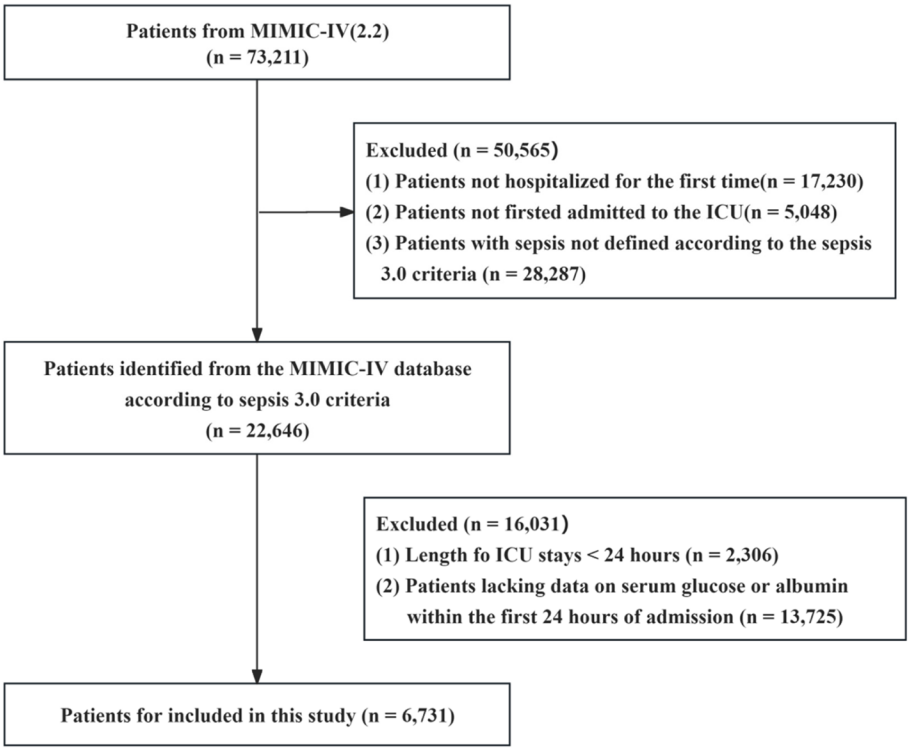

Fig. 1 Flowchart for inclusion and exclusion of patients with septicaemia

Study outcome

The main outcome of this study was the mortality rate due to any cause within 28 days of hospital admission among patients with sepsis.

Management of missing data

In this study, for variables with missing values of less than 5%, we addressed them by simply replacing the missing values. For continuous variables that followed a normal distribution (such as mean arterial pressure, respiratory rate, oxygen saturation, body temperature, and anion gap), we imputed missing values with the mean. In contrast, for variables with a skewed distribution (such as serum creatinine, blood urea nitrogen, and white blood cell count), we used the median for imputation.

Statistical analysis

In this study, when analyzing patient baseline characteristics, we used the mean ± standard deviation to quantitatively describe continuous variables that were normally distributed; for continuous variables with a skewed distribution, we utilized the median and interquartile range to reflect their distribution characteristics; meanwhile, for categorical variables, we presented them in percentage form. For continuous variables, we applied the t-test or Mann–Whitney U test to assess differences between groups; for categorical variables, we used the chi-square test for analysis. To thoroughly explore factors associated with 28-day mortality in sepsis patients, we conducted univariate Cox regression analysis. Furthermore, to investigate the relationship between the GAR and 28-day mortality in septic patients, we controlled for various confounding variables and constructed multivariate models. In addition, we also used restricted cubic spline curves to explore whether there is a non-linear relationship between the GAR and the 28-day mortality in patients with sepsis. Since the GAR is not normally distributed, we performed a log2 transformation on it to meet the requirements of normal distribution. If a non-linear relationship is found, we will conduct further analysis to determine the critical inflection points. Finally, we conducted subgroup analysis to ensure the reliability and validity of the research results.

The data analysis was conducted with R 4.3.1 (http://www.R-project.org) and Free Statistics version 1.9.1. Statistically significant differences were defined as those with a two-sided p-value of less than 0.05.

Table 1 Characteristics of the study population at baseline

Variables	Total	GAR			P
		Q1 (< 37.57)	Q2 (37.58—55.0)	Q3 (≥ 55.0)	
Participants	6731	2241	2239	2251	
Gender (%)					0.305
Female	2907 (43.2)	958 (42.7)	996 (44.5)	953 (42.3)	
Male	3824 (56.8)	1283 (57.3)	1243 (55.5)	1298 (57.7)	
Age (years)	62.9 ± 16.7	61.6 ± 18.1	63.1 ± 17.1	64.0 ± 14.9	< 0.001
28-day mortality	1662 (24.7)	482 (21.5)	510 (22.3)	670 (29.8)	< 0.001
Length of stay in hospital (hours)	241.2 (141.1, 429.3)	215.7 (128.5, 385.9)	241.5 (146.9, 422.4)	270.1 (146.5, 482.2)	< 0.001
Length of stay in ICU (hours)	93.4 (50.6, 187.9)	88.1 (46.8, 168.2)	91.4 (50.6, 185.9)	103.4 (55.4, 208.4)	< 0.001
Vital signs					
MAP (mmHg)	82.9 ± 20.1	84.2 ± 19.5	82.3 ± 20.1	82.0 ± 20.6	< 0.001
RR (t/min)	20.7 ± 6.3	20.4 ± 6.1	20.7 ± 6.3	21.0 ± 6.4	0.004
Temperature (℃)	36.8 ± 1.0	36.8 ± 0.9	36.8 ± 1.0	36.6 ± 1.1	< 0.001
SpO2 (%)	96.5 ± 4.6	96.7 ± 4.0	96.3 ± 4.8	96.5 ± 5.1	0.034
Laboratory parameters					
AG (mg/dL)	15.9 ± 5.0	15.8 ± 4.8	15.3 ± 4.6	16.7 ± 5.5	< 0.001
Positive blood culture, n (%)	571 (8.5)	147 (6.6)	193 (8.6)	231 (10.3)	< 0.001
Crea (mg/dL)	1.1 (0.8, 1.9)	1.1 (0.8, 1.8)	1.1 (0.8, 1.7)	1.3 (0.8, 2.0)	< 0.001
BUN (mg/dL)	23.0 (15.0, 40.0)	21.0 (13.0, 38.0)	23.0 (14.0, 38.0)	26.0 (17.0, 44.0)	< 0.001
WBC (10^9/L)	11.9 (7.9, 17.0)	10.8 (7.3, 15.2)	11.7 (7.9, 16.7)	13.5 (8.7, 19.1)	< 0.001
Comorbidities, *n* (%)					
Renal disease	1467 (21.8)	444 (19.8)	470 (21)	553 (24.6)	< 0.001
Chronic pulmonary disease	1689 (25.1)	564 (25.2)	555 (24.8)	570 (25.3)	0.914
Congestive heart failure	1923 (28.6)	609 (27.2)	643 (28.7)	671 (29.8)	0.146
Diabetes	1579 (23.5)	309 (13.8)	425 (19)	845 (37.5)	< 0.001
Severe liver disease	946 (14.1)	334 (14.9)	300 (13.4)	312 (13.9)	0.332
Sofa score	4.1 ± 2.4	3.8 ± 2.3	4.0 ± 2.2	4.5 ± 2.6	< 0.001

Abbreviations: *MAP* Mean Arterial Pressure, *RR* respiratory rate, SpO_2 arterial oxygen saturation, *AG* Anion gap, *BUN* urea nitrogen, *Crea* Creatinine, *WBC* White Blood Count, *GAR* Glucose/Albumin

Results

Basic characteristics of septicemia patients

Table 1 presents the basic characteristics of septic patients in this study. There were a total of 6731 participants, with 2907 females (43.2%) and 3824 males (56.8%), and the average age was 62.9 ± 16.7 years. The 28-day mortality rate after admission for these septic patients was 24.7%. The study data also indicate that with an increase in the GAR values, there is an increasing trend in the patients'age, 28-day mortality rate, length of hospital stay, ICU stay duration, respiratory rate, blood culture positivity rate, anion gap, creatinine levels, blood urea nitrogen levels, white blood cell count, and SOFA scores, while the average arterial pressure, body temperature, and oxygen saturation show a decreasing trend. In the group with the highest GAR values, the proportions of patients with comorbidities including kidney disease, chronic lung disease, heart failure, diabetes, and severe liver disease were 24.6%, 25.3%, 29.8%, 37.5%,and13.9%,respectively.

Correlation of LAR with 28-day mortality in patients with sepsis

The univariate Cox regression analysis showed that the length of hospital stay, length of ICU stay, mean arterial pressure, pulse rate, body temperature, blood oxygen saturation, anion gap, blood culture, creatinine, blood urea nitrogen, white blood cell count, severe liver disease, kidney disease, heart failure, and SOFA score were associated with the 28-day mortality rate of septic patients (Table 2). To further investigate the relationship between GAR and 28-day mortality in patients with sepsis, we adjusted for patient age, gender, vital signs, laboratory tests, and co-morbidities. The results showed that when not adjusted for covariates, GAR was an independent risk factor for 28-day mortality in patients with sepsis, with a 27% increase in the risk of death for each unit increase

Table 2 Univariate Cox regression analysis of the association between the blood glucose/albumin ratio and 28-day mortality in patients with sepsis

Variables	HR(95%CI)	P
Gender		
Female	Ref	
Male	1.03 (0.93,1.14)	0.547
Age	1.02 (1.02,1.02)	< 0.001
Length of stay in hospital (hours)	0.9971 (0.9968,0.9974)	< 0.001
Length of stay in ICU (hours)	0.9995 (0.9992,0.9998)	< 0.001
MAP (mmHg)	0.9944 (0.9919,0.9969)	< 0.001
RR (t/min)	1.02 (1.02,1.03)	< 0.001
Temperature (℃)	0.75 (0.73,0.78)	< 0.001
SpO2 (%)	0.98 (0.97,0.98)	< 0.001
AG (mg/dL)	1.07 (1.07,1.08)	< 0.001
Blood culture		
Negative	Ref	
Positive	1.25 (1.06,1.46)	0.007
Crea (mg/dL)	1.08 (1.05,1.1)	< 0.001
BUN (mg/dL)	1.01 (1.01,1.01)	< 0.001
WBC (10^9/L)	1.0071 (1.0051,1.0091)	< 0.001
Severe liver disease		
No	Ref	
Yes	1.47 (1.3,1.66)	< 0.001
Renal disease		
No	Ref	
Yes	1.18 (1.06,1.32)	0.003
Chronic pulmonary disease		
No	Ref	
Yes	1.08 (0.96,1.2)	0.192
Congestive heart failure		
No	Ref	
Yes	1.24 (1.12,1.38)	< 0.001
Diabetes		
No	Ref	
Yes	0.9956 (0.8888,1.1152)	0.939
Sofa score	1.13 (1.11,1.15)	< 0.001

Abbreviations: *MAP* Mean Arterial Pressure, *RR* respiratory rate, SpO_2 arterial oxygen saturation, *AG* Anion gap, *BUN* urea nitrogen, *Crea* Creatinine, *WBC* White Blood Count, *GAR* Glucose/Albumin

in the patient's risk of death (HR: 1.27, 95% CI: 1.19–1.36). Even after considering all covariates, GAR was still considered a significant risk factor for 28-day death in patients with sepsis (HR: 1.11, 95% CI: 1.04–1.19). In addition, when GAR was divided into three groups, the risk of 28-day death in septicaemic patients increased by 46% (HR: 1.46, 95%CI: 1.3–1.65) compared with the lowest group (Q1). The results remained robust even after adjustment for all variables (HR: 1.21, 95%CI: 1.07–1.37) (Table 3).

Non-linear relationship between GAR and 28-day mortality in patients with sepsis

After adjusting for all confounding variables, our analysis revealed a J-shaped correlation between the GAR and the 28-day mortality rate among patients with sepsis (Fig. 2). Through an analysis of the turning point, we identified a threshold for GAR of 4.804. When GAR is less than 4.804, the trend of 28-day mortality rate in septic patients is relatively slow (HR, 1.013, 95% CI, 0.67–1.533, $P = 0.9506$). However, when GAR is greater than or equal to 4.804, the mortality rate in septic patients significantly increases (HR, 1.186, 95% CI, 1.09–1.29, $P < 0.001$) (Table 4).

Subgroup analysis

To thoroughly investigate the correlation between the GAR and the all-cause 28-day mortality rate in patients with sepsis, we conducted stratified analyses, taking into account factors such as age, gender, white blood cell count, nephropathy, and diabetes. Subgroup analyses revealed no significant interactions between age, gender, white blood cell count, nephropathy, diabetes, and GAR, thereby further validating the stability and reliability of our research conclusions (Fig. 3).

Sensitivity analysis

To further verify the robustness of the association between the GAR and the 28-day mortality rate in sepsis patients, we conducted several sensitivity analyses. First, we excluded patients with diabetes, totaling 1,974 cases. In the fully adjusted model (Model 5), the analysis revealed that within the GAR tertiles, compared to the first tertile (Q1), the odds ratios (OR) for the second (Q2) and third (Q3) tertiles were 1.12 (95% confidence interval: 0.98–1.29) and 1.25 (95% confidence interval: 1.08–1.44), respectively, with a P-value for trend of 0.002 (Table 1S). Second, we excluded patients with extreme glucose values (glucose > 250 mg/dL), totaling 628 cases. In the GAR tertiles, using the fully adjusted model (Model 5), compared to the first tertile (Q1), the ORs for the second (Q2) and third (Q3) tertiles were 1.04 (95% confidence interval: 0.91–1.19) and 1.29 (95% confidence interval: 1.14–1.47), respectively, with a P-value for trend also of 0.002 (Table 2S).

Discussion

The findings of this study reveal that the Glucose-to-Albumin Ratio (GAR) is an independent risk factor for increased all-cause mortality risk within 28 days in patients with sepsis. As the GAR value rises, the risk of death within 28 days for patients also increases accordingly. Curve fitting analysis further demonstrates a nonlinear relationship between GAR and the 28-day

Table 3 Multivariable regression analysis of the association between blood glucose/albumin ratio and 28-day mortality in patients with sepsis

	GAR	Q1	Q2	Q3	*P* for trend
	HR(95%CI)	HR(95%CI)	HR(95%CI)	HR(95%CI)	
Model1	1.27(1.19–1.36)	Ref	1.06(0.94–1.2)	1.46(1.3–1.65)	< 0.001
Model2	1.26(1.18–1.35)	Ref	1.04(0.92–1.17)	1.43(1.27–1.6)	< 0.001
Model3	1.17(1.09–1.25)	Ref	1.01(0.89–1.14)	1.31(1.16–1.47)	0.002
Model4	1.1(1.03–1.17)	Ref	1.02(0.9–1.16)	1.2(1.06–1.35)	< 0.001
Model5	1.11(1.04–1.19)	Ref	1.03(0.91–1.17)	1.21(1.07–1.37)	0.002

Notes: Model 1: No covariances were adjusted; Model 2: Adjusted for age and gender; Model 3: Model2 + MAP + RR + T + SpO_2; Model 4: Model 3 + blood culture + AG + Crea + BUN + WBC

Model 5: Model 4 + sever liver disease + renal disease + chronic pulmonary disease + congestive heart failure + diabetes

Abbreviations: *HR* hazard ratio, *CI* confdence index, *MAP*, Mean Arterial Pressure, *RR* respiratory rate, *SpO2* arterial oxygen saturation, *T* Temperature, *AG* Anion gap, *BUN* urea nitrogen, *Crea* Creatinine, *WBC* White Blood Count, *GAR* Glucose/Albumin

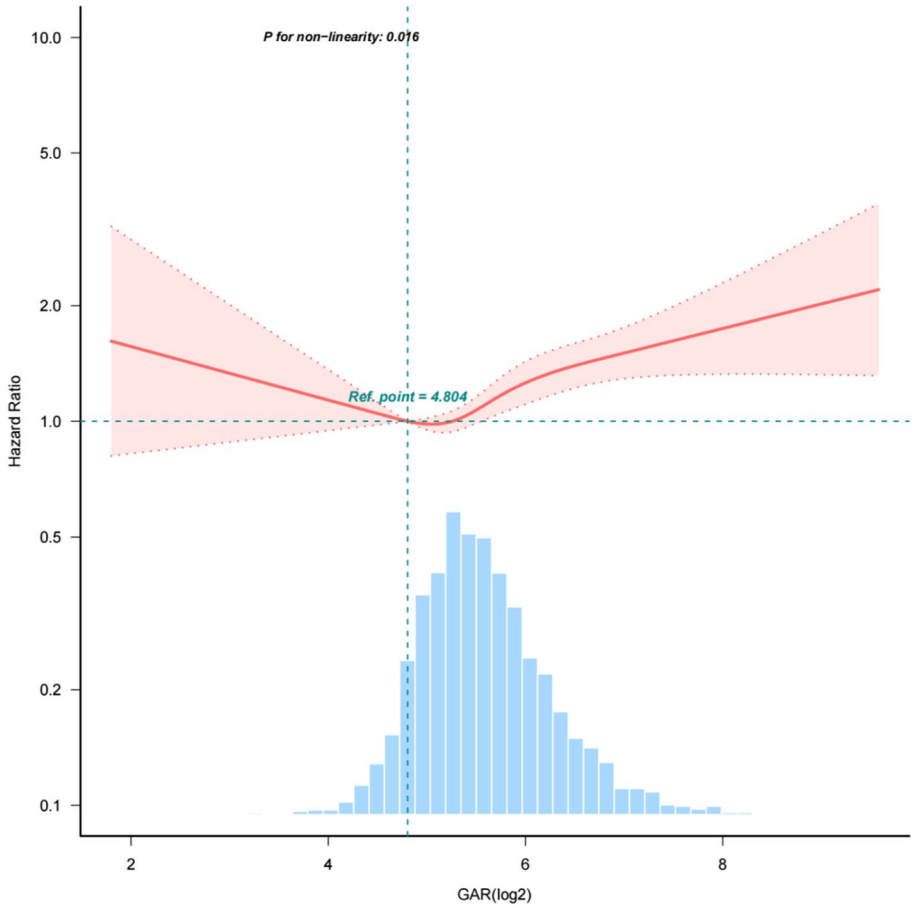

Fig. 2 The relationship between blood glucose/albumin ratio and 28-day mortality rate in sepsis patients. Solid and dashed lines represent predicted values and 95% confidence intervals, respectively. Adjusted for age, gender,MAP,RR, T,SpO_2,blood culture,AG, Crea,BUN,WBC, sever liver disease,renal disease, chronic pulmonary disease, congestive heart failure, diabetes. Abbreviations: MAP, Mean Arterial Pressure; RR, respiratory rate; SpO2, arterial oxygen saturation;T,Temperature;AG, Anion gap; BUN, urea nitrogen; Crea, Creatinine; WBC, White Blood Count; GAR, Glucose/Albumin

Table 4 Threshold effect analysis of the blood glucose/albumin ratio on the 28-day mortality rate in sepsis patients

GAR	HR(95%CI)	*P*
< 27.93	1.013 (0.67,1.533)	0.9506
≥ 27.93	1.186 (1.09,1.29)	< 0.001
Likelihood Ratio test	-	0.048

Notes: adjusted for age, gender,MAP,RR, T,SpO_2,blood culture,AG, Crea,BUN,WBC, sever liver disease,renal disease, chronic pulmonary disease, congestive heart failure, diabetes

Abbreviations: HR hazard ratio, *CI* confdence index, *MAP* Mean Arterial Pressure, *RR* respiratory rate, *SpO2* arterial oxygen saturation, *T* Temperature, *AG* Anion gap, *BUN* urea nitrogen, *Crea* Creatinine, *WBC* White Blood Count, *GAR* Glucose/Albumin

mortality risk in septic patients. Through inflection point analysis, we have determined a critical value of 4.804 for GAR. When the GAR value is below 4.804, changes in each unit have little impact on the mortality risk within 28 days for septic patients; however, when the GAR value reaches or exceeds 4.804, each unit increase is significantly associated with an 18.6% increase in the risk of death within 28 days. Moreover, subsequent subgroup analysis results confirm that the correlation between GAR and the 28-day mortality rate in septic patients is robust and consistent across different patient populations.

In recent years, with the continuous discovery of inflammatory markers, their application in predicting the prognosis of sepsis patients has become increasingly widespread. These biomarkers include the ratios of lactate to albumin [14], C-reactive protein to albumin [15, 16], and the Triglyceride and Glycated Albumin (TYG) index [17], among others. Existing research has confirmed that the GAR is associated with the mortality rate within 90 days for intracerebral hemorrhage patients, making it an important prognostic indicator [13]. However, to date, no studies have reported on the relationship

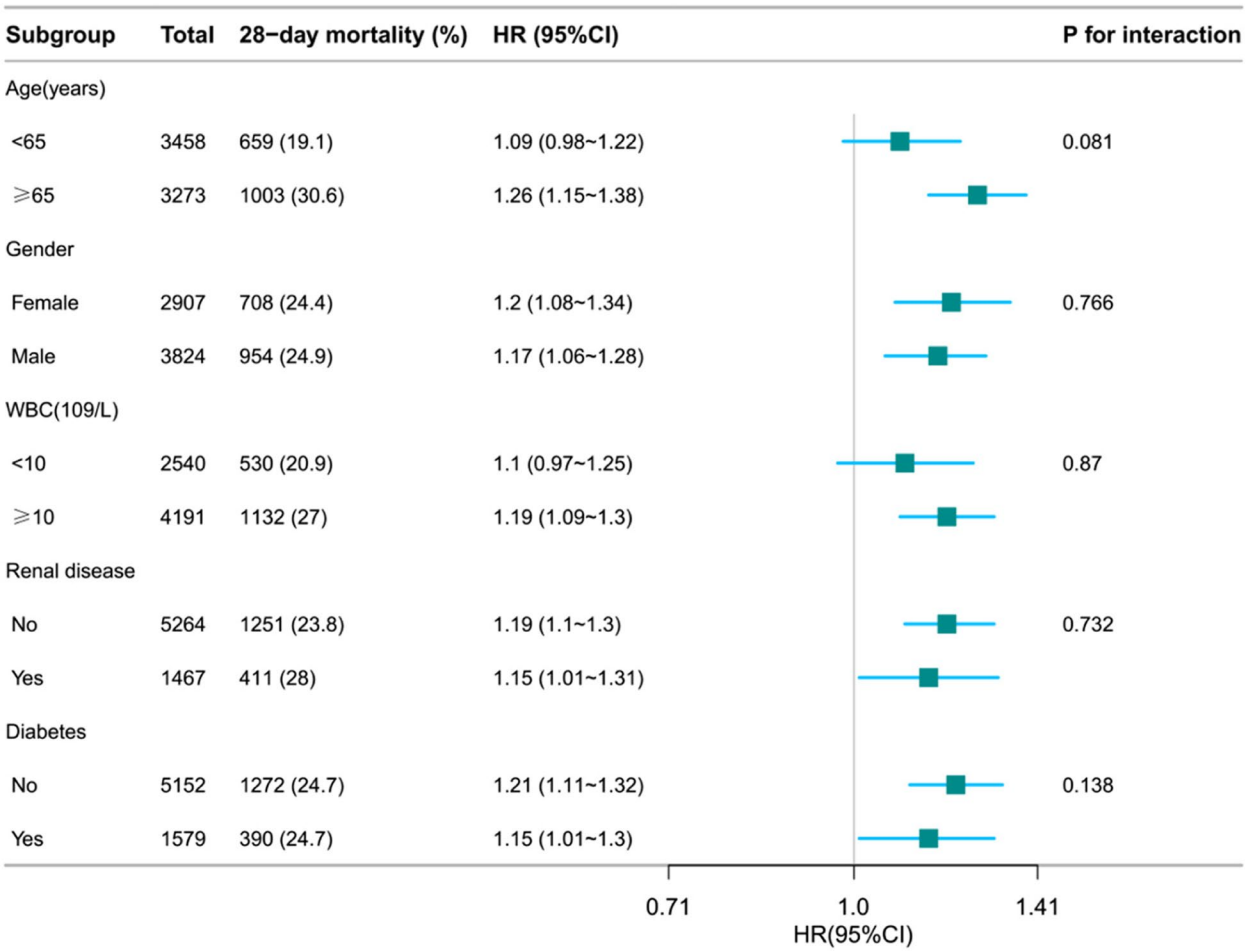

Fig. 3 Subgroup analysis forest plot of the association between blood glucose/albumin ratio and 28-day mortality rate in sepsis patients.Adjusted for age, gender,MAP,RR, T,SpO_2,blood culture,AG, Crea,BUN,WBC, sever liver disease,renal disease, chronic pulmonary disease, congestive heart failure, diabetes

between GAR and the all-cause mortality rate within 28 days in sepsis patients.

The variations in blood sugar levels among patients with sepsis are a complex phenomenon, and their relationship with the prognosis of septic patients has always been a key focus of research. Sepsis can cause metabolic disorders in blood sugar, mainly manifesting as hyperglycemia, hypoglycemia, and blood sugar fluctuation [18, 19]. The incidence of sugar metabolic disorders significantly increases among patients with sepsis and escalates with the severity of sepsis, from sepsis to severe sepsis, and then to septic shock [4]. This metabolic disorder not only reflects the abnormal hormone secretion in the patient's body and the severity of the disease but also correlates positively with the patient's mortality rate and the incidence of complications [5]. Our research results indicate that the increase in blood sugar levels in septic patients is closely related to adverse prognosis, which is consistent with the findings of Yarden Zohar and colleagues [20]. However, blood glucose levels can be affected by factors such as stress, liver disease, diet, and nutritional status. Consequently, the exclusive use of blood glucose levels as a prognostic indicator for poor outcomes in patients with sepsis presents certain limitations.

Albumin is the most abundant protein in plasma, primarily synthesized in the liver. Studies have indicated that low levels of albumin in septic patients are closely associated with poor prognosis [8, 21]. Part of this association is due to the fact that in inflammatory states, inflammatory cytokines such as Tumor Necrosis Factor-alpha (TNF-α) and Interleukin-6 (IL-6) directly inhibit the liver's synthesis of albumin, leading to a decrease in albumin levels. Additionally, inflammation increases the permeability of blood vessels, allowing albumin to seep out from the vasculature [22]. Beyond this, chronic diseases and states of malnutrition can also affect albumin levels, further increasing the limitations of using albumin levels alone to predict the prognosis of septic patients [23]. Therefore, in our research, we not only focus on changes in albumin levels but also take into account changes in glucose levels. By analyzing the ratio of glucose to albumin, we are able to more accurately predict the prognosis of septic patients. This comprehensive approach provides a more holistic assessment, aiding in a better understanding of the condition and prognosis of septic patients.

Although a multitude of research has delved into the connections between glucose and albumin levels in the context of different pathological conditions, the ratio of GAR and its relation to sepsis has not been fully explored. Nevertheless, studies suggest that increased blood glucose levels coupled with reduced serum albumin levels are significant predictors of mortality and clinical outcomes in individuals with sepsis. Drawing from this data, we hypothesize that in the context of sepsis, GAR may hold greater significance than the separate measurement of glucose and albumin. In our research, we determined that the Glucose to Albumin Ratio (GAR) exhibits a positive correlation with the 28-day mortality rate among septic patients, signifying that elevated GAR values are linked to a heightened mortality risk in this cohort. Our results align with the findings of Jialing He and the team, who established the predictive utility of GAR for mortality rates in patients with spontaneous intracerebral haemorrhage [13].

Our study demonstrates its strengths in several aspects. Firstly, our study's data framework is derived from the MIMIC-IV database, thereby ensuring the veracity and dependability of the data employed. Secondly, this work adopts a retrospective analysis method and employs a variety of statistical methods, including multifactorial Cox regression, to address potential confounding variables, thereby reducing research bias. Furthermore, we opted to utilize the initial glucose and albumin readings obtained during the patients'hospitalization, effectively mitigating the influence of subsequent therapeutic interventions on the data, which in turn, bolsters the precision of our study's outcomes. Lastly, our research pioneers the examination of the correlation between the GAR and the 28-day mortality rate among septic patients. Moreover, because the glucose and albumin levels in serum are easy to measure and cost-effective, this further enhances the feasibility of our research method.

Of course, our study does have some limitations. Firstly, the research data is primarily sourced from the MIMIC database, which, although it offers a wealth of clinical information, is derived entirely from a single center, potentially restricting the generalizability of our study's conclusions. Secondly, due to the retrospective design of our study, we relied on existing data for analysis rather than proactively collecting data through prospective research methods, which may not have fully controlled for all potential confounding factors. Lastly, the study utilized only the initial GAR values of patients upon hospital admission, without continuous tracking of their dynamic changes throughout the sepsis treatment process, limiting our in-depth understanding of the trends in GAR and its impact on patient prognosis.

Conclusion

The GAR has been found to correlate with the 28-day mortality among sepsis patients, where higher values of GAR suggest a greater risk of fatal outcomes.To conclusively ascertain the prognostic significance of GAR in sepsis, there is a necessity for extensive, multicenter research endeavors.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-11092-1.

Additional file 1

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Authors' contributions
ZT: Participated in study design, data analysis and manuscript writing. XC: Participated in data analysis and manuscript writing. LQ: Involved in study design, manuscript revision and review.

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Data availability
The data sets analyzed in this study are available upon reasonable request from the corresponding author.

Declarations

Ethics approval and consent to participate
The Beth Israel Deaconess Medical Center (BIDMC) Institutional Review Board (IRB) approved the database usage. All personal information is anonymized. Given the study's retrospective design and use of de-identified data, the BIDMC IRB waived the requirement for informed consent. The study followed the ethical principles of the Declaration of Helsinki, and all human data—related procedures were conducted within this framework. Also, we completed the CITI Program courses on human research and data/specimen—only studies to apply for database access (Record ID: 48255890).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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