ARCHIVES OF THE TURKISH SOCIETY OF CARDIOLOGY

Official journal of the TURKISH SOCIETY OF CARDIOLOGY

Effect of Albumin-Bilirubin Score on Prognosis in Ambulatory Heart Failure Patients with Reduced Ejection Fraction

Albümin-Bilirubin Skorunun Ambulatuar Düşük Ejeksiyon Fraksiyonlu Kalp Yetersizliği Hastalarının Prognozuna Etkisi

ABSTRACT

Objective: Heart failure (HF) often impacts liver function due to reduced cardiac output and increased venous congestion. The Albumin-Bilirubin (ALBI) score has recently been shown to possess prognostic value in patients hospitalized with HF. In this study, we aimed to evaluate the association of the ALBI score with long-term mortality in ambulatory HF patients with reduced ejection fraction (HFrEF).

Method: Consecutive patients with HFrEF were included between 2014 and 2019. The ALBI score was calculated using the following formula: ($\log_{10}$ total bilirubin [mg/dL] × 0.66) + (albumin [g/dL] × -0.085). Patients were categorized into two groups: low ALBI (≤ -2.60) and high ALBI score (> -2.60). The endpoint was all-cause mortality. Patients were followed up for a median of 55 (42.6-68.4) months.

Results: A total of 417 patients were included in the study. The mean age of the group was 51.5 ± 11.9 years, 74.8% were male, and 36.5% (*n* = 152) of the patients were in the high ALBI score group. Patients with a high ALBI score were more likely to be in the New York Heart Association functional class III/IV. These patients had significantly higher N-terminal pro-brain natriuretic peptide (NT-proBNP) levels, systolic pulmonary arterial pressure, and inferior vena cava diameter, along with worse right ventricular systolic function than patients with a low ALBI score. All-cause mortality was significantly increased in the high ALBI score group (41.4% vs. 27.2%, *P* = 0.003). Multivariate analysis revealed the ALBI score (HR 1.53, 95% CI 1.09-2.15, *P* = 0.02) as an independent predictor of long-term mortality.

Conclusion: The ALBI score is associated with increased long-term mortality in outpatients with HFrEF. It can easily be evaluated and utilized as a liver dysfunction score in this patient group, providing prognostic information.

Keywords: Albumin-bilirubin score, heart failure with reduced ejection fraction, mortality

ÖZET

Amaç: Kalp yetersizliği, kalp debisinde azalma ve venöz konjesyonda artmaya bağlı olarak karaciğer fonksiyonlarını etkiler. Yakın zamanda albümin-bilirubin (ALBI) skorunun kalp yetersizliği ile hastaneye yatırılan hastalarda prognostik değeri olduğu gösterilmiştir. Bu çalışmada, ambulatuvar düşük ejeksiyon fraksiyonlu kalp yetersizliği (DEF-KY) hastalarında ALBI skorunun uzun dönem mortalite ile ilişkisini değerlendirmeyi amaçladık.

Yöntem: Bu tek merkezli retrospektif çalışmaya 2014 ve 2019 yılları arasındaki ambulatuvar DEF-KY'li 417 ardışık hasta dahil edildi. ALBI skoru, ($\log_{10}$ total bilirubin [mg/dL] × 0,66) + (albümin [g/dL] × -0,085) formülü ile hesaplandı. Hastalar ALBI skorlarına göre düşük ALBI skor grubu (≤-2,60) ve yüksek ALBI skor grubu (>-2,60) olarak ikiye ayrıldı. Çalışmanın sonlanım noktası, tüm nedenlere bağlı ölüm olarak belirlendi. Hastalar ortanca 55 (42,6-68,4) ay takip edildi.

Bulgular: Çalışma grubunun yaş ortalaması 51,5 ± 11,9 idi ve hastaların %74,8'i erkekti. Hastaların %36,5'i (*n*=152) yüksek ALBI skoru grubundaydı. ALBI skoru yüksek grupta New York Kalp Cemiyeti fonksiyonel sınıf III/IV semptom daha fazlaydı. Bu grupta, ALBI skoru düşük gruba göre NT-proBNP düzeyleri, sistolik pulmoner arter basıncı ve inferior vena kava çapı anlamlı olarak daha yüksek, sağ ventrikül sistolik fonksiyonları anlamlı olarak daha düşüktü. Yüksek ALBI skoru grubunda tüm nedenlere bağlı ölüm anlamlı olarak daha fazla gözlendi (%41,4'e karşı %27,2, *P* = 0,003). Çok değişkenli lojistik regresyon analizi, ALBI skorunun (HR = 1,53, %95 GA = 1,09-2,15, *P* = 0,02) uzun dönem tüm nedenlere bağlı mortalitenin bağımsız bir belirleyicisi olduğunu ortaya koydu.

Sonuç: ALBI skoru, ambulatuar DEF-KY'li hastalarda artmış uzun dönem mortalite ile ilişkili

ORIGINAL ARTICLE
KLİNİK ÇALIŞMA

Aylin Sungur[1]
Mustafa Azmi Sungur[2]
Özlem Yıldırımtürk[2]

[1]*Department of Cardiology, Süreyyapaşa Chest Diseases and Thoracic Surgery Training and Research Hospital, İstanbul, Türkiye*
[2]*Department of Cardiology, Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Türkiye*

Corresponding author:
Aylin Sungur
✉ aylin_sungur@yahoo.com

Received: August 14, 2023
Accepted: October 04, 2023

Cite this article as: Sungur A, Sungur MA, Yıldırımtürk Ö. Effect of albumin-bilirubin score on prognosis in ambulatory heart failure patients with reduced ejection fraction. *Turk Kardiyol Dern Ars.* 2024;52(2):96-102.

DOI:10.5543/tkda.2023.04488

bulunmuştur. Rutin olarak bakılan iki laboratuvar parametresinden kolaylıkla hesaplanabilen ve prognostik bilgi veren ALBI skoru, bu hasta grubunda karaciğer fonksiyon bozukluğunu değerlendirmek için kullanılabilir.

Anahtar Kelimeler: Albümin-bilirubin skoru, düşük ejeksiyon fraksiyonlu kalp yetersizliği, mortalite

Heart failure (HF) is a severe disease associated with increased morbidity and mortality. It manifests as a clinical syndrome with a prevalence of 1-2% in the adult population. Roughly half of HF patients have heart failure with reduced ejection fraction (HFrEF), which impacts the functioning of multiple organ systems.[1] Cardiohepatic interactions have been known for a long time. Liver dysfunction in HFrEF primarily results from passive hepatic congestion and impaired liver perfusion, and is common in this patient group.[2-7]

Isolated elevations in total bilirubin (TB) levels and decreases in serum albumin levels have been found to be associated with worse outcomes in HF patients.[8-10] The Albumin-Bilirubin (ALBI) score was developed in 2015 to evaluate liver function in patients with hepatocellular cancer.[11] Since then, the ALBI score has been evaluated in various diseases as a more objective and sensitive method for detecting early deteriorations in liver function than both the Child-Pugh score and the model for end-stage liver disease (MELD) score.[12] Recently, the ALBI score was assessed in patients hospitalized with HF and in HF patients undergoing cardiac resynchronization therapy (CRT), and it was found to be associated with a poor prognosis.[13-18] To our knowledge, no studies have evaluated the prognostic predictive ability of the ALBI score in ambulatory chronic HFrEF patients. Therefore, we aimed to determine the effect of the ALBI score on long-term all-cause mortality in ambulatory HFrEF patients.

Materials and Methods

We reviewed the data of patients with chronic HFrEF (left ventricular ejection fraction, LVEF ≤ 40%) who were followed at the outpatient clinic of our hospital between 2014 and 2019 for this retrospective cohort study. Clinically stable patients older than 18 years of age, who were receiving guideline-recommended optimal medical treatment, were eligible for the study. We excluded patients with a diagnosis of liver diseases and malignancies in their medical records, those with end-stage renal disease requiring renal replacement therapy, those hospitalized with HF in the last three months, and those with missing laboratory data needed to assess the ALBI score. Ethics committee approval was obtained from Haydarpaşa Numune Research and Training Hospital (Approval Number: HNEAH-KAEK 2023/KK/25, Date: 20.02.23), and the study conformed to the principles outlined in the Declaration of Helsinki.

Clinical characteristics (age, gender, HF etiology, comorbidities, New York Heart Association [NYHA] functional class), device therapy (implantable cardioverter-defibrillator, CRT), and medications were gathered from hospital records.

Patients were followed up until January 2023 or until the occurrence of death. No patients received a heart transplant or ventricular assist device during the follow-up.

Echocardiographic Assessment

Transthoracic echocardiography was performed on all patients.[19] Parameters like LVEF (determined by the biplane method of disks), left ventricular end-diastolic diameter, left ventricular end-systolic diameter, left atrial anteroposterior diameter (LAAP), right ventricular diameters, tricuspid annular plane systolic excursion (TAPSE), tricuspid lateral annular systolic velocity (RV S' velocity), inferior vena cava (IVC) diameter, and systolic pulmonary artery pressure (sPAP) were recorded.

Laboratory Examination and Assessment of ALBI Score

Data from routine venous blood sampling obtained during the follow-ups were reviewed. Parameters such as complete blood count, creatinine, total cholesterol, N-terminal pro-brain natriuretic peptide (NT-proBNP), alanine transaminase, aspartate transaminase, TB, and albumin levels were collected. The estimated glomerular filtration rate was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation based on serum creatinine levels. Chronic kidney disease was defined as an estimated glomerular filtration rate of < 60 mL/min/1.73 m^2.

Serum albumin and TB levels were measured using the colorimetric method and diazo method with commercially available devices, respectively. The ALBI score was calculated using the following formula: $(\log_{10} TB\ [mg/dL] \times 0.66) + (albumin\ [g/dL] \times -0.085)$. Patients were dichotomized into a low ALBI score group (≤ -2.60) and a high ALBI score group (> -2.60). The cut-off value was derived from the original ALBI score study,

ABBREVIATIONS

ACEI/ARB	Angiotensin-Converting Enzyme Inhibitor/ Angiotensin Receptor Blocker
ALBI	Albumin-Bilirubin
CI	Confidence Interval
CRT	Cardiac Resynchronization Therapy
HF	Heart Failure
HFrEF	Heart Failure with Reduced Ejection Fraction
HR	Hazard Ratio
IVC	Inferior Vena Cava
LAAP	Left Atrial Anteroposterior Diameter
LVEF	Left Ventricular Ejection Fraction
MELD	Model for End-Stage Liver Disease
NT-proBNP	N-Terminal Pro-Brain Natriuretic Peptide
NYHA	New York Heart Association
RV S'	Doppler Tissue Imaging-Derived Tricuspid Lateral Annular Systolic Velocity
sPAP	Systolic Pulmonary Artery Pressure
TAPSE	Tricuspid Annular Plane Systolic Excursion
TB	Total Bilirubin

in which patients with an ALBI score ≤ -2.60 had better survival rates (a lower score = better prognosis).[11]

Statistical Analysis

Statistical analyses were performed using R 4.01 software (R Foundation for Statistical Computing, Vienna, Austria) with the "ipw", "ggplot", "rms" packages. Two-sided p-values < 0.05 were considered statistically significant. Categorical data were presented as numbers (percentages) while continuous data were reported as mean ± standard deviation or median (interquartile range), as appropriate. Pearson's chi-square test or Fisher's exact test were used to compare categorical data. Continuous data were compared with Student's t-test or the Mann-Whitney U test, depending on suitability. Correlations with the ALBI score were determined using Pearson's correlation analysis. Multivariable Cox regression analysis was employed to identify predictors of all-cause mortality. Results are presented as hazard ratios (HR) with 95% confidence intervals (CI) and p-values. Transformations were applied if continuous variables did not meet the linearity assumption of the Cox models. Variables with p-values < 0.05 in the univariable analysis were included in the multivariable model. In cases of collinearity between variables, only one of them was included in the multivariable model. Survival was depicted using Kaplan-Meier curves. Survival rates of the groups were compared with the log-rank test.

Results

Four hundred seventeen patients met the inclusion criteria. The mean age of the study group was 51.1 ± 11.9 years, 74.8% (n=312) of the patients were men, 43.6% (n=182) of the cohort had HF due to ischemic etiology, and the mean LVEF of the group was 26.1 ± 7.5%. The baseline characteristics of the patients are summarized in Table 1.

The median ALBI score of the study group was -2.80 (-2.40 to -3.10) (Figure 1). A total of 152 patients (36.5%) had a high ALBI score (> -2.60). No differences were observed between the high and low ALBI score groups in terms of age, gender, etiologies of HF, medications, and device therapy used. Although comorbidities tended to be higher in the high ALBI score group, statistical significance was reached only for atrial fibrillation. Patients with a high ALBI score were more likely to be in NYHA functional class III/IV than I/II.

Regarding laboratory parameters, patients with a high ALBI score had lower hemoglobin and higher creatinine and NT-proBNP levels than those with a low ALBI score.

LVEF did not differ between groups. The high ALBI score group exhibited significantly higher LAAP, right ventricular basal diameter, sPAP, and IVC diameter. They also had significantly lower TAPSE and RV S' velocity compared to the low ALBI score group.

The ALBI score correlated positively with age, NT-proBNP, sPAP, LAAP, and IVC diameter. A negative correlation was observed between hemoglobin, TAPSE, RV S' velocity, and the ALBI score (Table 2).

During a median follow-up time of 55 (42.6-68.4) months, 135 patients (32.4%) died. The survival rate of the high ALBI score group was significantly lower than that of the low ALBI score group (58.6% vs. 72.8%, P = 0.003). Figure 2 shows the Kaplan-Meier curve, indicating significantly lower survival among patients with a high ALBI score during long-term follow-up (log rank P = 0.0022). Over a median follow-up time of 55 months, the probability of mortality for a patient with an ALBI score of -3.40 was found to be approximately 40%, while for a patient with an ALBI score of -2.00, it was about 55% (Figure 3). Multivariate Cox proportional hazards analysis identified the ALBI score (HR: 1.53, 95% CI: 1.06-2.15, P = 0.02) as an independent predictor of long-term all-cause mortality in ambulatory HFrEF patients. The observed HR was 0.75 when the ALBI score was -3.40, 1 when it was -2.80, and 1.25 when it was -2.25 (Figure 4). Other predictors of long-term mortality are presented in Table 3.

Discussion

The main findings of this study are: (1) Liver dysfunction, assessed using the ALBI score, is common in ambulatory HFrEF patients, and (2) The ALBI score is independently associated with poor prognosis in this patient group.

Heart failure is a complex systemic disease that negatively affects other organ systems. Liver dysfunction in chronic HF is common. It has been termed congestive hepatopathy or cardiohepatic syndrome in literature for quite some time. The primary pathophysiological mechanism underlying the cardiohepatic interaction in this patient group is increased right-sided cardiac pressures leading to passive hepatic congestion (backward failure). Backward failure is predominantly characterized by elevations in TB, alkaline phosphatase, gamma-glutamyl transferase (cholestatic liver parameters), and hypoalbuminemia.[2-7] The incidence of liver dysfunction assessed with the ALBI score in the present study was 36.5%, corroborating the literature that it is a frequent occurrence among HFrEF patients.

Patients in the high ALBI score group displayed more severe disease (evidenced by diminished functional capacity and elevated NT-proBNP levels). They were also more likely to exhibit characteristics associated with congestion and right heart dysfunction (such as higher NT-proBNP, sPAP, IVC diameter, and lower TAPSE and RV S' velocity). Notable correlations were observed between the ALBI score and these parameters. While the current data do not determine causality, they reinforce prior literature suggesting that backward failure is the primary driver of liver dysfunction in chronic HF. Additionally, it has been reported in patients with HF that all liver function tests correlate with invasively measured central venous pressure, which aligns with our results. However, in contrast to our findings, after adjusting for central venous pressure and cardiac index in their analyses, none of the liver function tests remained associated with reduced survival.[20] In our study, the association of the ALBI score with mortality remained independent from indirect measures of elevated central venous pressure and reduced cardiac index.

The serum albumin level in patients with HF can be influenced by various mechanisms.[21] Hypoalbuminemia is common in chronic HF and is linked with an unfavorable prognosis.[10,22,23] In HF, both hepatocellular injury and hepatic congestion can lead to rises in bilirubin levels.[4] Several studies involving large cohorts have highlighted the prognostic significance of TB in chronic HF

Table 1. Baseline Characteristics of the Study Group

	Total population (n = 417)	Low ALBI score (≤ -2.60) group (n = 265)	High ALBI score (> 2.60) group (n = 152)	*P*
Age (years)	51.5 ± 11.9	51.2 ± 11.9	52.2 ± 12	0.43
Male	312 (74.8)	193 (72.8)	119 (78.3)	0.22
NYHA class I/II III/IV	325 (77.9) 92 (22.1)	218 (82.3) 47 (17.7)	107 (70.4) 45 (29.6)	**0.003**
Ischemic Etiology	182 (43.6)	110 (41.5)	72 (47.4)	0.25
ICD/CRT	165 (39.6)	105 (39.6)	60 (39.5)	0.97
Comorbidities				
Hypertension	184 (44.1)	108 (40.8)	76 (50)	0.07
Diabetes mellitus	160 (38.4)	93 (35.1)	67 (44.1)	0.07
CKD	111 (26.6)	64 (24.2)	47 (30.9)	0.13
Atrial Fibrillation	75 (18)	37 (14)	38 (25)	**0.005**
Laboratory parameters				
WBC (×10^3/μL)	8.8 ± 2.8	8.8 ± 2.5	8.9 ± 3.4	0.62
Hemoglobin (g/dL)	13.6 ± 1.7	13.8 ± 1.5	13 ± 2.2	**<0.001**
Creatinine (mg/dL)	1.0 ± 0.4	1.0 ± 0.3	1.1 ± 0.6	**0.03**
TC (mg/dL)	154.2 ± 72.8	152.3 ± 79.4	158.9 ± 62.3	0.36
AST (IU/L)	26 (18-56)	25 (18-98)	26 (18-43)	0.33
ALT (IU/L)	24 (17-32)	23 (17-30)	25 (17-36)	0.33
TB (mg/dL)	0.7 (0.49-0.96)	0.6 (0.4-0.8)	0.9 (0.6-1.4)	**<0.001**
Albumin (g/dL)	4.1 (3.7-4.4)	4.3 (4.1-4.5)	3.6 (3.4-3.8)	**<0.001**
ALBI score	-2.8 (-2.4 to -3.1)	-3 (-2.8 to -3.2)	-2.3 (-2.1 to -2.5)	**<0.001**
NT-proBNP (pg/mL)	232 (117-394)	182 (99-337)	296 (169-440)	**<0.001**
Echocardiographic parameters				
LVEF (%)	26.1 ± 7.5	26.0 ± 7.2	26.2 ± 8.0	0.76
LVEDD (mm)	62.2 ± 8.6	62.8 ± 8.7	61.3 ± 8.7	0.09
LVESD (mm)	50.9 ± 10.3	51.5 ± 10.2	49.7 ± 10.2	0.09
LAAP (mm)	43.9 ± 7.2	43.3 ± 7.2	44.9 ± 7	**0.03**
RVD (mm)	37.3 ± 7.2	36.6 ± 6.3	38.6 ± 8.5	**0.007**
TAPSE (mm)	18.7 ± 4.7	19.1 ± 4.4	17.8 ± 5	**0.005**
RV S' velocity (cm/s)	10.5 ± 2.9	10.8 ± 2.9	10.0 ± 3.0	**0.01**
sPAP (mmHg)	36.4 ± 23.2	34.3 ± 20.1	40.0 ± 26.9	**0.006**
IVC (mm)	17.8 ± 5.5	16.8 ± 5	19.5 ± 5.9	**<0.001**
Medications				
ACEI/ARB	327 (78.4)	215 (81.1)	112 (73.7)	0.07
Beta-blocker	394 (94.5)	254 (95.8)	140 (92.1)	0.11
MRA	329 (78.9)	210 (79.2)	119 (78.3)	0.82
All-cause mortality	135 (32.4)	72 (27.2)	63 (41.4)	**0.003**

Categorical data are presented as numbers (percentages), and continuous data are presented as mean ± standard deviation or median (interquartile range), as appropriate. ACEI/ARB, Angiotensin-converting enzyme inhibitor/Angiotensin receptor blocker; ALBI, Albumin-bilirubin; ALT, Alanine aminotransferase; AST, Aspartate aminotransferase; CKD, Chronic kidney disease; CRT, Cardiac resynchronization therapy; ICD, Implantable cardioverter defibrillator; IVC, Inferior vena cava; LAAP, Left atrium anteroposterior diameter; LVEDD, Left ventricular end-diastolic diameter; LVEF, Left ventricular ejection fraction; LVESD, Left ventricular end-systolic diameter; MRA, Mineralocorticoid receptor antagonist; NT-proBNP, N-terminal pro-brain natriuretic peptide; NYHA, New York Heart Association; RVD, Right ventricular basal diameter; RV S'velocity, Tricuspid lateral annular systolic velocity; sPAP, Systolic pulmonary artery pressure; TAPSE, Tricuspid annular plane systolic excursion; TB, Total bilirubin; TC, Total cholesterol; WBC, White blood cell. Bold *p* values indicate statistical significance.

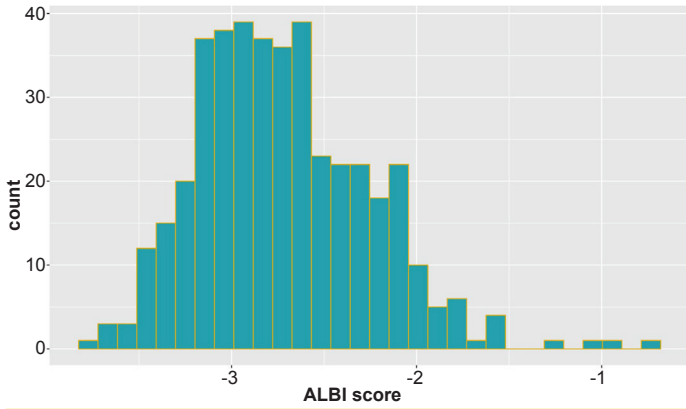

Figure 1. Histogram showing the distribution of the albumin-bilirubin (ALBI) score in the study group.

Table 2. Correlates of ALBI Score

Variables	Pearson's r	*P*
Age	0.14	0.003
Hemoglobin	-0.16	<0.001
NT-proBNP	0.18	<0.001
LAAP	0.16	0.001
sPAP	0.18	<0.001
IVC	0.23	<0.001
TAPSE	-0.16	0.001
RV S' velocity	-0.14	0.004

ALBI, Albumin-bilirubin; IVC, Inferior vena cava; LAAP, Left atrium anteroposterior diameter; NT-proBNP, N-terminal pro-brain natriuretic peptide, RV S'velocity, Tricuspid lateral annular systolic velocity; sPAP, Systolic pulmonary artery pressure; TAPSE, Tricuspid annular plane systolic excursion.

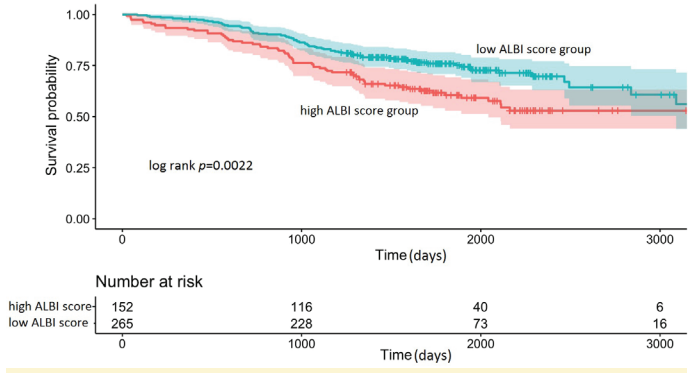

Figure 2. Kaplan-Meier curve assessing mortality among patients with high (> -2.60) and low (≤ -2.60) ALBI scores.

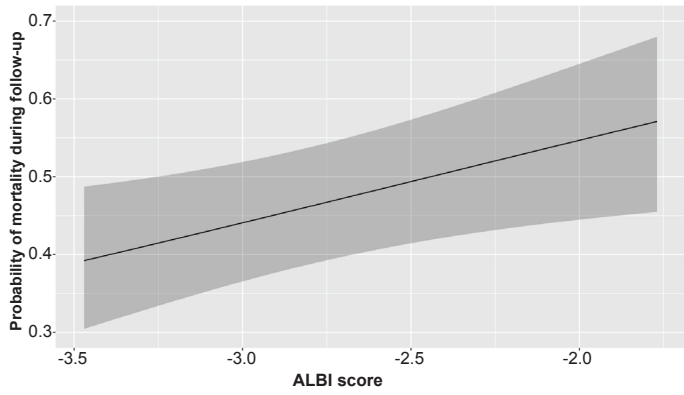

Figure 3. Marginal effect plot demonstrating the probability of mortality according to the ALBI score during the follow-up period.

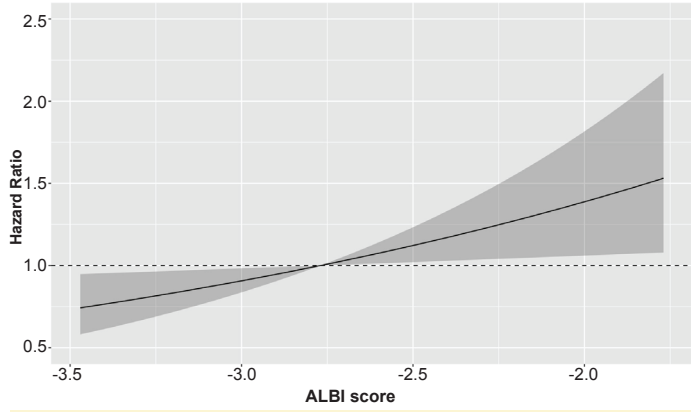

Figure 4. Hazard ratio plot for the association of the ALBI score with long-term all-cause mortality.
Adjusted for age, gender, etiology of heart failure, hypertension, diabetes mellitus, New York Heart Association functional class, N-terminal pro-brain natriuretic peptide, hemoglobin, creatinine, left ventricular ejection fraction, and tricuspid annular plane systolic excursion.

patients.[8,9,24] The ALBI score was initially defined as a measure of hepatic function in patients with hepatocellular carcinoma, with a statistical model demonstrating that serum albumin and TB levels were the key parameters lending prognostic value to the Child-Pugh score.[11] Among the scores evaluating liver functions, the ALBI score stands out because it is more objective than the Child-Pugh score and can detect subtle changes in liver function compared to the MELD score.[12] Consequently, the ALBI score has been utilized in various clinical conditions beyond hepatic diseases as a marker of liver dysfunction. It has also been examined in acute HF and in HF patients treated with CRT. Matsue et al.[13] evaluated the ALBI score and Model for End-Stage Liver Disease Excluding International Normalized Ratio (MELD-XI) scores in acute HF patients and found that the ALBI score was associated with volume overload and 1-year mortality, but the MELD-XI score was not. The ALBI score was also reported to be associated with short- and long-term mortality in HF patients admitted to the intensive care unit, and as an independent predictor of in-hospital mortality in patients hospitalized for HF in several studies.[14-16]

Yamada et al.[17] studied 180 patients with HF (LVEF ≤ 50%, with 37.2% of the patients receiving inotropic agents) undergoing CRT. They evaluated the baseline ALBI scores of patients and followed them for a median duration of 50 months. In alignment with our

Table 3. Multivariate Cox Regression Analysis for Long-Term All-Cause Mortality

Variables	Univariate		Multivariate	
	Hazard Ratio (95% CI)	*P*	Hazard Ratio (95% CI)	*P*
Age	1.02 (1.01-1.03)	**0.04**	1.00 (0.99-1.02)	0.55
Male gender	0.54 (0.34-0.84)	**0.006**	0.78 (0.49-1.24)	0.30
NYHA class III-IV	1.73 (1.19-2.51)	**0.004**	1.25 (0.85-1.85)	0.26
Ischemic HF etiology	2.09 (1.47-2.99)	**<0.001**	1.54 (1.06-2.25)	**0.02**
Hypertension	1.36 (0.97-1.91)	0.07	-	-
Diabetes Mellitus	1.15 (0.82-1.62)	0.42	-	-
ALBI score	1.93 (1.37-2.72)	**<0.001**	1.53 (1.09-2.15)	**0.02**
Hemoglobin	0.96 (0.87-1.06)	0.39	-	-
Creatinine	1.09 (0.78-1.52)	0.62	-	-
Log NT-proBNP*	11.80 (6.4-21.8)	**<0.001**	6.98 (3.59-13.59)	**<0.001**
LVEF	0.94 (0.91-0.96)	**<0.001**	0.97 (0.95-0.99)	**0.04**
TAPSE	0.89 (0.86-0.92)	**<0.001**	0.95 (0.91-0.99)	**0.01**

ALBI, Albumin-bilirubin; CI, Confidence interval; HF, Heart failure; LVEF, Left ventricular ejection fraction; NT-proBNP, N-terminal pro-brain natriuretic peptide, NYHA, New York Heart Association; TAPSE, Tricuspid annular plane systolic excursion. *Log-transformed. Bold *p* values indicate statistical significance.

findings, patients with high ALBI scores were more likely to be in NYHA functional class III/IV and had elevated NT-proBNP levels. In echocardiographic findings, they also reported a significantly larger IVC diameter and higher sPAP in the high ALBI score group, while LVEF values were similar across groups, consistent with our study. During the follow-up period, although HF deaths occurred more frequently in the high ALBI score group, Kaplan-Meier analysis revealed no significant differences between the groups. Moreover, high ALBI scores were not associated with HF deaths in multivariate analysis. Another study assessing the relationship between the ALBI score before CRT implantation and all-cause mortality reported that a higher ALBI score was significantly associated with more severe disease (worsened NYHA functional class and higher NT-proBNP), congestion (a higher prevalence of moderate or severe tricuspid regurgitation and higher sPAP), and all-cause mortality after adjustment, similar to our findings.[18]

We evaluated a well-defined patient group composed of consecutive, clinically stable HFrEF patients over a long follow-up period. However, several limitations exist in the present study. Due to its retrospective and observational nature, it could not establish a cause-effect relationship and is subject to inherent biases. Our study population included younger patients with a higher prevalence of non-ischemic etiology, and the utilization of evidence-based medical treatment was higher than reported in other HF studies conducted in Türkiye.[25,26] Discrepancies between the studies may arise from the fact that our study was conducted in a single, tertiary referral center, and the results should be interpreted within this context. The ALBI score was assessed only once at enrollment, and changes during the follow-up were not monitored. Alkaline phosphatase and gamma-glutamyl transferase were not evaluated due to incomplete data in the medical records. Although patients with known liver diseases were excluded from the study, some might have been overlooked. Changes in medical and device therapy during the follow-up were not assessed.

Conclusion

Liver dysfunction, as assessed by the ALBI score, is common in ambulatory HFrEF patients, and the ALBI score is independently associated with long-term mortality in these patients. The ALBI score can be determined using two simple, widely available, and inexpensive laboratory tests and provides valuable prognostic information. It should be used to evaluate liver function and for the risk stratification of HFrEF patients during routine assessments.

Ethics Committee Approval: Ethics committee approval was obtained from Haydarpaşa Numune Research and Training Hospital Ethics Committee (Approval Number: HNEAH-KAEK 2023/KK/25, Date: 20.02.23).

Informed Consent: Informed consent was not required due to the retrospective nature of this study.

Peer-review: Externally/Internally peer-reviewed.

Author Contributions: Concept – A.S., M.A.S., Ö.Y.; Design – A.S., M.A.S., Ö.Y.; Supervision – M.A.S., Ö.Y.; Resource – A.S., M.A.S., Ö.Y.; Materials – A.S., M.A.S.; Data Collection and/or Processing - M.A.S., Ö.Y.; Analysis and/or Interpretation – A.S.; Writing – A.S., M.A.S.; Critical Review – A.S., M.A.S., Ö.Y.

Conflict of Interest: No conflict of interest disclosure has been received from the authors.

Funding: The authors declared that this study received no financial support.

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