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CONUT-Defined Nutritional Risk and Length of Hospital Stay in Patients with Heart Failure: A Retrospective Cohort Study

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ABSTRACT: Heart failure (HF) is frequently accompanied by nutritional impairment, yet the relationship between nutrition-related risk and hospital length of stay (LOS) remains uncertain. This retrospective cohort study evaluated 103 adults hospitalized with HF at Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia, between January 2023 and December 2025. Nutritional risk was assessed using the Controlling Nutritional Status (CONUT) score and categorized as normal, mild, moderate, or severe. The primary outcome was LOS in days; prolonged LOS (>14 days) and in-hospital mortality were secondary outcomes. Negative binomial regression was used for LOS and binary logistic regression for secondary outcomes, adjusting for age, sex, body mass index, left ventricular ejection fraction, and comorbidity burden. CONUT status was normal in 7.8%, mild in 30.1%, moderate in 49.5%, and severe in 12.6%. Median LOS was 13.5, 11, 13, and 14 days across these categories, respectively ($p=0.890$). CONUT was not associated with LOS in crude (overall $p=0.844$) or adjusted analyses (overall $p=0.932$). Adjusted mean ratios were 1.063 for mild, 0.994 for moderate, and 1.089 for severe CONUT status compared with normal status. No significant associations were observed with prolonged LOS or in-hospital mortality. Continuous-score sensitivity analysis was concordant (aMR 0.987, 95% CI 0.949–1.026; $p=0.514$). CONUT-defined nutritional risk was not independently associated with hospitalization duration in this cohort.

1. INTRODUCTION

Heart failure (HF) remains a major global health burden, affecting more than 64 million people and accounting for substantial morbidity, mortality, and healthcare expenditure [1]. Its prevalence is expected to increase further with population aging and improved survival from cardiovascular disease. Although guideline-directed therapy has substantially advanced HF management, hospitalization continues to mark a clinically vulnerable phase and remains a major contributor to healthcare use [2,3]. Length of stay (LOS) is particularly relevant in hospitalized HF because prolonged hospitalization directly increases resource utilization; in a large contemporary inpatient analysis, malnutrition was associated with markedly longer hospital stays and substantially greater hospital charges [4].

Nutritional impairment is common in HF and arises from interacting disease-related mechanisms rather than inadequate intake alone. Anorexia, intestinal congestion and edema, impaired nutrient absorption, systemic inflammation, neurohormonal activation, increased metabolic demand, and progressive loss of muscle mass may all contribute as HF advances [5,6]. At the same time, nutritional assessment in HF remains challenging because available screening tools capture different dimensions of nutritional vulnerability and no single method has emerged as a universally accepted standard [5]. In a prospective cohort of patients with chronic HF, several commonly used nutritional tools, including the Controlling Nutritional Status (CONUT) score, provided prognostic information for mortality and the composite of hospitalization or death [7].

The CONUT score is attractive in routine practice because it is calculated from three readily available laboratory variables, including serum albumin, total cholesterol, and total lymphocyte count, and therefore provides an objective measure of nutrition-related and immunometabolic vulnerability [8]. Its components, however, are also influenced by inflammation and disease severity, so CONUT is more appropriately interpreted as a nutrition-related risk index than as a stand-alone diagnostic definition of malnutrition [5]. Evidence for its prognostic value in HF is substantial. A meta-analysis of 18 observational studies comprising 12,532 patients found that each one-point increase in CONUT was associated with higher risks of all-cause mortality and major adverse cardiac events [8]. More recent pooled evidence involving 28 cohort studies similarly demonstrated an association between higher CONUT scores and greater all-cause mortality [9]. Studies in specific HF populations have further linked higher CONUT scores with readmission [10], adverse post-discharge outcomes in acute and systolic HF [11,12], and in-hospital mortality in acute decompensated HF [13].

In contrast, evidence specifically relating CONUT to the duration of the index hospitalization is less developed than that for mortality and post-discharge outcomes. Nutritional risk assessed with NRS-2002 has been associated with a longer initial hospital stay in HF [14], while a retrospective CHF cohort found longer hospitalization and greater hospital expenditure among patients classified as malnourished using CONUT [15]. Large administrative data have also demonstrated substantially longer LOS among hospitalized HF patients with malnutrition, although nutritional status in those analyses was not defined by CONUT [4]. These differences in nutritional assessment, HF populations, and analytical approaches limit direct inference regarding whether increasing CONUT severity is independently associated with the actual number of hospital days.

Accordingly, this study investigated the association between CONUT-defined nutritional risk and length of hospital stay among patients hospitalized with HF at a tertiary referral hospital in Indonesia. LOS was retained as the number of hospital days for the primary analysis, while prolonged hospitalization (>14 days) and in-hospital mortality were evaluated as secondary outcomes. We additionally examined whether the association persisted after adjustment for relevant clinical characteristics and whether findings were consistent when the raw CONUT score was analyzed as a continuous exposure. Given the recognized geographic variation in HF epidemiology and the relative paucity of evidence from developing-country settings, evaluation in an Indonesian hospitalized population may provide complementary evidence on the short-term clinical relevance of CONUT [1].

2. MATERIALS AND METHODS

2.1 Study Design, Setting, and Participants

This single-center retrospective cohort study included adult patients with heart failure hospitalized at Dr. Wahidin Sudirohusodo General Hospital, Makassar, Indonesia. Medical records from hospitalizations between January 2023 and December 2025 were reviewed. Of 702 patients identified, 103 met the eligibility criteria and were included in the final analysis.

Patients were eligible if they were aged ≥18 years, had a principal diagnosis of heart failure requiring hospitalization during the study period, and had sufficient laboratory data obtained early during hospitalization to determine the Controlling Nutritional Status (CONUT) score. Required laboratory measurements included a complete blood count with lymphocyte count, serum albumin, and total cholesterol obtained within the first 1–5 days of hospitalization.

Patients were excluded if medical records were incomplete or if they had severe infection or sepsis at admission, maintenance hemodialysis, chronic liver disease, autoimmune disease, or malignancy. Patients who received albumin before laboratory assessment or had prior lipid-lowering therapy were also excluded.

2.2 Data Collection and CONUT Assessment

Data were retrospectively extracted from medical records. Variables included age, sex, body mass index (BMI), number of documented comorbidities, left ventricular ejection fraction (LVEF), Clinical Nutrition consultation status, laboratory parameters required to determine the CONUT score, length of hospital stay (LOS), and hospital disposition. BMI was calculated as body weight in kilograms divided by height in meters squared. LVEF was analyzed as a continuous variable in multivariable models and additionally classified descriptively as <40%, 40–49%, and ≥50%. The number of comorbidities was analyzed as a continuous count of documented coexisting conditions. Clinical Nutrition consultation status was recorded for descriptive analysis but was not included in the multivariable models.

The CONUT score was determined using serum albumin, total lymphocyte count, and total cholesterol measured early during hospitalization. Serum albumin was assigned 0 points for ≥3.5 g/dL, 2 points for 3.0–3.49 g/dL, 4 points for 2.5–2.99 g/dL, and 6 points for <2.5 g/dL. Total lymphocyte count was assigned 0 points for ≥1600 cells/mm³, 1 point for 1200–1599 cells/mm³, 2 points for 800–1199 cells/mm³, and 3 points for <800 cells/mm³. Total cholesterol was assigned 0 points for ≥180 mg/dL, 1 point for 140–179 mg/dL, 2 points for 100–139 mg/dL, and 3 points for <100 mg/dL.

The three component scores were summed to obtain a total CONUT score ranging from 0 to 12. CONUT categories were derived from the recorded raw score using the standard classification: normal, 0–1; mild, 2–4; moderate, 5–8; and severe, 9–12.

2.3 Outcome Definitions

The primary outcome was LOS, calculated from the date of hospital admission to discharge or in-hospital death. Prolonged LOS was defined as hospitalization lasting >14 days. In-hospital mortality was defined as death from any cause during the hospitalization and was evaluated as a secondary outcome.

2.4 Statistical Analysis

Continuous variables were assessed for normality using the Shapiro–Wilk test and summarized as mean ± standard deviation or median with first and third quartiles (Q1–Q3), as appropriate. Categorical variables were presented as frequencies and percentages. Comparisons across CONUT categories were performed using one-way analysis of variance for normally distributed continuous variables and the Kruskal–Wallis test for non-normally distributed variables. Categorical variables were compared using the Fisher–Freeman–Halton exact test with Monte Carlo estimation based on 100,000 sampled tables when expected cell counts were sparse.

Given the right-skewed and overdispersed distribution of LOS, the association between CONUT category and LOS was examined using negative binomial regression with a log link. Normal CONUT status was used as the reference category. Results were reported as mean ratios (MRs) with 95% confidence intervals (CIs). The crude model included CONUT category alone, whereas the adjusted model included age, sex, BMI, LVEF, and number of comorbidities.

Associations of CONUT category with prolonged LOS (>14 days) and in-hospital mortality were evaluated using binary logistic regression. Crude and adjusted odds ratios (ORs) with 95% CIs were calculated, with normal CONUT status as the reference category. Adjusted models included age, sex, BMI, LVEF, and number of comorbidities. Given the limited number of in-hospital deaths, the mortality analysis was considered exploratory.

A sensitivity analysis was conducted using the raw CONUT score as a continuous variable in the adjusted negative binomial regression model. Multicollinearity was assessed using variance inflation factors. All statistical tests were two-sided, and $P<0.05$ was considered statistically significant. Analyses were performed using IBM SPSS Statistics, version 30.0 (IBM Corp., Armonk, NY, USA).

3. RESULTS AND DISCUSSION

3.1 Baseline Characteristics

Among the 103 patients included in the analysis, 8 (7.8%) were classified as normal, 31 (30.1%) as mild, 51 (49.5%) as moderate, and 13 (12.6%) as severe according to the CONUT score. Baseline characteristics according to CONUT category are presented in Table 1. Age differed significantly across CONUT categories (p=0.014), with the highest median age observed in the normal CONUT group. In contrast, there were no statistically significant differences across CONUT categories in sex (p=0.904), body mass index (p=0.586), left ventricular ejection fraction (p=0.505), LVEF category (p=0.738), number of comorbidities (p=0.839), or Clinical Nutrition consultation (p=1.000).

Table 1. Baseline Characteristics of Patients According to CONUT Category

Characteristics	Normal (n=8)	Mild (n=31)	Moderate (n=51)	Severe (n=13)	p-value
Age, years	70.5 (64.0–82.3)	57.0 (53.0–63.0)	56.0 (48.0–64.0)	56.0 (49.5–67.0)	**0.014*[b]**
Sex, n (%)					0.904[c]
Male	4 (50.0)	18 (58.1)	31 (60.8)	7 (53.8)	
Female	4 (50.0)	13 (41.9)	20 (39.2)	6 (46.2)	
BMI, kg/m²	24.8 (19.0–32.7)	22.9 (20.5–25.7)	23.8 (20.2–26.7)	21.3 (19.9–24.0)	0.586[b]
LVEF, %	41.6 ± 12.9	36.7 ± 12.2	41.3 ± 14.6	38.5 ± 13.8	0.505[a]
LVEF category, n (%)					0.738[c]
<40%	3 (37.5)	20 (64.5)	25 (49.0)	8 (61.5)	
40–49%	3 (37.5)	6 (19.4)	14 (27.5)	2 (15.4)	
≥50%	2 (25.0)	5 (16.1)	12 (23.5)	3 (23.1)	
Number of comorbidities	2.0 (0.3–2.0)	2.0 (1.0–2.0)	2.0 (1.0–2.0)	2.0 (1.0–2.5)	0.839[b]
Clinical Nutrition consultation, n (%)					1.000[c]
Yes	2 (25.0)	7 (22.6)	12 (23.5)	3 (23.1)	
No	6 (75.0)	24 (77.4)	39 (76.5)	10 (76.9)	

Note: Data are presented as mean ± standard deviation (SD), median (Q1–Q3), or n (%), as appropriate. [a]One-way analysis of variance (ANOVA). [b]Kruskal–Wallis test. [c]Fisher–Freeman–Halton exact test. *Significant at p<0.05.

Abbreviations: BMI, body mass index; CONUT, Controlling Nutritional Status; LVEF, left ventricular ejection fraction; Q1, first quartile; Q3, third quartile; SD, standard deviation.

3.2 Clinical Outcomes According to CONUT Category

Clinical outcomes according to CONUT category are presented in Table 2. Median length of stay was 13.5 days in the normal group, 11.0 days in the mild group, 13.0 days in the moderate group, and 14.0 days in the severe group, with no statistically significant difference across CONUT categories (p=0.890). The proportion of patients with prolonged hospitalization (>14 days) was also comparable across groups (p=0.988). In-hospital mortality occurred in 37.5% of patients with normal CONUT status, 29.0% with mild, 23.5% with moderate, and 15.4% with severe CONUT status; however, this difference was not statistically significant (p=0.632).

Table 2. Clinical Outcomes According to CONUT Category

Clinical outcome	Normal (n=8)	Mild (n=31)	Moderate (n=51)	Severe (n=13)	p-value
Length of stay, days	13.5 (8.5–15.8)	11.0 (8.0–20.0)	13.0 (9.0–19.0)	14.0 (10.0–22.5)	0.890[a]
Prolonged LOS >14 days, n (%)	3 (37.5)	12 (38.7)	22 (43.1)	5 (38.5)	0.988[b]
In-hospital mortality, n (%)	3 (37.5)	9 (29.0)	12 (23.5)	2 (15.4)	0.632[b]

Note: Data are presented as median (Q1–Q3) or n (%), as appropriate. [a]Kruskal–Wallis test. [b]Fisher–Freeman–Halton. *Significant at p<0.05.

Abbreviations: CONUT, Controlling Nutritional Status; LOS, length of stay; Q1, first quartile; Q3, third quartile.

3.3 Association Between CONUT Category and Length of Stay

The association between CONUT category and length of stay is presented in Table 3. In the unadjusted negative binomial regression, CONUT category was not significantly associated with length of stay overall (p=0.844). Compared with patients with normal CONUT status, no significant differences in expected length of stay were observed for the mild, moderate, or severe CONUT categories. After adjustment for age, sex, BMI, LVEF, and number of comorbidities, the association remained not statistically significant overall (p=0.932). The adjusted mean ratios were 1.063 (95% CI 0.655–1.725) for mild, 0.994 (95% CI 0.629–1.571) for moderate, and 1.089 (95% CI 0.641–1.852) for severe CONUT status.

Table 3. Association Between CONUT Category and Length of Stay

CONUT category	Crude MR (95% CI)	p-value	Adjusted MR (95% CI)	p-value
Overall CONUT effect	—	0.844[a]	—	0.932[a]
Normal	Reference	—	Reference	—
Mild	1.231 (0.764–1.983)	0.394	1.063 (0.655–1.725)	0.804
Moderate	1.136 (0.718–1.797)	0.586	0.994 (0.629–1.571)	0.980
Severe	1.174 (0.684–2.014)	0.561	1.089 (0.641–1.852)	0.752

Note: Negative binomial regression with a log link was used. MR represents the ratio of expected mean length of stay. The adjusted model included age, sex, BMI, LVEF, and number of comorbidities. Normal CONUT status was used as the reference category. [a]Overall Type III Wald test for CONUT category. *Significant at p<0.05.

Abbreviations: BMI, body mass index; CI, confidence interval; CONUT, Controlling Nutritional Status; LVEF, left ventricular ejection fraction; MR, mean ratio.

3.4 Secondary Analyses of Prolonged Length of Stay and In-Hospital Mortality

Secondary logistic regression analyses are presented in Table 4. CONUT category was not significantly associated with prolonged length of stay (>14 days) in either the crude or adjusted analyses. After adjustment for age, sex, BMI, LVEF, and number of comorbidities, the odds of prolonged hospitalization were not significantly different for mild, moderate, or severe CONUT status compared with normal CONUT status.

Similarly, no statistically significant association was observed between CONUT category and in-hospital mortality. Although the adjusted odds ratios for mortality were numerically below 1.0 across the mild, moderate, and severe groups, all confidence intervals were wide and crossed 1.0. Therefore, these findings do not support a significant association between CONUT category and in-hospital mortality.

Table 4. Secondary Logistic Regression Analyses of Prolonged Length of Stay and In-Hospital Mortality According to CONUT Category

Outcome / CONUT category	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Prolonged LOS >14 days				
Normal	Reference	—	Reference	—
Mild	1.053 (0.212–5.232)	0.950	1.165 (0.206–6.593)	0.863
Moderate	1.264 (0.272–5.868)	0.765	1.286 (0.243–6.813)	0.767
Severe	1.042 (0.169–6.402)	0.965	1.122 (0.162–7.794)	0.907
In-hospital mortality				

Normal	Reference	—	Reference	—
Mild	0.682 (0.134–3.473)	0.645	0.398 (0.065–2.447)	0.320
Moderate	0.513 (0.107–2.467)	0.405	0.286 (0.048–1.700)	0.169
Severe	0.303 (0.038–2.421)	0.260	0.173 (0.019–1.598)	0.122

Note: Binary logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs). Adjusted models included age, sex, BMI, LVEF, and number of comorbidities. Normal CONUT status was used as the reference category. *Significant at $p<0.05$.

Abbreviations: BMI, body mass index; CI, confidence interval; CONUT, Controlling Nutritional Status; LOS, length of stay; LVEF, left ventricular ejection fraction; OR, odds ratio.

3.5 Discussion

In this cohort of patients hospitalized with heart failure, CONUT-defined nutritional risk was not significantly associated with length of stay (LOS). Median LOS was similar across the four CONUT categories, and the absence of association persisted after adjustment for age, sex, body mass index, left ventricular ejection fraction, and comorbidity burden. The continuous-score sensitivity analysis yielded a concordant result: each one-point increase in CONUT was associated with an adjusted mean ratio of 0.987 (95% CI, 0.949–1.026; P=0.514). CONUT category was also not associated with hospitalization lasting >14 days. This contrasts with pooled evidence linking malnutrition more broadly with prolonged hospitalization in HF, although the certainty of that evidence remains very low [16].

Several studies have reported associations between nutritional impairment and longer hospitalization, but important methodological differences limit direct comparison with the present findings. Chen et al. [14], in 2,830 patients with HF, found that higher NRS-2002 scores were associated with a lower probability of discharge and longer initial hospitalization. Jia et al. [15], using CONUT, reported longer hospital stays and greater hospital expenditure among patients classified as malnourished, whereas Bansal et al. [4] found substantially longer LOS among hospitalized patients with HF and coded malnutrition. More recently, Knobloch et al. [16] pooled seven studies and found that malnutrition was associated with prolonged hospitalization but emphasized the very low certainty of the evidence. Differences in nutritional instruments, patient populations, sample sizes, and outcome modeling may partly explain the discrepant findings.

The consistency between categorical and continuous CONUT analyses makes it less likely that the primary null finding resulted solely from the selected category thresholds or the small normal-CONUT group. Nevertheless, a single early-hospitalization measurement may incompletely represent nutritional status throughout an admission. Takada et al. [21] assessed CONUT at both admission and discharge in 1,705 hospitalized patients with HF and found that patients whose initially high CONUT status normalized by discharge had a lower subsequent risk of cardiovascular death or HF readmission than those with persistently high CONUT. This supports viewing nutritional status as a dynamic rather than fixed characteristic during HF hospitalization.

The absence of an association with LOS does not negate the broader prognostic relevance of CONUT. A pooled analysis of 18 studies involving 12,532 patients showed that increasing CONUT scores were associated with higher risks of all-cause mortality and major adverse cardiac events [8]. Subsequent meta-analyses have similarly linked poor nutritional status, including that identified by CONUT, with mortality in HF [9,17]. Among 465 patients hospitalized with acute HF, Uemura et al. [18] found that CONUT remained independently associated with post-discharge cardiac events after multivariable adjustment, whereas the Geriatric Nutritional Risk Index and Mini Nutritional Assessment–Short Form did not. CONUT has also demonstrated prognostic value in older patients admitted with acute HF [12]. These findings suggest that prognostic information for mortality or subsequent cardiovascular events does not necessarily translate into an independent association with the duration of the index hospitalization.

This distinction is biologically plausible because CONUT is better interpreted as an **immune-nutritional risk index** than as a stand-alone diagnosis of malnutrition. Its components are susceptible to non-nutritional influences: serum albumin varies with inflammation and acute illness, while lymphocyte count and cholesterol also reflect immunologic, inflammatory, and metabolic processes [5,18]. Decompensated HF adds further complexity through congestion, edema, reduced appetite, inflammation, and altered nutrient absorption, potentially obscuring underlying nutritional status [19]. Moreover, malnutrition, frailty, sarcopenia, and cachexia are distinct but frequently overlapping conditions in HF, and no single laboratory-based index captures this entire phenotype [20].

Importantly, the absence of an independent CONUT–LOS association should not discourage nutritional assessment or intervention. Among hospitalized patients with chronic HF at nutritional risk, individualized nutritional support reduced 30-day mortality and major cardiovascular events compared with standard hospital food, while LOS itself was not significantly altered [22]. This distinction reinforces the possibility that nutritional care can influence clinically important outcomes even when hospitalization duration is not closely related to a baseline nutritional score.

The mortality findings require particular caution. Although adjusted odds ratios were numerically below unity across the mild, moderate, and severe CONUT categories, all confidence intervals were wide and crossed 1.0; therefore, these estimates provide no evidence of a protective association.

In contrast, Huang et al. [13] reported that increasing CONUT was independently associated with greater in-hospital mortality among 1,230 patients with acute decompensated HF. The present analysis included only 26 deaths and eight patients in the normal-CONUT reference group, substantially limiting statistical precision. The mortality analysis should therefore be considered exploratory and should not be interpreted as contradicting the larger prognostic literature [8,19].

The limited event number is particularly relevant when interpreting category-specific odds ratios because small reference groups can produce unstable estimates and wide confidence intervals. Accordingly, the present study provides insufficient evidence to determine the relationship between CONUT severity and in-hospital mortality, and larger studies with adequate event numbers are required for this outcome.

A strength of this study was the evaluation of CONUT using both standard categorical classifications and the raw continuous score. The concordant findings across these approaches support the robustness of the primary observation that baseline CONUT-defined nutritional risk was not independently associated with LOS in this cohort. LOS was also analyzed as an actual count outcome using negative binomial regression rather than relying exclusively on an arbitrary dichotomous threshold.

Several limitations should nevertheless be acknowledged. The retrospective, single-center design and modest sample size limit generalizability, while the small normal-CONUT group reduced precision in categorical comparisons. The limited number of deaths restricted the reliability of multivariable mortality estimates. Residual confounding from renal function, congestion severity, pharmacotherapy, functional status, and other clinical factors also remains possible.

CONUT was measured only once early during hospitalization, without serial assessment, body-composition measurements, dietary intake assessment, muscle-strength evaluation, or formal multidimensional diagnostic criteria for malnutrition. These limitations are important because nutritional screening tools may perform differently in decompensated HF and may capture different dimensions of nutritional vulnerability [19,20].

Overall, the present findings suggest that CONUT-defined nutritional risk does not necessarily translate into longer index hospitalization in every HF population. The consistency of the categorical and continuous analyses supports this interpretation, while the wider literature continues to support the prognostic relevance of nutritional impairment for mortality and other adverse outcomes. Larger prospective multicenter studies incorporating serial CONUT measurements and multidimensional nutritional assessment are needed to clarify which aspects of nutritional vulnerability are most closely related to the inpatient course of HF [16,17].

4. CONCLUSION

In this retrospective cohort of patients hospitalized with heart failure, CONUT-defined nutritional risk was not independently associated with length of hospital stay. The finding remained consistent after adjustment for age, sex, body mass index, left ventricular ejection fraction, and comorbidity burden, and was unchanged when CONUT was analyzed as a continuous score. CONUT category was also not significantly associated with prolonged hospitalization, while the mortality analysis was inconclusive because of the limited number of events and imprecise estimates. These findings suggest that although CONUT remains a practical marker of nutritional and prognostic vulnerability in heart failure, its ability to predict the duration of the index hospitalization may be context dependent. Larger prospective studies incorporating serial nutritional assessment and multidimensional measures of nutritional status are warranted to clarify the relationship between nutritional risk and short-term inpatient outcomes.

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AUTHOR CONTRIBUTIONS

IMM: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, and Writing – Original Draft.

NAT: Conceptualization, Methodology, Supervision, Validation, and Writing – Review & Editing.

AB: Methodology, Supervision, Validation, and Writing – Review & Editing.

AYS: Methodology, Supervision, Validation, and Writing – Review & Editing.

A: Methodology, Formal Analysis, Validation, and Writing – Review & Editing.

NA: Methodology, Supervision, Validation, and Writing – Review & Editing.

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

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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ETHICS STATEMENT

The study was reviewed and approved by the Health Research Ethics Committee, Faculty of Medicine, Hasanuddin University (Approval No. 514/UN4.6.4.5.31/PP36/2026; Protocol No. UH26030397; 14 April 2026). Research permission was subsequently obtained from the Education and Research Division of Dr. Wahidin Sudirohusodo General Hospital (No. DP.04.03/D.XVIII.2/8372/2026).

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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