Aging Clinical and Experimental Research (2025) 37:283
https://doi.org/10.1007/s40520-025-03190-6

RESEARCH

Impact of malnutrition on long-term atrial high-rate episodes, atrial fibrillation, and mortality in octogenarians with dual-chamber pacemakers

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Received: 3 August 2025 / Revised: 23 August 2025 / Accepted: 1 September 2025
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Abstract

Background Malnutrition is common among elderly patients, often leading to severe complications. This study sheds light on the connection between malnutrition and the occurrence of atrial high-rate episodes (AHREs) and atrial fibrillation (AF), as well as all-cause mortality, in individuals aged 80 and older (octogenarians) with dual-chamber permanent pacemakers (DCPM). We employed the Controlling Nutritional Status (CONUT) score and Prognostic Nutritional Index (PNI) to assess malnutrition status effectively.

Methods In this comprehensive retrospective analysis, we evaluated 324 octogenarians who underwent DCPM implantation and received consistent long-term monitoring at a leading tertiary cardiac clinic. Participants were classified into three nutritional status categories based on their CONUT scores.

Results During long-term follow-up, the incidence of AHREs did not differ significantly across CONUT score categories; however, AF and the combined endpoint of AHREs + AF were significantly higher in the moderate-to-severe malnutrition group ($p < 0.001$). Long-term mortality rates increased progressively from normal CONUT scores to moderate-to-severe scores. In the adjusted Cox model, mild malnutrition was associated with a 3.6-fold increased risk of mortality (95% CI: 2.2–14.2), while moderate-to-severe malnutrition conferred a 6.0-fold increased risk (95% CI: 3.4–20.4). Mortality risk rose consistently with worsening nutritional status, with multivariable-adjusted hazard ratios of 3.2 (95% CI: 1.6–11.6) and 5.4 (95% CI: 3.0–19.6) for mild and moderate-to-severe malnutrition, respectively. The CONUT score demonstrated superior predictive value compared with the PNI for both AHREs/AF (AUC 0.73 vs. 0.69) and all-cause mortality (AUC 0.67 vs. 0.61).

Conclusion Malnutrition, as assessed by the CONUT score, is independently associated with long-term AHREs + AF and all-cause mortality in octogenarians undergoing standard pacemaker follow-up, with the CONUT score demonstrating greater predictive accuracy than the PNI.

Keywords Octogenarians · Malnutrition · Dual-chamber pacemakers

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Published online: 07 October 2025

Introduction

Nutrition is vital for protecting the elderly against diseases and enhancing both quality of life and longevity. Malnutrition presents a significant threat to this population, as older adults face a higher risk of nutritional deficiencies, partly due to cognitive and functional deterioration associated with aging [1, 2]. More than 50% of adults over the age of eighty struggle with malnutrition [3]. Malnutrition can lead to the deterioration of the immune system, autonomic dysfunction, and an increase in inflammatory cytokines, ultimately resulting in considerable morbidity and heightened mortality, which can become a vicious cycle [4]. Validated tools for assessing nutritional status in clinical settings include the Prognostic Nutritional Index (PNI), which is based on serum albumin levels and total lymphocyte count, and the Controlling Nutritional Status (CONUT) score, a composite marker that incorporates albumin, total cholesterol, and lymphocyte count [5, 6].

Atrial high-rate episodes (AHREs), which generally last longer than 5 min and exhibit an atrial rate of ≥170 bpm, are defined as subclinical manifestations of atrial fibrillation (AF) and are identified using cardiac implantable electronic devices (CIEDs) with atrial leads [7]. Although they are less severe than clinical AF, AHREs are associated with an increased risk of thromboembolic events and elevated all-cause mortality risk [8]. The recognized risk factors for both AHREs and AF include age, increased left atrial volume index, and inflammation; however, the role of malnutrition as a potentially modifiable risk factor remains largely unexplored [9–11].

Given the growing aging population and the increased use of permanent pacemaker (PPM) therapy, it is clinically important to investigate whether poor nutritional status, as indicated by PNI and CONUT scores, is linked to the development of AHREs, AF, and adverse outcomes. This study aims to evaluate the predictive significance of PNI and CONUT scores concerning the incidence of AHREs, AF, and mortality in octogenarians (aged 80 and older) who have undergone dual-chamber pacemaker implantation (DCPM) over a longer follow-up period.

Materials and methods

Study population and design

This study evaluates the outcomes of 324 octogenarians who underwent DCPM implantation for complete atrioventricular (AV) block, sick sinus syndrome (SSS), or other indications (including unexplained syncope with bifascicular block or alternating bundle branch block) at a tertiary

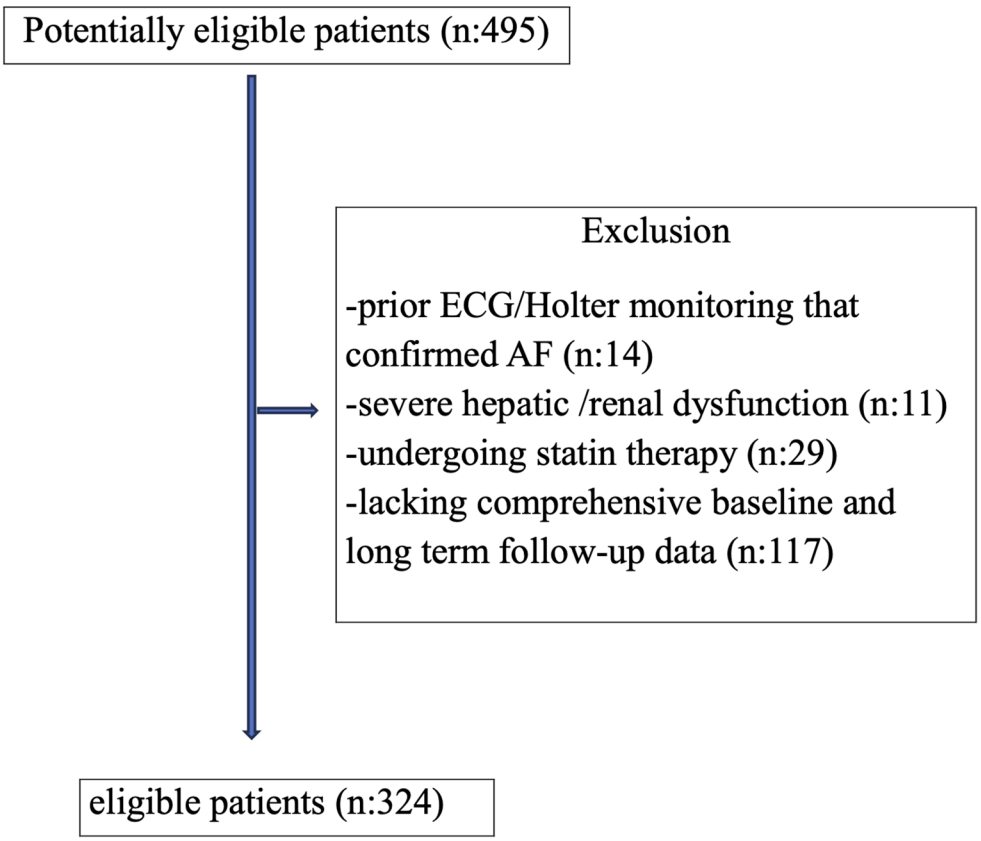

Fig. 1 Flow chart of patient enrolment in our study

Table 1 Scoring system for the controlling nutritional status (CONUT) score

Degree of undernutrition	CONUT score	Serum albumin (g/dl)	Total lymphocyte (/mm3)	Total cholesterol (mg/dl)
Normal	0–1	≥3.50 (0)	≥1,600 (0)	≥180 (0)
Mild	2–4	3.00–3.49 (2)	1,200–1,599 (1)	140–179 (1)
Moderate	5–8	2.50–2.99 (4)	800–1,199 (2)	100–139 (2)
Severe	9–12	<2.50 (6)	<800 (3)	<100 (3)

cardiac center between January 2014 and January 2020. We prioritized the integrity of our findings by excluding patients with prior electrocardiograms (ECGs) or Holter monitoring that confirmed AF, those with severe hepatic or renal dysfunction, patients who did not survive their hospital stay following DCPM implantation, individuals undergoing statin therapy, or those lacking comprehensive baseline and long-term follow-up data (Fig. 1). Our study included

Table 2 Comparison of demographic, clinical characteristics and medical therapies of patients according to CONUT score following dual-chamber pacemaker implantation

Out of 495 patients, 171 were excluded, evaluated 324 patients				
	Normal	Mild Malnutrition	Moderate to Severe Malnutrition	
	(CONUT = 0–1)	(CONUT = 2–4)	(CONUT = 5–12)	
	n = 117	n = 154	n = 53	P value
Age, y	83 (81–85)	84 (82–87)	84 (82–86)	0.053
Male gender	61 (52. 1)	90 (58.4)	26 (49.1)	0.394
Hypertension	87 (74.4)	121 (78.6)	36 (67.9)	0.296
Diabetes Mellitus	33 (28.2)	51 (33.1)	19 (35.8)	0.543
Hyperlipidemia	45 (38.5)	42 (27.3)	13 (24.5)	0.078
Smoking	11 (9.4)	32 (20.9)	13 (24.5)	0.011
Chronic renal failure	28 (23.9)	70 (45.5)	22 (41.5)	0.001
Chronic obstructive pulmonary disease	10 (8.5)	20 (13.0)	8 (15.1)	0.365
Cerebrovascular accident	7 (6.0)	8 (5.2)	5 (9.4)	0.539
Coronary artery disease	48 (41.0)	48 (31.2)	19 (35.8)	0.244
Percutaneous coronary intervention	17 (14.5)	23 (14.9)	5 (9.4)	0.562
Coronary artery bypass grafting	16 (13.7)	15 (9.7)	3 (5.7)	0.245
Alzheimer	10 (8.5)	12 (7.8)	7 (13.2)	0.514
Admission symptom				
Presyncope/syncope	73 (62.4)	90 (58.4)	31 (58.5)	0.786
Dyspnea	14 (12.0)	21 (13.6)	8 (15.1)	0.842
Angina	0 (0.0)	1 (0.6)	2 (3.8)	0.084
Atypical symptoms	30 (25.6)	42 (27.3)	12 (22.6)	0.796
Indication				
Complete AV block	80 (68.4)	112 (72.7)	38 (71.7)	0.732
Mobitz type 2 AV block	9 (7.7)	6 (3.9)	2 (3.8)	0.348
2:1 AV block	6 (5.1)	12 (7.8)	4 (7.5)	0.669
Sick sinus syndrome	15 (12.8)	19 (12.3)	8 (15.1)	0.874
Others	7 (6.0)	5 (3.2)	1 (1.9)	0.361
Medical therapy				
Acetylsalicylic acid	50 (42.7)	57 (37.0)	22 (41.5)	0.611
Clopidogrel	18 (15.4)	24 (15.6)	6 (11.3)	0.735
Beta blocker	34 (29.1)	45 (29.2)	11 (20.8)	0.441
Ca channel blocker/non-dihydropyridine	2 (1.7)	4 (2.6)	0 (0.0)	0.476
Ca channel blocker/ dihydropyridine	38 (32.5)	47 (30.5)	17 (32.1)	0.938
Ace inh/ARB	67 (57.3)	84 (54.5)	22 (41.5)	0.15
Spironolactone	5 (4.3)	8 (5.2)	1 (1.9)	0.593
Furosemide	51 (43.6)	57 (37.0)	15 (28.3)	0.155
Warfarin	4 (3.4)	3 (1.9)	1 (1.9)	0.709
New oral anticoagulants	2 (1.7)	6 (3.9)	0 (0.0)	0.232

Abbreviations: AV, Atrioventricular; ACEIs, Angiotensin-converting-enzyme inhibitors; ARBs, Angiotensin II receptor blockers

Table 3 Comparison of laboratory, electrocardiographic, transthoracic echocardiographic parameters and progressive clinical alterations of patients according to CONUT score following dual-chamber pacemaker implantation

	Normal (CONUT = 0–1) *n* = 92	Mild Malnutrition (CONUT = 2–4) *n* = 154	Moderate to Severe Malnutrition (CONUT = 5–12) *n* = 53	*P* value
Laboratory variables at implantation				
Hb (g/dl)	12.0 (10.8–13.1)	11.6 (10.6–12.5)	12. 0 (10.4–13.1)	0.225
WBC (cells/μL)	7.2 (6.3–8.8)	7.3 (6.1–8.9)	7.0 (5.3–8.0)	0.117
Platelet count (/mm^3)	216 (181–261)	226 (171–284)	218 (169–262)	0.698
Lymphocytes	1.9 (1.7–2.3)	1.4 (1.1–1.8)	1.0 (0.8–1.2)	<0.001
Urea	23 (18–29)	25 (19–33)	27 (22–32)	0.097
Creatinine (mg/dL)	1.0 (0.8–1.2)	1.1 (0.8–1.4)	1.0 (0.8–1.2)	0.044
TSH	1.5 (0.9–2.2)	1.5 (0.9–2.2)	1.1 (0.5–2.6)	0.592
Glucose (mg/dl)	100 (91–116)	103 (92–137)	107 (94–133)	0.148
Sodium	140 (138–141)	139 (137–142)	140 (138–142)	0.320
Potassium	4.3 (4.1–4.7)	4.4 (4.1–4.7)	4.4 (4.1–4.6)	0.611
Calcium (corrected)	8.8 (8.3–9.4)	8.8 (8.3–9.2)	8.7 (8.1–9.1)	0.238
Magnesium	1.9 (1.8–2.1)	1.9 (1.7–2.1)	1.9 (1.8–2.1)	0.702
Albumin	3.9 (3.6–4.0)	3.4 (3.3–3.8)	2.9 (2.7–3.2)	<0.001
Total Cholesterol	194 (173–206)	160 (142–193)	151 (131–158)	<0.001
CONUT score	0 (0–1)	3 (2–4)	6 (5–7)	<0.001
Prognostic nutritional index	48.2 (45.9–52.0)	42.6 (40.0–44.5)	35.0 (33.6–37.6)	<0.001
Electrocardiography after implantation				
Pacing QRS duration, ms	165 (151–178)	168 (155–181)	165 (154–180)	0.453
Echocardiography variables at implantation				
Ejection fraction, %	62 (61–62)	62 (57–62)	62 (57–62)	0.263
LVEDD, mm	48 (45–50)	47 (44–50)	46 (44–50)	0.580
LVESD, mm	30 (27–34)	29 (26–33)	30 (27–33)	0.626
LAAP, mm	40 (36–45)	40 (36–44)	41 (37–44)	0.929
Long-term atrial fibrillation	11 (9.4)	37 (24.0)	18 (34.0)	<0.001
Long-term AHREs	3 (2.6)	8 (5.2)	5 (9.4)	0.157
Long-term AHREs + atrial fibrillation	13 (11.1)	41 (26.6)	21 (39.6)	<0.001
Long-term mortality	27 (23.1)	77 (50.0)	40 (75.5)	<0.001
Follow-up, months	35 (12–68)	32 (14–57)	29 (11–53)	

Continuous variables are presented as median (interquartile range)

Nominal variables presented as frequency (%)

Abbreviations: Hb, Hemoglobin; WBC, White Blood Count; TSH, Thyroid-stimulating hormone; LVEDD, Left ventricular end-diastolic dimension; LVESD, Left ventricular end-systolic dimension; LAAP, Left atrium anteroposterior; AHREs, Atrial high-rate episodes

patients who maintained consistent follow-up documentation at 3- to 6-month intervals, ensuring comprehensive data collection through routine evaluations. These evaluations encompassed thorough physical examinations, ECG assessments, and detailed DCPM device evaluations. Notably, the settings for the DCPM were tailored to each patient's needs based on the discretion of the attending physician. During these evaluations, we established a clear definition of AHREs as indicated by the pacemaker's intra-cavity ECG recordings, specifically highlighting sustained atrial rates of ≥170 bpm for over 5 min [7]. This significant marker was further substantiated by the DCPM device's synchronous automatic mode conversion. Our extensive data collection included demographic factors, transthoracic echocardiographic (TTE) and ECG characteristics, laboratory results, medication usage, procedural details, complications, and long-term follow-up outcomes, all sourced from hospital medical records and the national health database. Importantly, our research protocol strictly follows the principles outlined in the Declaration of Helsinki and has received approval from the local ethics commission, ensuring both ethical rigor and reliability in our findings (Istanbul Medipol University Approval Number: E-10840098-202.3.02-5492).

Definitions and study outcome

AF is characterized by the absence of P waves and irregular RR intervals that exceed 30 s, observable on a standard 12-lead ECG or during 24-hour rhythm monitoring [7]. The PNI is derived from serum albumin concentration and peripheral lymphocyte count, calculated using the formula: PNI = albumin (g/L) + 5 × total lymphocyte counts (×10^9/L) [12]. On the other hand, the CONUT score is a composite index created from three lab parameters: serum albumin, total lymphocyte count, and total cholesterol [6]. Each parameter gets an individual score, and their sum represents the overall CONUT score, indicating the level of nutritional impairment. The scoring system is explained in Table 1. The

Table 4 Cox regression models for any grade of malnutrition by CONUT score

	CONUT score		
	Normal (CONUT = 0–1) *n* = 117	Mild Malnutrition (CONUT = 2–4) *n* = 154	Moderate to Severe Malnutrition (CONUT = 5–12) *n* = 53
Long-term AHREs + atrial fibrillation Number of patients	13	41	21
Case rate, %	11.1	26.6	39.6
Long-term AHREs + atrial fibrillation, HR (%95 CI) Model 1: unadjusted	1[Reference]	2.9 (1.3– 6.0)	4.2 (2.2–11.4)
Model 2: adjusted for all covariates[a]	1[Reference]	3.6 (2.2–14.2)	6.0 (3.4–20.4)
Long-term mortality Number of patients	27	77	40
Case rate, %	23.1	50.0	75.5
Long-term mortality, HR (%95 CI) Model 1: unadjusted	1[Reference]	2.6 (1.4– 5.5)	3.9 (2.5– 12.1)
Model 2: adjusted for all covariates[a]	1[Reference]	3.2 (1.6– 11.6)	5.4 (3.0– 19.6)

Abbreviations: AHREs, Atrial high-rate episodes; CI, confidence interval; HR, hazard ratio

study outcomes were defined as the incidence of AHREs and AF, as well as all-cause mortality, among individuals aged ≥ 80 years with DCPM, categorized according to their CONUT scores.

Statistical analysis

Statistical analyses were carried out using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as median and interquartile range (IQR) due to their non-normal distribution, while categorical variables were summarized as frequencies

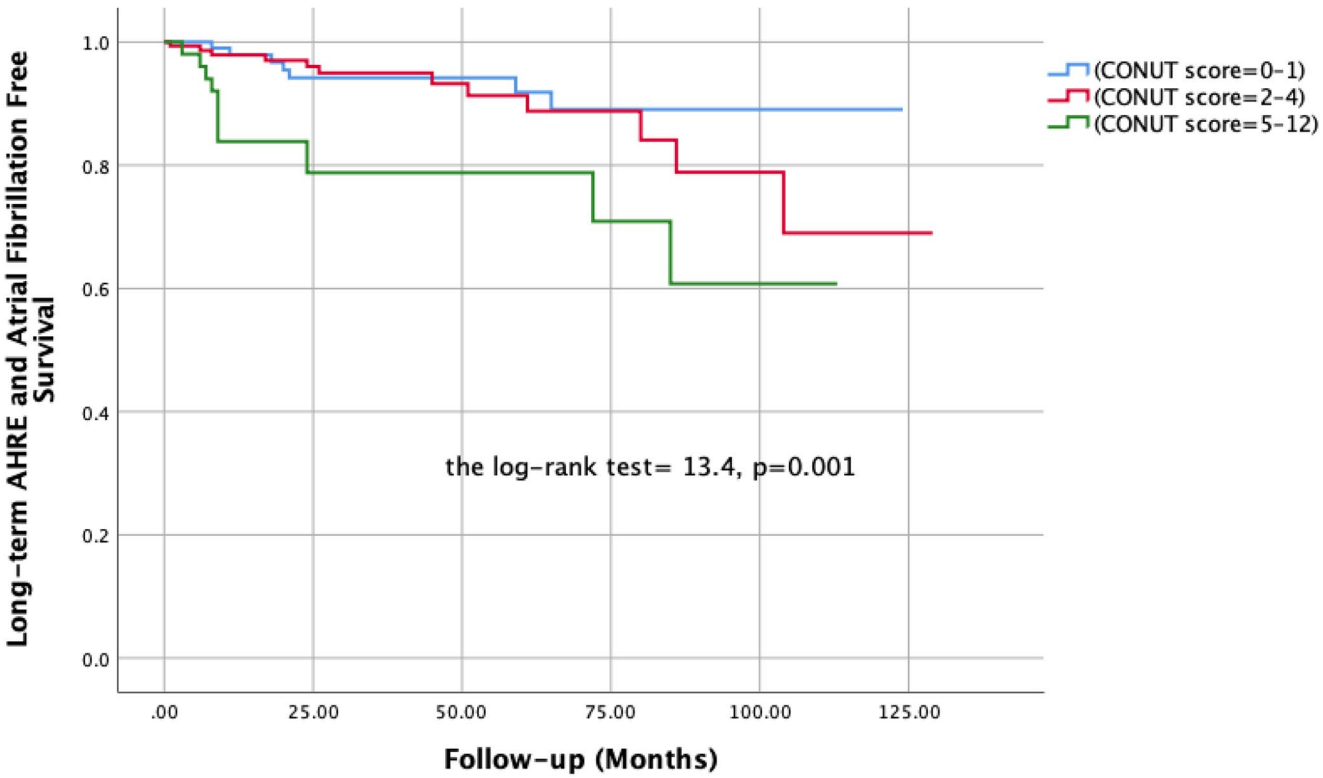

Fig. 2 Kaplan–Meier survival curves illustrating the cumulative incidence of long-term atrial high-rate episodes and atrial fibrillation in patients stratified by the controlling nutritional status (CONUT) score

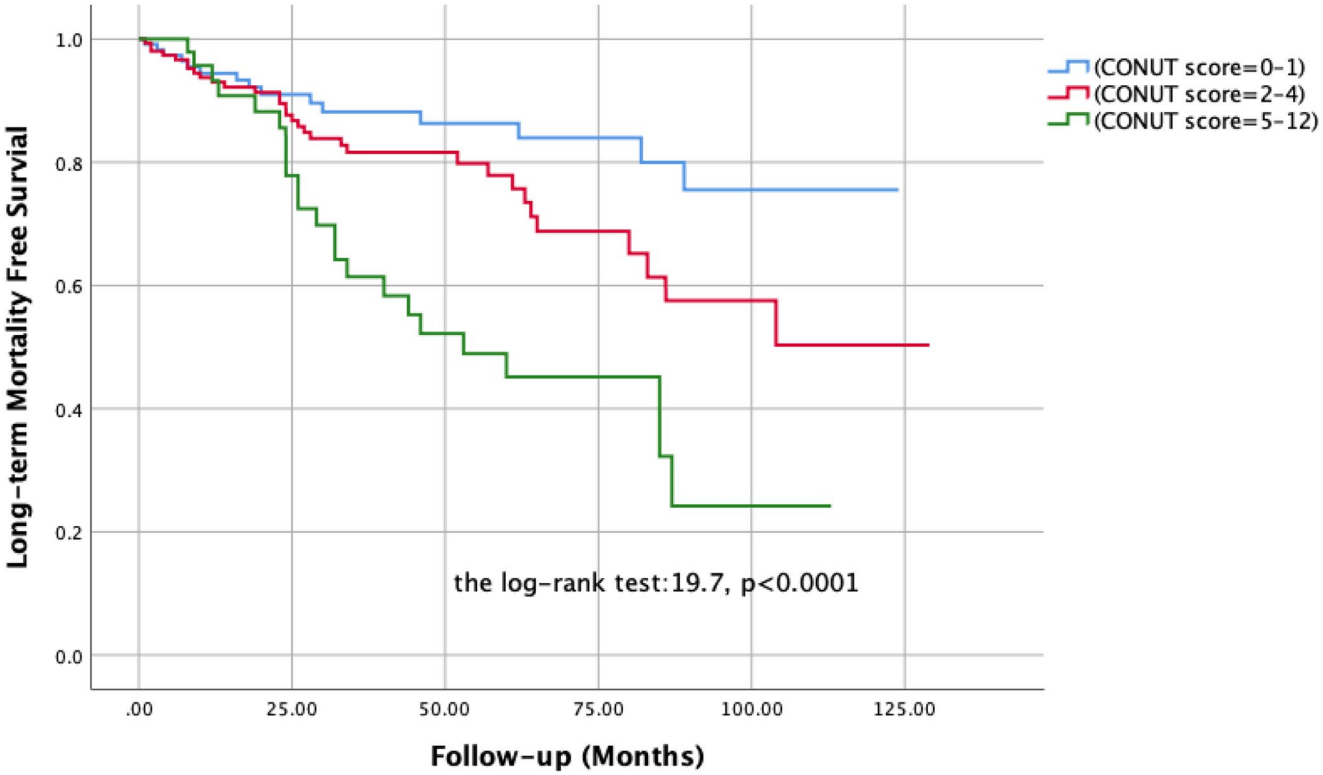

Fig. 3 Kaplan–Meier survival analysis for all-cause mortality in patients stratified by controlling nutritional status (CONUT) score

and percentages. Normality was assessed using the Kolmogorov–Smirnov test. To compare the three malnutrition groups (normal, mild, and moderate to severe) based on the CONUT score, the Kruskal–Wallis test was utilized for continuous variables. For categorical variables, comparisons were made using either the chi-square test or Fisher's exact test, depending on the context. Receiver Operating Characteristic (ROC) curve analysis was conducted to evaluate the predictive performance of the CONUT score and PNI concerning the development of AHREs, AF, and long-term mortality. The calculations for the area under the curve (AUC), sensitivity, specificity, and optimal cut-off values were performed. To determine the independent relationship between nutritional status (according to CONUT categories) and long-term outcomes including AF, AHREs, and all-cause mortality, Cox proportional hazards regression models were employed. Hazard ratios (HRs) together with 95% confidence intervals (CIs) were reported. The multivariate models were adjusted for potential confounding factors such as age, smoking status, chronic renal failure, blood urea nitrogen, creatinine levels, left ventricular ejection fraction (LVEF), and paced QRS duration—variables that showed statistical significance in univariate analysis. A two-tailed *p*-value of less than 0.05 was regarded as statistically significant throughout the analysis.

Results

The study involved 324 patients aged 80 and older, who were divided into three groups based on their CONUT scores: normal (0–1), mild (2–4), and moderate to severe (5–12). The distribution showed 117 patients (37%) in the normal group, 154 (46%) in the mild group, and 53 (17%) in the moderate to severe malnutrition group. The average age across the groups was comparable, and no significant differences were noted in comorbidities, symptoms, block types, or the use of medicinal therapy. The demographic and clinical characteristics of the patients are summarized in Table 2.

Laboratory data and TTE findings during DCPM implantation are presented in Table 3. Notable declines in lymphocyte, albumin, and total cholesterol levels were observed in the moderate to severe malnutrition group compared to the other groups, while a higher CONUT score correlated with a lower PNI. No significant differences were found in TTE results among the groups.

The average follow-up duration was 35 months for the normal group, 32 months for the mild group, and 29 months for the moderate to severe group. While there was no significant difference in AHREs observed based on CONUT scores during the long-term follow-up, the presence of AF accompanying AHREs and AF alone was statistically significant in the moderate to severe malnutrition group.

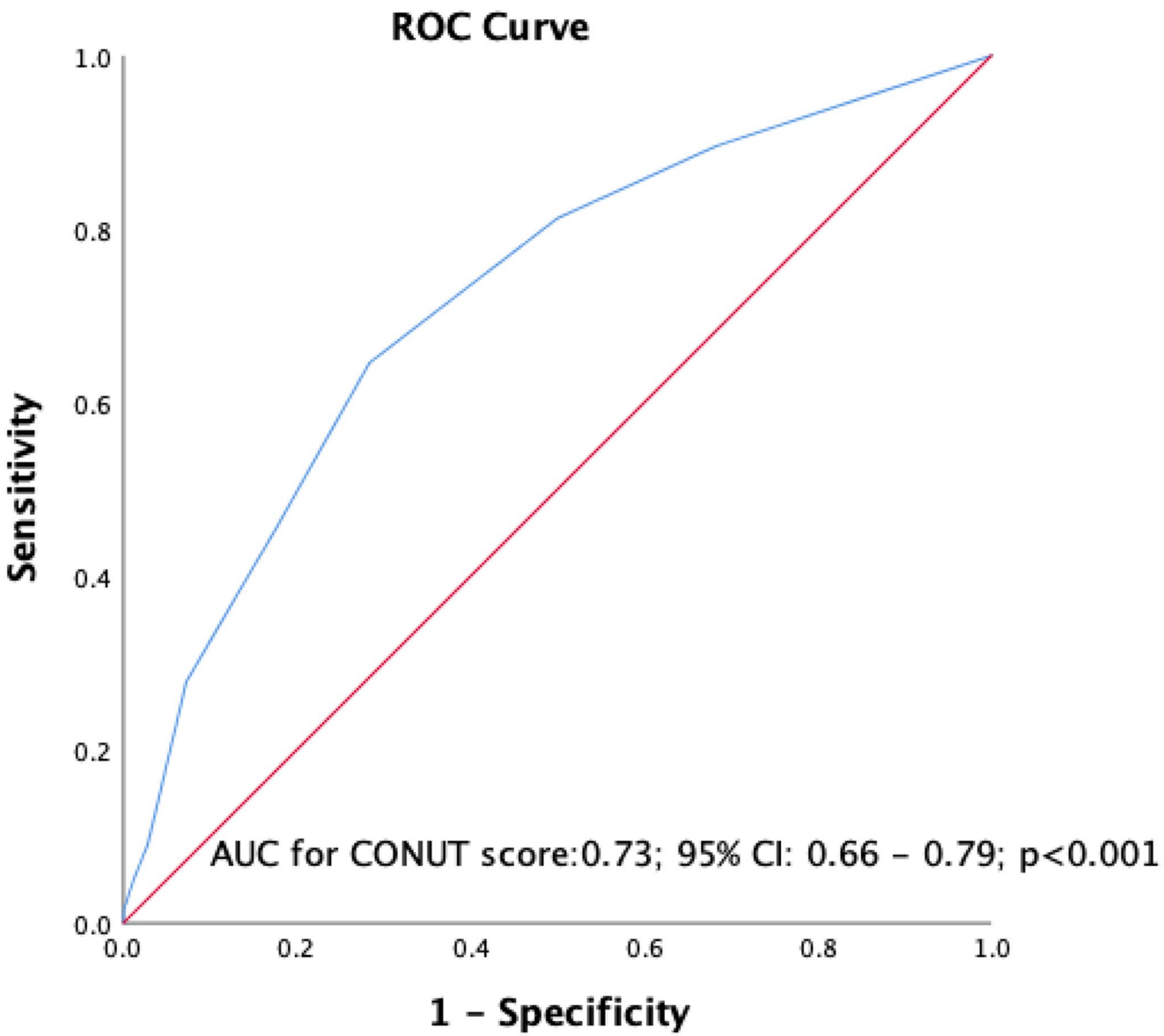

Fig. 4 A receiver operating characteristic (ROC) curve analyses of controlling nutritional status (CONUT) score during during long follow-up for mortality

Long-term mortality rates increased significantly from the normal CONUT score group to the moderate to severe group.

Table 4 provides the outcomes from Cox proportional hazards regression models examining the relationship between malnutrition (as assessed by the CONUT score) and long-term clinical events, including AHREs+AF and overall mortality. The incidence of long-term AHREs+AF escalated across malnutrition categories: 11.1% in the normal group to 26.6% and 39.6% in the mild and moderate-to-severe groups, respectively. In an unadjusted Cox model, both mild malnutrition (HR: 2.9; 95% CI: 1.3–6.0) and moderate to severe malnutrition (HR: 4.2; 95% CI: 2.2–11.4) significantly elevated the risk of AHREs+AF. These associations persisted after adjusting for covariates, with adjusted hazard ratios increasing to 3.6 (95% CI: 2.2–14.2) and 6.0 (95% CI: 3.4–20.4).

Mortality rates also showed a progressive increase corresponding to nutritional status: from 23.1% in the normal group, to 50.0% in the mild group, and 75.5% in the moderate-to-severe group. Unadjusted analyses revealed a significantly higher mortality risk in both the mild (HR: 2.6; 95% CI: 1.4–5.5) and the moderate-to-severe groups (HR: 3.9; 95% CI: 2.5–12.1) when compared to the normal group. These associations were consistent in the multivariate-adjusted model, showing adjusted HRs of 3.2 (95% CI: 1.6–11.6) and 5.4 (95% CI: 3.0–19.6), respectively.

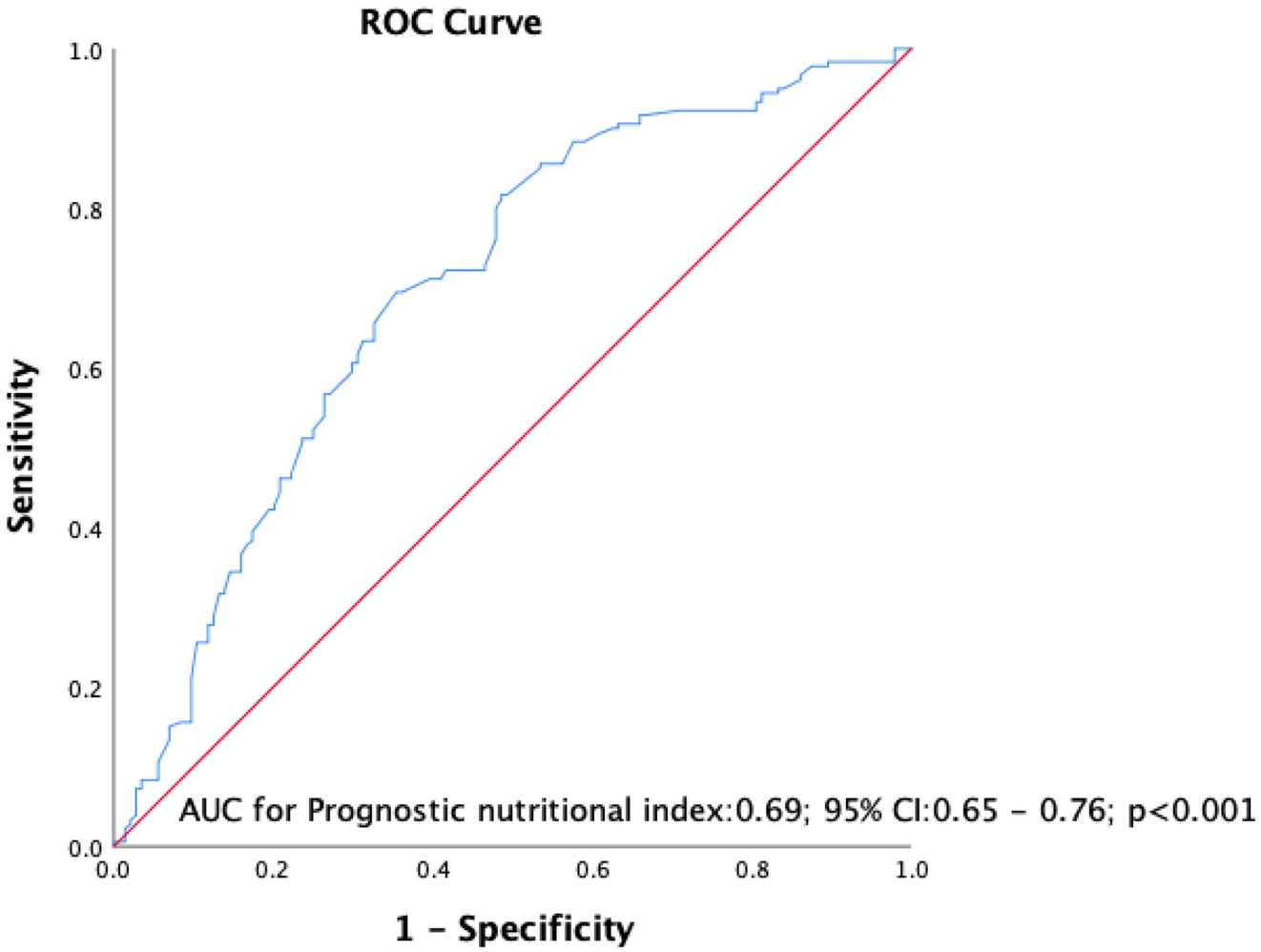

Fig. 5 A receiver operating characteristic (ROC) curve analysis of prognostic nutritional index (PNI) during long follow-up for mortality

Kaplan–Meier survival curves in Fig. 2 illustrate the cumulative incidence of long-term AHREs and AF according to nutritional status, showcasing those patients with higher CONUT scores had a significantly lower AHREs/AF-free survival over time, with a statistically significant difference among groups ($\chi^2 = 13.4$, $p = 0.001$). Similarly, Fig. 3 outlines the survival analysis for all-cause mortality, whereby the moderate to severe malnutrition group demonstrated a noticeably lower survival rate compared to the mild and normal groups—a statistically significant difference (log-rank test: $\chi^2 = 19.7$, $p < 0.0001$).

ROC curve analysis for mortality demonstrated that a CONUT score≥4 predicted long-term mortality in malnourished patients with 45% sensitivity and 83% specificity, whereas a PNI > 43.6 predicted survival with 65% sensitivity and 68% specificity (HR: 0.73, 95% CI: 0.66–0.79, $p < 0.001$; HR: 0.69, 95% CI: 0.65–0.76, $p < 0.001$), as shown in Figs. 4 and 5. Furthermore, ROC curve analysis revealed that the CONUT score provided the highest AUC for predicting AHREs and AF during long-term follow-up. A CONUT score≥4 predicted AHREs and AF in malnourished patients with 46% sensitivity and 75% specificity (HR: 0.67, 95% CI: 0.60–0.73, $p < 0.001$). In contrast, a PNI > 42.9 predicted the absence of AHREs and/or AF with 61% sensitivity and 58% specificity (HR: 0.61, 95% CI: 0.54–0.69, $p < 0.001$), as shown in Figs. 6 and 7.

Discussion

In this study, we stratified octogenarians based on the CONUT score to assess their nutritional status during routine DCPM follow-up, revealing that those with malnutrition exhibited significantly elevated long-term rates of AHREs + AF and all-cause mortality and with the CONUT score proving more predictive than the PNI.

The relationship between malnutrition and the onset of atrial arrhythmias is likely driven by several complex pathophysiological mechanisms. Malnutrition fosters a pervasive pro-inflammatory environment, marked by elevated levels

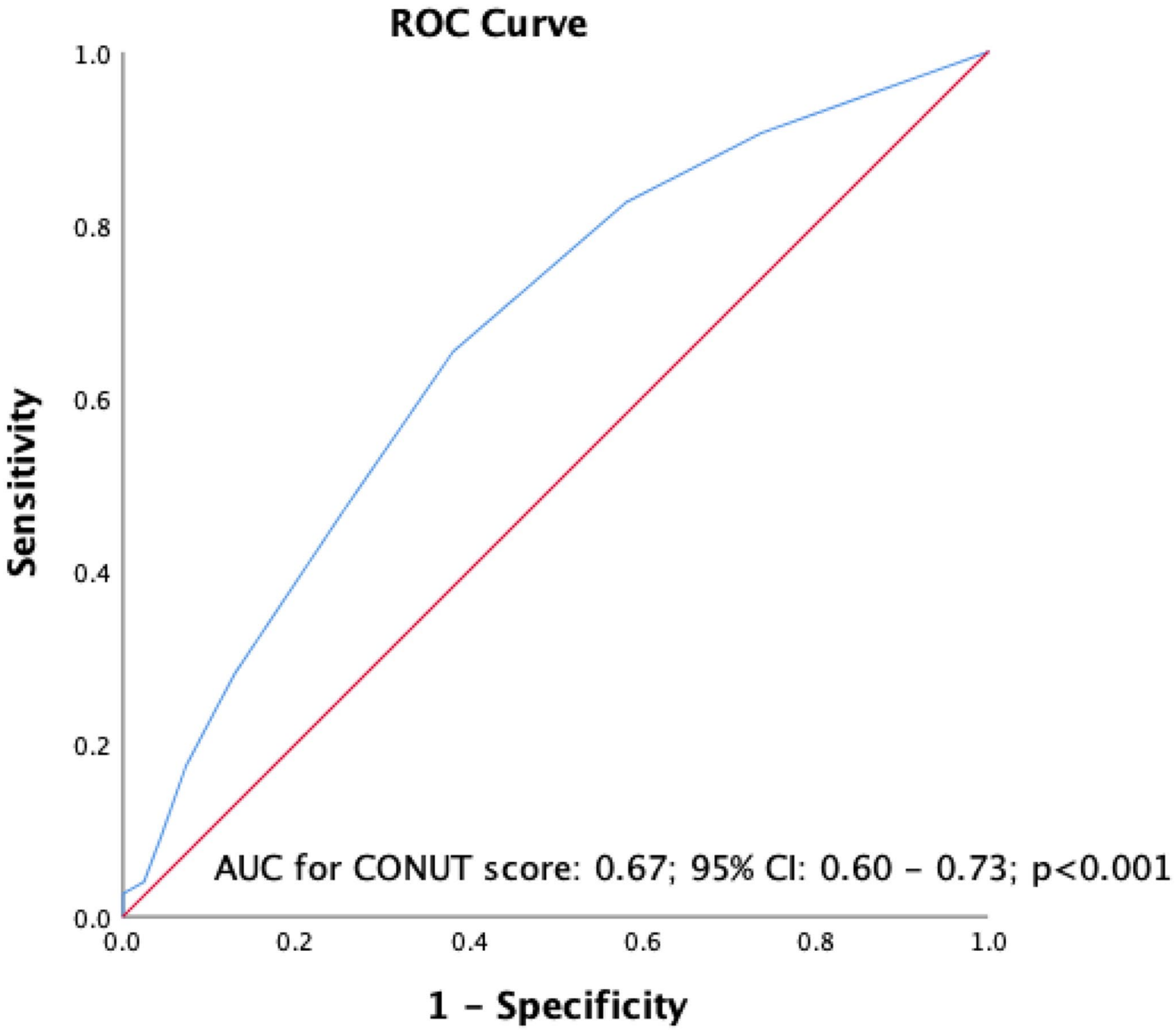

Fig. 6 A receiver operating characteristic (ROC) curve analyses of controlling nutritional status (CONUT) score during long follow-up for atrial high-rate episodes and atrial fibrillation

of cytokines such as IL-6 and TNF-α, which play a pivotal role in atrial remodeling and electrical instability. Additionally, hypoalbuminemia is associated with increased oxidative stress, endothelial dysfunction, and a reduced capacity for antioxidant defenses. The interplay of systemic inflammation, myocardial remodeling, and autonomic instability significantly heightens the risk of atrial arrhythmias in malnourished individuals [13, 14]. Inflammation is widely recognized as a catalyst for AF [15]. Consequently, malnutrition was shown to increase the levels of several cytokines and interleukins associated with inflammation. This may lead to chronic inflammation in the body and promote the onset of AF [16].

AHREs have recently captured significant attention due to their strong association with stroke and cardiovascular mortality. Research consistently shows that these events are independently linked to thromboembolic occurrences [9, 17, 18]. According to a recent large-scale review, patients with AHREs have an increased risk of stroke and consequently a higher risk of bleeding associated with the initiation of anticoagulant therapy. Therefore, it has been emphasized that decisions regarding anticoagulant use should be individualized [19]. In addition, among patients with pacemakers, appropriate device programming is crucial to minimize unnecessary pacing and preserve physiological cardiac activation. A review by Mei DA et al. reported a reduced incidence of AF and cardiovascular hospitalization in patients

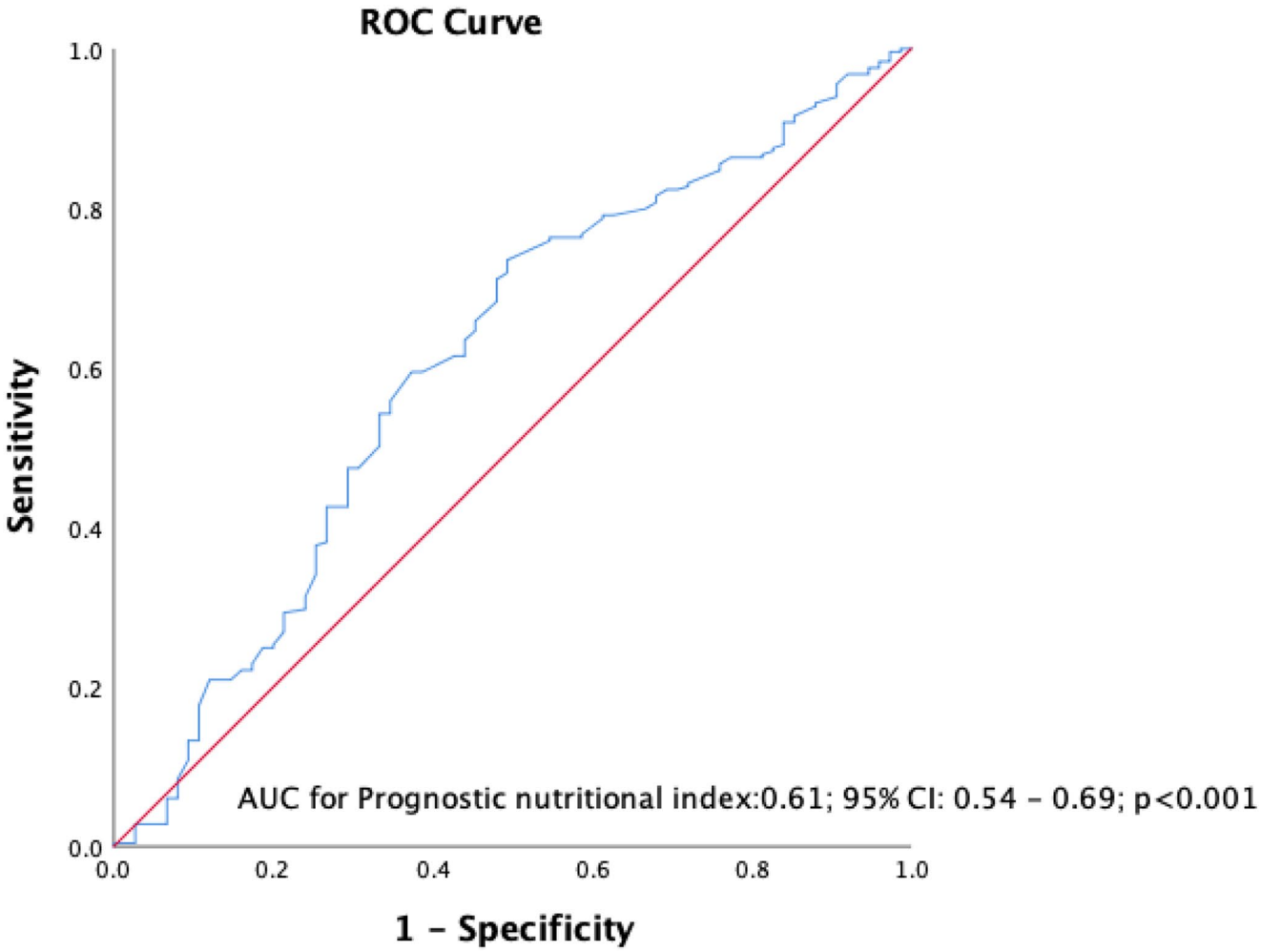

Fig. 7 A receiver operating characteristic (ROC) curve analysis of prognostic nutritional index (PNI) during long follow-up for atrial high-rate episodes and atrial fibrillation

using algorithms designed to minimize right ventricular pacing (RVPm), compared with those managed with standard DCPM [20].

AF, in particular, significantly elevates the risk of both cardiovascular mortality and morbidity, resulting in devastating consequences such as strokes and heart failure, which ultimately diminish patients' quality of life [21]. In this context, tools like the CONUT score and the PNI have emerged as reliable and accessible means for evaluating nutritional status and predicting adverse outcomes across various cardiovascular conditions, including heart failure, coronary artery disease, and valvular heart disease [22–25]. Our findings reveal that patients with lower PNI and higher CONUT scores face a pronounced long-term burden of AHREs + AF, reinforcing the critical link between poor nutritional status and atrial electrical instability. Furthermore, we observed that decreased serum albumin levels—a key element of both the CONUT and PNI—were independently associated with an increased burden of AF [26]. Our study starkly illustrates that those in our cohort with the lowest albumin levels experienced significantly higher instances of long-term AHREs and AF. Malnutrition is a factor influencing disease severity and facilitates the progression to chronicity [27]. Our study revealed no significant link between AHREs patients and malnutrition itself; however, it revealed a significantly higher prevalence of both AF and AHREs + AF among malnourished patients. Hereby, malnutrition may plausibly exacerbate disease severity in people with AHREs, perhaps resulting in persistent AF.

The research conducted by Gocer K et al. highlights the critical role of malnutrition in the onset of AF and its association with elevated one-year mortality rates among the elderly [14]. In a similar study, Cheng N et al. have confirmed that malnutrition stands as an independent predictor of adverse outcomes for very elderly patients afflicted with nonvalvular AF [28]. In our study, we found that the CONUT score not only predicted long-term AHREs + AF more accurately, but also demonstrated a stronger correlation

with mortality when compared to the PNI. The distinction is attributed to the incorporation of total cholesterol in the CONUT score, a significant indicator sometimes neglected in PNI evaluation. Given the established link between low total cholesterol and malnutrition, it becomes evident why the CONUT score captures a more comprehensive picture of nutritional status [29]. Furthermore, our findings revealed that malnourished patients exhibit significantly higher all-cause mortality rates. This underscores prior research showing that low PNI and elevated CONUT scores are strong predictors of mortality in both elderly populations and those with cardiovascular disease [30]. Importantly, studies have also validated the CONUT score as a vital indicator of mortality risk for hospitalized elderly patients [31–34].

Our study revealed critical clinical implications. Firstly, by integrating nutritional scoring systems into routine pacemaker follow-up protocols, we can significantly enhance our ability to identify high-risk patients at an early stage. Secondly, addressing nutritional deficiencies within this vulnerable population has the potential to not only elevate overall health status but also to substantially decrease the incidence of both subclinical and clinical arrhythmias, along with their associated complications. It is essential that future prospective studies should investigate whether targeted nutritional interventions can effectively reduce atrial arrhythmogenesis and improve survival rates among malnourished elderly patients.

Limitations

While our study offers valuable insights, we must acknowledge several limitations. The primary concern stems from our retrospective methodology, which increases the risk of unmeasured confounding variables, particularly in the context of our limited patient sample size. Additionally, the lack of data on atrial and ventricular pacing percentages within the study population constrains our findings. Nutritional parameters were derived solely from laboratory data at the time of pacemaker placement, neglecting any subsequent changes. Furthermore, the insufficient evidence regarding the exact causes of long-term mortality prevents us from categorizing deaths as either cardiac or non-cardiac.

Conclusion

This study revealed that malnutrition, as assessed by the CONUT score, is independently associated with long-term AHREs + AF and all-cause mortality in octogenarians undergoing standard pacemaker follow-up, with the CONUT score showing superior predictive performance compared with the PNI. These findings highlight the importance of incorporating objective nutritional indices into arrhythmia monitoring and risk stratification, thereby improving the quality of care for geriatric patients with DCPM.

Author contributions Conceptualization, M.I.H. and T.C; methodology, K.K.; software, M.I.H and K.G.; formal analysis K.K. and L.P.; data curation, G.Y., G.A.B., K. KE. and C.C. writing, review and editing K.K, M.I.H. and T.C. All authors have read and agreed to the published version of the manuscript.

Funding This study did not get any particular financing from governmental, commercial, or non-profit entities.

Data availability No datasets were generated or analysed during the current study.

Declarations

Institutional review board statement, informed consent statement Written informed consent was obtained from the patients included in this retrospective analysis.

Competing interests The authors declare no competing interests.

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