Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 09 May 2026
Revised 25 June 2026
Accepted 05 July 2026

Natural Resources for Human Health 2026, Vol. 6 (5): 793–803

KEYWORDS:
Heart Failure; Malnutrition; Length of Stay; Nutritional Status; Retrospective Studies; Electrolytes.

Malnutrition Severity and Length of Hospital Stay in Adults Hospitalized with Heart Failure: A Retrospective Cohort Study

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ABSTRACT: Malnutrition is common in heart failure (HF), but the association between Global Leadership Initiative on Malnutrition (GLIM)-defined severity and hospital length of stay (LOS) remains uncertain. This single-center retrospective cohort study included 277 adults hospitalized with HF between January 2023 and December 2025. Nutritional status was classified as no malnutrition, moderate malnutrition, or severe malnutrition using GLIM criteria. LOS was analyzed using nonparametric comparisons and negative binomial regression. GLIM-defined malnutrition was present in 30.7% of patients: 10.1% had moderate and 20.6% severe malnutrition. Median LOS was 7.0 days in patients without malnutrition, 8.5 days in those with moderate malnutrition, and 8.0 days in those with severe malnutrition (Kruskal–Wallis p=0.025); however, no pairwise comparison remained significant after Bonferroni correction, and no significant ordinal trend was observed (p=0.054). After adjustment for age, sex, HF phenotype, comorbidity, and cumulative electrolyte burden, neither moderate malnutrition (adjusted IRR 1.188, 95% CI 0.964–1.465; p=0.107) nor severe malnutrition (adjusted IRR 1.063, 95% CI 0.905–1.250; p=0.456) was independently associated with LOS. Findings were similar among survivors. GLIM-defined malnutrition was prevalent, but increasing severity was not independently associated with longer hospitalization.

1. INTRODUCTION

Heart failure (HF) remains a major cause of morbidity, mortality, recurrent hospitalization, and healthcare utilization worldwide. Although HF incidence has stabilized or declined in some high-income settings, its prevalence continues to increase, driven by population aging, a growing burden of risk factors, advances in treatment, and improved survival [1]. Nutritional impairment is common in HF and may result from reduced dietary intake, anorexia, intestinal edema and impaired nutrient absorption, systemic inflammation, neurohormonal activation, increased metabolic demands, and progressive loss of skeletal muscle and energy reserves [2,3]. A recent systematic review and meta-analysis of 90 studies involving 51,086 patients estimated a pooled malnutrition prevalence of 44.6% and found that malnutrition was associated with higher risks of mortality and prolonged hospitalization, although the certainty of evidence for these outcomes was very low [4].

The Global Leadership Initiative on Malnutrition (GLIM) provides an international consensus framework for the diagnosis of adult malnutrition. The diagnosis requires at least one phenotypic criterion, including non-volitional weight loss, low body mass index, or reduced muscle mass, and at least one etiologic criterion, including reduced food intake or assimilation, or inflammation/disease burden. Once malnutrition is diagnosed, severity is graded according to phenotypic criteria as Stage 1 (moderate) or Stage 2 (severe) [5,6]. In older adults hospitalized with acute decompensated HF, GLIM-defined malnutrition was independently associated with 90-day all-cause mortality after multivariable adjustment [7]. In contrast, among chronic HF outpatients, Joaquín et al. [8] found that GLIM-defined malnutrition was associated with all-cause mortality in univariable analysis but did not remain independently associated after adjustment, whereas malnutrition assessed using the Mini Nutritional Assessment did. Importantly, the operationalization of the reduced-muscle-mass criterion may also influence GLIM classification and its prognostic performance. In hospitalized patients with HF, Hu et al. (2023) reported variation in malnutrition prevalence according to the method used to assess muscle mass and found that GLIM classifications incorporating calf circumference, mid-upper arm circumference, or physical examination were associated with adverse outcomes, including prolonged hospital stay [9].

Length of hospital stay (LOS) is a clinically relevant measure of inpatient burden and healthcare resource utilization. In an analysis of more than 1.1 million HF hospitalizations in the United States, ICD-10-coded malnutrition was associated with a substantially longer mean LOS than the absence of malnutrition (10.09 vs. 5.42 days) [10]. In a separate cohort of older hospitalized patients with HF, the combination of malnutrition and low muscle strength was associated with long LOS, whereas either condition alone was not [11]. Moreover, meta-analytic evidence indicates that malnutrition is associated with an increased risk of prolonged hospitalization in HF, although nutritional assessment methods vary substantially across studies [4]. Despite these findings, evidence specifically relating standardized GLIM-based malnutrition severity to LOS in hospitalized patients with HF remains limited, as previous studies have used heterogeneous nutritional assessment methods, administrative diagnostic coding, or differing approaches to operationalize GLIM criteria. This study therefore examined the association between malnutrition severity and LOS among adults hospitalized with HF.

2. MATERIALS AND METHODS

2.1 Study Design and Participants

This single-center retrospective cohort study included adult patients hospitalized with heart failure (HF) at Dr. Wahidin Sudirohusodo General Hospital, a tertiary referral hospital in Makassar, Indonesia. Medical records corresponding to hospitalizations between January 2023 and December 2025 were retrospectively reviewed. Data access and extraction were performed from May to June 2026 after ethical approval had been obtained. The primary objective was to examine the association between GLIM-defined malnutrition severity and hospital length of stay (LOS).

Patients were eligible if they were aged ≥18 years, had been hospitalized with a documented diagnosis of HF during the study period, and had sufficient clinical and laboratory information for assessment of the study variables. All eligible patients were included using total sampling, and each individual contributed only one hospitalization to the analytic cohort.

Patients were excluded if their medical records were incomplete or unavailable or if they had end-stage renal disease, severe hepatic dysfunction, cardiogenic shock, respiratory failure, arrhythmia, malignancy, or pregnancy. The final analytic cohort comprised 277 unique patients.

2.2 Data Collection and Clinical Variables

Data were retrospectively extracted from medical records using a structured data collection form. Recorded variables included age, sex, nutritional status, left ventricular ejection fraction (LVEF), presence of comorbidity, routine hematologic and biochemical parameters, serum sodium, potassium, and chloride concentrations, hospital disposition, and LOS. Extracted data were checked for completeness, consistency, duplicate records, and implausible values before statistical analysis.

HF phenotype was categorized according to LVEF as heart failure with reduced ejection fraction (HFrEF; LVEF ≤40%), heart failure with mildly reduced ejection fraction (HFmrEF; LVEF 41–49%), or heart failure with preserved ejection fraction (HFpEF; LVEF ≥50%). Comorbidity was categorized as present or absent according to whether at least one documented coexisting condition was recorded.

2.3 Assessment of Nutritional Status

Nutritional status was classified according to the international Global Leadership Initiative on Malnutrition (GLIM) consensus framework [5,6]. Malnutrition was diagnosed when at least one phenotypic criterion—non-volitional weight loss, low body mass index (BMI), or reduced muscle mass—and at least one etiologic criterion—reduced food intake or assimilation, or disease burden/inflammation—were present.

Non-volitional weight loss, BMI, reduced muscle mass, reduced food intake or assimilation, and disease burden/inflammation were assessed from the nutritional and clinical information documented in the medical record in accordance with the GLIM criteria. Reduced muscle mass was determined according to the GLIM-recommended assessment available in the source nutritional evaluation.

After malnutrition was diagnosed, severity was determined exclusively from the phenotypic criteria and classified as Stage 1 (moderate malnutrition) or Stage 2 (severe malnutrition). Patients who did not fulfill the diagnostic criteria were classified as having no malnutrition. Accordingly, the primary exposure consisted of three ordered categories: no malnutrition, moderate malnutrition, and severe malnutrition.

2.4 Length of Hospital Stay

The primary outcome was hospital LOS, defined as the number of days from hospital admission to hospital disposition. LOS was analyzed primarily as a numerical count outcome rather than dichotomized into prolonged and non-prolonged hospitalization. Because death during hospitalization may result in a shorter LOS despite greater clinical severity, the primary analysis included the entire cohort, and a sensitivity analysis was performed after excluding patients who died during the index hospitalization.

2.5 Electrolyte Assessment

Serum sodium, potassium, and chloride concentrations were obtained from laboratory results recorded during hospitalization. Hyponatremia and hypernatremia were defined as serum sodium concentrations <135 mmol/L and >145 mmol/L, respectively. Hypokalemia and hyperkalemia were defined as potassium concentrations <3.5 mmol/L and >5.0 mmol/L, respectively, whereas hypochloremia and hyperchloremia were defined as chloride concentrations <96 mmol/L and >106 mmol/L, respectively.

For secondary analyses, cumulative electrolyte burden was defined as the number of sodium, potassium, and chloride abnormalities present in an individual patient. One point was assigned for each abnormal electrolyte, producing a score ranging from 0 to 3.

2.6 Statistical Analysis

Continuous variables were summarized as mean ± standard deviation when approximately normally distributed and as median with interquartile range (IQR) when distributions were skewed. Categorical variables were presented as frequencies and percentages. Distributional assumptions were evaluated using graphical assessment and appropriate tests of normality.

Baseline characteristics were described overall and according to GLIM malnutrition category. Differences in continuous variables across the three nutritional categories were assessed using one-way analysis of variance or the Kruskal–Wallis test, as appropriate. Categorical variables were compared using Pearson's chi-square test or Fisher's exact test when expected cell counts were small.

Unadjusted differences in LOS across the three GLIM categories were evaluated using the Kruskal–Wallis test. When the overall test was statistically significant, pairwise post-hoc comparisons were performed with correction for multiple comparisons. A trend analysis was additionally performed to assess whether LOS increased across the ordered categories of no malnutrition, moderate malnutrition, and severe malnutrition.

Because LOS was a right-skewed count outcome, negative binomial regression was used for the principal multivariable analysis. Model dispersion was evaluated to confirm the appropriateness of the negative binomial distribution relative to a Poisson model. Associations were expressed as incidence rate ratios (IRRs) with 95% confidence intervals (CIs).

GLIM nutritional status was entered as a categorical exposure, with patients without malnutrition serving as the reference group. Covariates were prespecified on clinical grounds rather than selected solely according to bivariable statistical significance. The primary adjusted model included age, sex, HF phenotype, and presence of comorbidity. A secondary expanded model additionally included cumulative electrolyte burden to assess whether the association between malnutrition severity and LOS remained after accounting for concurrent electrolyte abnormalities.

To evaluate a graded association, GLIM category was additionally modeled as an ordinal variable. Model fit and dispersion were assessed using appropriate goodness-of-fit statistics. Multicollinearity among covariates was examined before multivariable modeling.

A prespecified sensitivity analysis repeated the principal negative binomial regression after excluding patients who died during hospitalization. Effect estimates, rather than statistical significance alone, were emphasized in interpretation. All statistical tests were two-sided, and a p value <0.05 was considered statistically significant. Analyses were performed using IBM SPSS Statistics version 30 (IBM Corp., Armonk, NY, USA).

3. RESULTS AND DISCUSSION

3.1 Baseline Characteristics and GLIM-Defined Nutritional Status

A total of 277 patients hospitalized with heart failure were included in the analysis. According to the GLIM criteria, 192 patients (69.3%) had no malnutrition, 28 (10.1%) had moderate malnutrition, and 57 (20.6%) had severe malnutrition, corresponding to an overall prevalence of GLIM-defined malnutrition of 30.7%. The mean age of the cohort was 53.95 ± 15.66 years, and 182 patients (65.7%) were male. HFrEF was the predominant heart failure phenotype, accounting for 69.3% of the cohort. Most patients (94.6%) had at least one documented comorbidity.

As shown in Table 1, age, sex, heart failure phenotype, LVEF, NLR, TLC, serum sodium, potassium, chloride, and cumulative electrolyte burden did not differ significantly across GLIM categories. The prevalence of documented comorbidity differed across nutritional-status groups (p=0.010). Median BMI decreased across GLIM categories; however, because BMI contributes to the phenotypic criteria used for GLIM classification, this pattern was considered descriptive and was not subjected to an inferential between-group test.

Table 1. Baseline characteristics according to GLIM-defined nutritional status

Characteristic	Overall (n=277)	No malnutrition (n=192)	Moderate malnutrition (n=28)	Severe malnutrition (n=57)	*p* value
Age, years	53.95 ± 15.66	54.62 ± 14.05	49.21 ± 17.03	54.04 ± 19.57	0.289[a]
Male sex, n (%)	182 (65.7)	132 (68.8)	13 (46.4)	37 (64.9)	0.066[b]
LVEF, %, median (IQR)	33.0 (24.0–44.0)	32.0 (24.0–44.0)	30.5 (24.3–36.2)	37.0 (27.5–47.0)	0.088[c]
Heart failure phenotype, n (%)					0.191[d]
HFrEF	192 (69.3)	133 (69.3)	24 (85.7)	35 (61.4)	
HFmrEF	44 (15.9)	31 (16.1)	1 (3.6)	12 (21.1)	
HFpEF	41 (14.8)	28 (14.6)	3 (10.7)	10 (17.5)	
Comorbidity present, n (%)	262 (94.6)	186 (96.9)	27 (96.4)	49 (86.0)	0.010[d]
BMI, kg/m², median (IQR)	21.91 (19.45–23.84)	22.89 (21.62–25.00)	19.33 (18.75–19.64)	17.63 (16.70–18.33)	—
NLR, median (IQR)	3.81 (2.58–6.14)	3.73 (2.60–6.19)	4.22 (2.41–6.03)	4.03 (2.41–6.41)	0.894[c]

TLC, cells/µL, median (IQR)	1421 (1048–1931)	1423 (1077–1959)	1541 (959–1958)	1347 (948–1823)	0.377[c]
Sodium, mmol/L, median (IQR)	134 (132–137)	134 (132–137)	135 (131–137.8)	134 (132–137)	0.521[c]
Potassium, mmol/L, median (IQR)	3.80 (3.40–4.40)	3.80 (3.40–4.40)	3.85 (3.33–4.38)	4.10 (3.35–4.50)	0.794[c]
Chloride, mmol/L, median (IQR)	101 (97–104)	101 (97–103)	102 (99–106)	101 (97.5–104.5)	0.216[c]
Electrolyte burden, median (IQR)	1 (1–2)	1 (0–2)	1 (1–2)	1 (1–2)	0.550[c]

Note: [a]Welch ANOVA; [b]Pearson chi-square test; [c]Kruskal–Wallis test; [d]Fisher–Freeman–Halton exact test.

Abbreviations: BMI, body mass index; GLIM, Global Leadership Initiative on Malnutrition; HFmrEF, heart failure with mildly reduced ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; IQR, interquartile range; LVEF, left ventricular ejection fraction; NLR, neutrophil-to-lymphocyte ratio; TLC, total lymphocyte count.

3.2 Unadjusted Association Between GLIM Nutritional Status and Length of Stay

As shown in Table 2, hospital LOS differed significantly across GLIM nutritional-status categories (Kruskal–Wallis $H=7.361$, $p=0.025$). Median LOS was 7.0 days (IQR 5.0–10.0) among patients without malnutrition, 8.5 days (IQR 7.0–13.0) among those with moderate malnutrition, and 8.0 days (IQR 5.0–11.0) among those with severe malnutrition. Although the unadjusted comparison between no malnutrition and moderate malnutrition yielded a nominal p value of 0.009, none of the three pairwise comparisons remained statistically significant after Bonferroni correction. In addition, the Jonckheere–Terpstra test did not indicate a statistically significant monotonic increase in LOS across increasing GLIM severity ($p=0.054$).

Table 2. Unadjusted association between GLIM-defined nutritional status and hospital length of stay

Panel A. Length of stay according to GLIM category

GLIM nutritional status	n	LOS, median (IQR), days	*p* value
No malnutrition	192	7.0 (5.0–10.0)	
Moderate malnutrition	28	8.5 (7.0–13.0)	
Severe malnutrition	57	8.0 (5.0–11.0)	
Overall comparison			**0.025[a]**

Panel B. Pairwise comparisons

Comparison	Adjusted *p* value
No malnutrition vs moderate malnutrition	0.027[b]
No malnutrition vs severe malnutrition	0.744[b]
Moderate vs severe malnutrition	0.342[b]

Note: [a]Kruskal–Wallis test; [b]Mann–Whitney U test with Bonferroni correction.

Abbreviations: GLIM, Global Leadership Initiative on Malnutrition; IQR, interquartile range; LOS, length of stay.

3.3 Multivariable Association with Length of Stay

Negative binomial regression was used to evaluate the association between GLIM nutritional status and LOS. The crude and adjusted estimates are presented in Table 3, Panel A. In the crude model, the moderate-malnutrition category had a higher expected LOS than the no-malnutrition category (IRR 1.298, 95% CI 1.051–1.603; p=0.016), whereas the corresponding estimate for severe malnutrition was not statistically significant (IRR 1.064, 95% CI 0.904–1.252; p=0.455). The overall categorical GLIM effect did not reach statistical significance (p=0.051).

After adjustment for age, sex, heart failure phenotype, and presence of comorbidity, the estimate for moderate malnutrition was attenuated and no longer statistically significant (adjusted IRR 1.197, 95% CI 0.970–1.477; p=0.094). Severe malnutrition also remained unassociated with LOS (adjusted IRR 1.076, 95% CI 0.915–1.264; p=0.377), and the overall GLIM effect was not significant (p=0.204). Further adjustment for cumulative electrolyte burden produced similar results: the adjusted IRR was 1.188 (95% CI 0.964–1.465; p=0.107) for moderate malnutrition and 1.063 (95% CI 0.905–1.250; p=0.456) for severe malnutrition. The overall association between GLIM category and LOS remained non-significant (p=0.243).

Other covariates in the expanded adjusted model are presented in Table 3, Panel B. Increasing age was associated with a slightly lower expected LOS (adjusted IRR 0.993 per year, 95% CI 0.989–0.997; p<0.001). Sex, heart failure phenotype, presence of comorbidity, and cumulative electrolyte burden were not significantly associated with LOS in the full cohort. Each additional electrolyte abnormality corresponded to an estimated 7.0% higher expected LOS, although this association did not reach statistical significance (adjusted IRR 1.070, 95% CI 0.994–1.152; p=0.073). When GLIM status was modeled ordinally, there was no evidence of a graded association between increasing GLIM severity and LOS (adjusted IRR per one-category increase 1.043, 95% CI 0.964–1.129; p=0.295).

A sensitivity analysis excluding the eight patients who died during hospitalization yielded similar results (Table 3, Panel C). Among the remaining 269 patients, the overall GLIM effect remained non-significant (p=0.159). Compared with no malnutrition, the adjusted IRR was 1.202 (95% CI 0.985–1.468; p=0.071) for moderate malnutrition and 1.079 (95% CI 0.923–1.261; p=0.338) for severe malnutrition. In this survivors-only analysis, cumulative electrolyte burden was associated with longer LOS, with each additional electrolyte abnormality corresponding to a 9.2% higher expected LOS (adjusted IRR 1.092, 95% CI 1.016–1.173; p=0.017). Age remained inversely associated with LOS (adjusted IRR 0.993 per year, 95% CI 0.989–0.997; p<0.001).

Table 3. Negative binomial regression analyses of hospital length of stay Panel A. Association between GLIM nutritional status and length of stay

GLIM nutritional status	Crude IRR (95% CI)	*p* value	Adjusted IRR, Model 1[b] (95% CI)	*p* value	Adjusted IRR, Model 2[c] (95% CI)	*p* value
Overall GLIM effect[a]	—	0.051	—	0.204	—	0.243
No malnutrition	Reference	—	Reference	—	Reference	—
Moderate malnutrition	1.298 (1.051–1.603)	0.016	1.197 (0.970–1.477)	0.094	1.188 (0.964–1.465)	0.107
Severe malnutrition	1.064 (0.904–1.252)	0.455	1.076 (0.915–1.264)	0.377	1.063 (0.905–1.250)	0.456

Panel B. Covariates in the expanded adjusted model[c]

Predictor	Adjusted IRR (95% CI)	*p* value
Age, per year	0.993 (0.989–0.997)	<0.001
Female vs male	1.119 (0.979–1.279)	0.100
HFmrEF vs HFrEF	0.998 (0.835–1.192)	0.978

HFpEF vs HFrEF	0.929 (0.771–1.121)	0.444
Comorbidity present vs absent	1.222 (0.910–1.641)	0.183
Electrolyte burden, per additional abnormality	1.070 (0.994–1.152)	0.073

Panel C. Sensitivity analysis restricted to patients discharged alive[d]

Predictor	Adjusted IRR (95% CI)	*p* value
Overall GLIM effect[a]	—	0.159
No malnutrition	Reference	—
Moderate malnutrition	1.202 (0.985–1.468)	0.071
Severe malnutrition	1.079 (0.923–1.261)	0.338
Age, per year	0.993 (0.989–0.997)	<0.001
Female vs male	1.067 (0.937–1.215)	0.326
HFmrEF vs HFrEF	0.996 (0.838–1.182)	0.959
HFpEF vs HFrEF	0.910 (0.756–1.094)	0.315
Comorbidity present vs absent	1.191 (0.893–1.589)	0.235
Electrolyte burden, per additional abnormality	1.092 (1.016–1.173)	0.017

Note: [a]Type III Wald test for the overall GLIM effect; [b]adjusted for age, sex, heart failure phenotype, and comorbidity; [c]additionally adjusted for cumulative electrolyte burden; [d] survivors-only analysis, n=269.

Abbreviations: CI, confidence interval; GLIM, Global Leadership Initiative on Malnutrition; HFmrEF, heart failure with mildly reduced ejection fraction; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; IRR, incidence rate ratio; LOS, length of stay.

3.4 Discussion

This study found GLIM-defined malnutrition in 30.7% of adults hospitalized with heart failure, but its association with hospital length of stay was not linear. LOS differed across nutritional-status categories in the unadjusted analysis, yet none of the pairwise comparisons remained significant after correction for multiple testing, and there was no significant monotonic trend with increasing GLIM severity. After multivariable adjustment, neither moderate nor severe malnutrition was independently associated with LOS. These findings should be interpreted against broader evidence showing that malnutrition is associated with prolonged hospitalization in HF overall, although the certainty of this evidence remains very low and nutritional assessment methods vary considerably across studies [4]. GLIM-specific estimates may also depend on how its phenotypic criteria, particularly reduced muscle mass, are operationalized [9].

The prevalence observed in our cohort is consistent with the wide variation reported across contemporary HF populations. Oguri et al. (2022) identified GLIM-defined malnutrition in 24.2% of 314 older patients hospitalized with acute decompensated HF [7]. In another hospitalized elderly cohort, Hirose et al. (2021) reported a prevalence of 42.4% [12]. Hu et al. (2023) reported estimates ranging from 35.2% to 42.6%, depending on the approach used to assess reduced muscle mass [9]. A considerably higher prevalence of 56.2% was reported by López Guillén et al. [13] among 121 HF outpatients. These cohorts differed substantially in age, clinical setting, and implementation of the GLIM criteria, making direct comparison of prevalence estimates difficult. The updated GLIM consensus similarly acknowledges that variation in the criteria assessed and differences among study populations can influence observed prevalence [5].

Several previous studies have linked malnutrition with longer hospitalization, although their definitions and populations differ from ours. In a US National Inpatient Sample analysis of more than 1.1 million HF admissions, ICD-10-coded malnutrition was associated with an adjusted increase in LOS of 4.67 days [10]. Among older patients hospitalized with HF, Kojima et al.

(2023) found that the combination of malnutrition and low muscle strength was associated with long LOS, whereas either condition alone was not [11]. Hu et al. (2023) reported that GLIM classifications incorporating calf circumference, mid-upper arm circumference, or physical examination were associated with prolonged hospital stay [9]. Beyond HF-specific populations, Brito et al. (2021) found that GLIM-defined malnutrition was associated with 1.76-fold higher odds of prolonged hospitalization in a prospective cohort of hospitalized adults [14]. These findings suggest that nutritional impairment may contribute to hospitalization burden, but GLIM severity alone may not adequately capture the clinical complexity that determines discharge timing.

The absence of a graded relationship in our data is also noteworthy. Moderate malnutrition showed the largest crude estimate for LOS, whereas severe malnutrition did not show a corresponding increase, and the ordinal GLIM analysis was non-significant. The relatively small moderate-malnutrition group may have reduced precision, but measurement issues are also relevant. The updated GLIM consensus specifically notes that fluid overload in non-compensated HF can complicate interpretation of weight loss and BMI [5]. Nutritional impairment in HF also coexists with frailty and sarcopenia, making nutritional categories an incomplete representation of functional reserve [15]. Hemodynamic evidence further demonstrates that congestion is associated with poorer nutritional status in HFrEF, whereas inflammation is more closely associated with malnutrition in HFmrEF and HFpEF [16]. Thus, greater GLIM severity should not necessarily be expected to translate into a proportional increase in LOS.

The electrolyte findings provide a secondary observation. Cumulative electrolyte burden was not significantly associated with LOS in the full cohort but became significant in the survivors-only analysis, in which each additional electrolyte abnormality corresponded to a 9.2% higher expected LOS. This finding should remain exploratory because the analysis combined abnormalities in sodium, potassium, and chloride and did not establish the contribution of any individual electrolyte. Electrolyte disturbances in HF commonly occur in the setting of neurohormonal activation and decongestive therapy [17]. Chloride may be particularly relevant: lower serum chloride was independently associated with mortality in patients hospitalized with ADHF-HFpEF [17], while a meta-analysis of seven studies involving 6,787 patients with acute HF found hypochloremia associated with increased all-cause mortality [18]. These studies support the clinical relevance of electrolyte disturbances but do not establish that chloride or cumulative electrolyte burden independently determines LOS.

Excluding the eight patients who died during hospitalization did not materially alter the GLIM estimates, reducing concern that truncation of LOS by in-hospital death drove the primary result. The small inverse association between age and LOS should nevertheless be interpreted cautiously because retrospective data cannot distinguish biological effects from differences in treatment intensity, discharge practices, or other unmeasured factors. Nutritional abnormalities in HF frequently coexist with renal dysfunction [19]. They are also associated with markers of advanced disease severity; in patients with severe HF, higher natriuretic peptide concentrations were independently associated with malnutrition, which in turn was associated with higher 1-year mortality [20]. These relationships reinforce the likelihood of residual clinical complexity that cannot be fully represented by a limited adjustment model.

Several limitations should therefore be considered. This was a single-center retrospective study, and GLIM classification depended on information available in routine medical records rather than a prospectively standardized nutritional evaluation. Fluid accumulation may compromise weight- and BMI-based phenotypic assessment, while the method used to evaluate reduced muscle mass can materially influence GLIM classification [5]. Hu et al. (2023) demonstrated that alternative muscle-mass assessments produced different malnutrition prevalence estimates and prognostic associations in HF [9]. The moderate-malnutrition group was relatively small, comorbidity was available only as a binary variable, and potentially relevant determinants of LOS, including functional status, frailty, and response to decongestion, were not comprehensively captured. Residual confounding cannot therefore be excluded.

The absence of an independent association with LOS should not be interpreted as evidence that nutritional assessment lacks clinical value in HF. GLIM-defined malnutrition has been independently associated with mortality in hospitalized HF populations [7,12]. Malnutrition assessed using GNRI has likewise been associated with mortality in severe HF [20]. Importantly, this prognostic relationship may be outcome-specific: in the COAPT population, GNRI-defined malnutrition was independently associated with 4-year mortality but not with HF hospitalization [21]. Future multicenter studies using prospectively standardized GLIM assessment, explicit measurement of muscle mass, and detailed characterization of congestion, functional status, and electrolyte trajectories may clarify which nutritional phenotypes are most relevant to inpatient resource utilization.

4. CONCLUSION

GLIM-defined malnutrition was common among adults hospitalized with heart failure, but increasing malnutrition severity was not independently associated with longer hospital stay after multivariable adjustment. The absence of a graded relationship suggests that GLIM severity alone may not adequately reflect the clinical complexity influencing hospitalization duration in this population. Electrolyte burden showed a secondary association with LOS among survivors and warrants further investigation. Prospective multicenter studies with standardized GLIM assessment and more detailed characterization of congestion, functional status, and treatment response are needed to clarify the role of nutritional status in hospital resource use.

ACKNOWLEDGEMENTS

The authors acknowledge Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, for facilitating access to the medical records used in this study. The authors also thank the medical records personnel and clinical staff whose documentation supported data collection, as well as the Faculty of Medicine, Hasanuddin University, for academic and institutional support.

AUTHOR CONTRIBUTIONS

Fransiska Anggraeni Utami: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, and Writing – Original Draft.

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All authors critically reviewed the manuscript, approved the final version, and agreed to be accountable for the accuracy and integrity of the work.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

FUNDING

This research received no external funding.

ETHICS STATEMENT

The study protocol was approved by the Research Ethics Committee of Hasanuddin University, Makassar, Indonesia (approval No. 543/UN4.6.4.5.31/PP36/2026; protocol No. UH26030465; 21 April 2026). The study used retrospective medical-record data without direct patient intervention. Patient confidentiality was maintained throughout the study, and personally identifying information was excluded from the analytic dataset.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable ethical and institutional restrictions.

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