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ORIGINAL RESEARCH

Impact of Laboratory-Derived Frailty Index on Clinical Outcomes in Critical Care Patients with COPD: A Retrospective Analysis Using the MIMIC-IV Database

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Background and Objective: Chronic obstructive pulmonary disease (COPD) is associated with high mortality and morbidity worldwide. Notably, 20% of COPD patients are admitted to the ICU, and among them, there is a 25% mortality rate. Therefore, identifying novel risk factors for effective intervention is crucial for managing COPD. This research aims to investigate the relationship between the physiological and laboratory - based frailty index (FI - Lab) and mortality among critical care patients with COPD.

Methods: The FI-Lab was constructed using 33 items. This index was used to quantify the frailty level of critically ill patients with COPD in the ICU. We analyzed data from the Medical Information Mart for Intensive Care-IV (MIMIC-IV) database. Our study group consisted of 6825 COPD patients with an average age of 65.8 ± 14.8 years, and 52.2% of them were male. The primary outcomes were 30-day and 90-day mortality rates. Multivariable Cox regression was used for statistical analysis. Propensity score matching (PSM) was applied to ensure robustness.

Results: In total, 6825 patients were included in the study, and the PSM cohort had 1282 patients. Both continuous and categorical increases in the FI-Lab were significantly associated with higher mortality ($P < 0.001$). These results were further validated by PSM. Subgroup analyses corroborated these findings. Restricted cubic splines illustrated a linear relationship between the FI-Lab and mortality. Kaplan–Meier analysis revealed significantly reduced 90-day survival with increasing FI-Lab (Log rank test, $P < 0.001$).

Conclusion: Elevated FI-Lab is an independent predictor of increased mortality in critical care patients with COPD. Further randomized controlled trials are required to confirm these results and refine patient management strategies.

Keywords: COPD, frailty, mortality, propensity score

Introduction

Chronic obstructive pulmonary disease (COPD) is a major global health concern due to its high mortality and morbidity rates.[1,2] The 2019 Global Burden of Disease (GBD) study highlighted COPD imposes substantial social and economic burden.[3] Although various treatment modalities have been developed, the pathogenesis of COPD is still not fully elucidated, underscoring the need for identifying new risk factors to enhance the clinical management of COPD.

Historically, the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines did not address frailty until 2022.[4] However, the 2023 GOLD update acknowledged frailty and defined it as a clinical syndrome marked by diminished strength, endurance, and physiological function, with a higher prevalence in patients with COPD compared to that in non-COPD individuals. This recognition underscores the potential of frailty assessments to identify patients at risk

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for adverse outcomes.[5] In 2016, the European Innovation Partnership on Active and Healthy Ageing emphasized that frailty should be a key consideration in the management of chronic respiratory diseases.[6] However, research examining the interplay between frailty and chronic respiratory diseases is a comparatively novel field.

A systematic review that included 24 cross - sectional and several longitudinal studies reported that the prevalence of frailty in COPD patients ranged from 9% to 28%.[7] A large cohort study involving 2142 individuals and utilizing the Fried criteria for frailty found a frailty prevalence of 10.2% among patients with COPD.[8] Although the importance of timely frailty assessment is recognized, it still remains a challenging task, particularly in ICU settings where patients may be sedated or have an altered mental status. This is further complicated by the fact that traditional frailty measures, such as grip strength, could be impractical in these contexts. Thus, multiple studies have suggested that developing alternative frailty-assessment tools using routinely collected data could improve the feasibility of frailty screening in clinical practice.[9,10]

The physiological and laboratory - based frailty index (FI - Lab), put forward by Howlett et al, combines objective laboratory tests and vital signs, which can be easily incorporated into regular clinical workflows.[11] The FI - Lab has demonstrated strong diagnostic accuracy and predictive ability for clinical outcomes among various patient groups.[12–17]

Given the critical role of frailty in COPD management, it is crucial to investigate its impact on critical care patients with COPD. This retrospective study utilizes the Medical Information Mart for Intensive Care (MIMIC-IV) database, spanning from 2008 to 2019, to explore the association between the FI-Lab and mortality among critical care patients with COPD.

Methods

Data Source and Study Population

We conducted an analysis of data from the MIMIC - IV database. This database contains 431,231 admission records and 73,181 ICU admission records from Beth Israel Deaconess Medical Center (BIDMC) in Boston, Massachusetts, USA, covering the period from 2008 to 2019.[18] One of the authors, Yi Yu, obtained the permission to access the database, with the certificate ID being 6477678. The Institutional Review Board of Beth Israel Deaconess Medical Center decided to exempt the need for individual patient consent. This exemption was given because the research project had no substantial influence on clinical care, and all protected health information in the data was de - identified. As the patient data did not come from the Second Affiliated Hospital of Guilin Medical University, the 924th Hospital of the Joint Logistic Support Force of the PLA, the First Affiliated Hospital of Sun Yat - sen University, and the Second Affiliated Hospital of Guangzhou University of Chinese Medicine, the Institutional Review Boards of these institutions also waived the requirement for ethical approval. The study was carried out in accordance with the STROBE guidelines for observational research.[19]

Inclusion and Exclusion Criteria

Our analysis centered on patients diagnosed with COPD (using ICD - 9 or ICD - 10 criteria) who were admitted to the ICU for the first time. Patients were removed from the study if they fulfilled one or more of the following conditions: (i) being under 18 years old; (ii) having an ICU stay of less than 24 hours; (iii) lacking more than 12 items necessary for constructing the FI - Lab scale. We gathered data regarding patient demographics, laboratory test results, vital signs, clinical severity scores, comorbid conditions, and other details at the time of admission.

Construction of the FI-Lab

The FI - Lab was built using 33 items. Among them, 30 were laboratory tests conducted from 24 hours before to 48 hours after ICU admission. These included blood samples (such as white blood cell count, platelet count, hemoglobin, total bilirubin, alanine transaminase, albumin, alkaline phosphatase, lactate dehydrogenase, urea nitrogen, creatinine, glucose, potassium, sodium, calcium, phosphorus, plasminogen time, international normalized ratio, activated partial thromboplastin time, fibrinogen, and troponin T), arterial blood gas samples (pH, partial pressure of oxygen, partial pressure of carbon dioxide, and lactate), and urine samples (leukocytes, erythrocytes, proteins, glucose, ketone bodies, and bilirubin).

The remaining three items were vital signs (systolic blood pressure, diastolic blood pressure, and heart rate), which were averaged over the first day in the ICU.

Each item was divided into two categories based on the normal reference ranges provided in the database. A score of 0 was assigned when the value was within the reference range, and a score of 1 was given when it was outside the reference range. The reference values for each item are presented in Table S1. The FI - Lab scores were calculated by adding up the individual scores of these items and then dividing the sum by the total number of included items. The theoretical range of the FI - Lab is from 0 to 1.

Covariates

Apart from the variables needed for calculating the FI - Lab, we collected demographic and admission - related data of the study population. This included age, sex, race, body mass index (BMI), length of hospital stay, respiration rate, pulse oxygen saturation, and survival status at 30 and 90 days.

We also collected data on several clinical scores, such as the Acute Physiology Score III (APSIII), Simplified Acute Physiology Score II (SAPS II), Oxford Acute Severity of Illness Score (OASIS), and Sequential Organ Failure Assessment (SOFA) scores. Information on comorbidities like myocardial infarction, congestive heart failure (CHF), cerebrovascular diseases, diabetes, renal diseases, malignant cancers, severe liver diseases, and sepsis was also gathered. Additionally, we recorded the interventions received during the ICU stay, including mechanical ventilation, vasoactive drugs, and renal replacement therapy (RRT).

We used the variance inflation factor (VIF) to assess multicollinearity among these variables. A VIF value greater than 2 indicated the presence of multicollinearity.

Outcome

The main outcome of interest was the 30-day and 90-day mortality of patients with COPD.

Statistical Analysis

We analyzed the baseline characteristics of patients across different groups. For categorical data, we presented them as counts along with their corresponding percentages. When it came to continuous data, we described them using either the mean ± standard deviation or the median (interquartile range), depending on the data distribution. To assess differences in continuous variables, we employed analysis of variance or rank - sum tests. For categorical variables, we used the chi - squared test or Fisher's exact test. Throughout the study, we maintained consistent formatting and citation styles.

The proportion of missing data for covariates was less than 1% in all analyses. We imputed the median values for these missing data points. To determine the association between the FI - Lab and mortality while adjusting for various covariates, we used multivariate Cox regression analysis. Five regression models were used in this process. We also carried out additional analyses such as subgroup and interaction analyses. To balance the baseline characteristics between the surviving and non - surviving groups, we applied propensity score matching (PSM). We used a 1:1 nearest - neighbor matching algorithm with a caliper of 0.2.

We assessed in - hospital survival using Kaplan–Meier survival curves according to the FI - Lab groupings. A log - rank test was used to evaluate these curves. We conducted stratified and interaction analyses based on multiple factors, including age (categorized as <65 or ≥65 years), sex (male or female), race (white, black, or other), BMI (<25 or ≥25), marital status (married or unmarried), the presence of myocardial infarction (yes or no), malignant cancer (yes or no), sepsis (yes or no), congestive heart failure (CHF, yes or no), diabetes (no, without complication, or with complication), renal replacement therapy (RRT, yes or no), and ventilation (yes or no). To illustrate the relationship between the FI - Lab and mortality risk, we used restricted cubic spline (RCS) curves.

We performed all statistical analyses using STATA software (version 17.0), R (http://www.R-project.org, The R Foundation), and Free Statistics software version 1.8.[20] We defined statistical significance as a two - tailed $P < 0.05$. All statistical analyses were performed using STATA software (version 17.0), R (http://www.R-project.org, The R Foundation), and Free Statistics software version 1.8.

Results

Participants

Initially, 27,538 patients fulfilled the sepsis criteria. After eliminating repeated admissions to the ICU, those under 18 years old, and those with an ICU stay of less than 24 h, a final cohort comprising 6825 patients was obtained. The selection process for the study participants is illustrated in Figure 1.

Baseline Characteristics

The study population consisted of 6825 patients, with 52.2% being men. The average age of these patients was 65.8 ± 14.8 years. Table 1 provides a detailed account of the baseline characteristics of these patients. Notably, comparisons between the survival groups showed differences. The survival group was younger, had a higher proportion of women, a lower Charlson Comorbidity Index, and a shorter ICU stay.

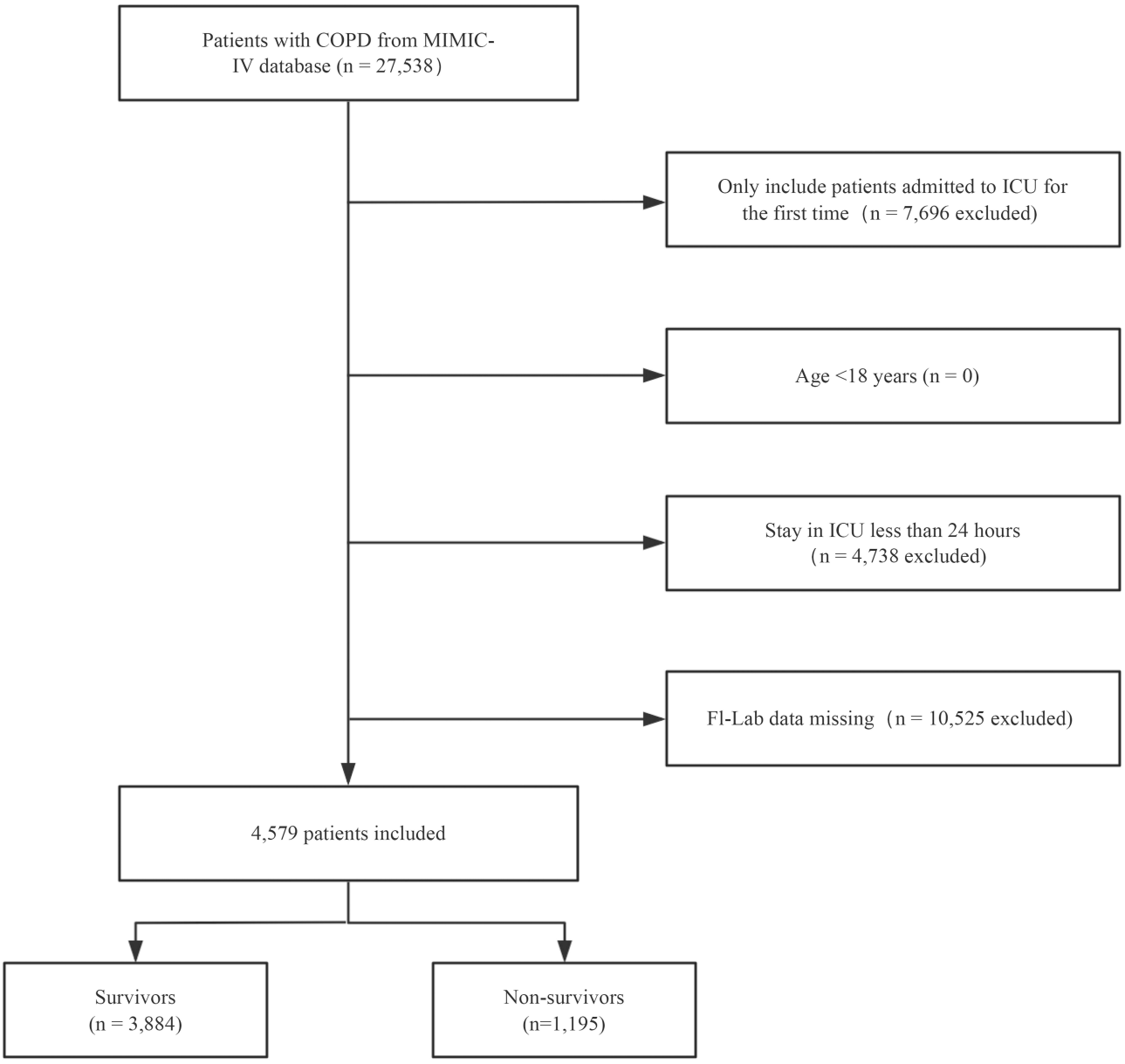

Figure 1 Flowchart for the enrollment of study participants.

Table 1 Baseline Characteristics of Participants

Variables	Total (n = 4579)	Survival (n = 3384)	Non-Survival (n = 1195)	P value
Age (years)	65.2 ± 14.9	64.1 ± 15.0	68.3 ± 13.9	< 0.001
Sex, Male, n (%)	2401 (52.4)	1779 (52.6)	622 (52.1)	0.757
BMI (kg/m^2)	29.6 ± 7.9	29.8 ± 8.0	28.8 ± 7.7	< 0.001
Race, n (%)				0.041
White	3024 (66.0)	2264 (66.9)	760 (63.6)	
Black	543 (11.9)	403 (11.9)	140 (11.7)	
Others	1012 (22.1)	717 (21.2)	295 (24.7)	
Marital status, n (%)				0.705
Married	2780 (60.7)	2049 (60.5)	731 (61.2)	
Unmarried	1799 (39.3)	1335 (39.5)	464 (38.8)	
Insurance, n (%)				< 0.001
Medicaid	366 (8.0)	295 (8.7)	71 (5.9)	
Medicare	2505 (54.7)	1762 (52.1)	743 (62.2)	
Other	1708 (37.3)	1327 (39.2)	381 (31.9)	
Respiration rate (bpm)	20.2 ± 4.1	19.8 ± 3.9	21.4 ± 4.4	< 0.001
SPO2 (%)	96.5 ± 2.5	96.6 ± 2.2	96.1 ± 3.2	< 0.001
Myocardial infarct, n (%)	1019 (22.3)	711 (21)	308 (25.8)	< 0.001
Congestive heart failure, n (%)	2111 (46.1)	1526 (45.1)	585 (49)	0.021
Cerebrovascular disease, n (%)	516 (11.3)	352 (10.4)	164 (13.7)	0.002
Diabetes, n (%)				0.833
None	2983 (65.1)	2198 (65)	785 (65.7)	
Without complications	1003 (21.9)	742 (21.9)	261 (21.8)	
With complications	593 (13.0)	444 (13.1)	149 (12.5)	
Renal disease, n (%)	1395 (30.5)	949 (28)	446 (37.3)	< 0.001
Malignant cancer, n (%)	613 (13.4)	371 (11)	242 (20.3)	< 0.001
Severe liver disease, n (%)	345 (7.5)	224 (6.6)	121 (10.1)	< 0.001
Sepsis, n (%)	3324 (72.6)	2321 (68.6)	1003 (83.9)	< 0.001
Charlson comorbidity index	7.2 ± 2.8	6.8 ± 2.8	8.1 ± 2.7	< 0.001
APSIII	60.0 ± 25.5	54.3 ± 22.3	76.0 ± 27.1	< 0.001
SAPSII	42.2 ± 14.3	39.4 ± 13.1	50.1 ± 14.9	< 0.001
OASIS	36.5 ± 9.4	34.9 ± 8.9	40.9 ± 9.4	< 0.001
SOFA score	4.1 ± 2.5	4.0 ± 2.4	4.6 ± 2.7	< 0.001
APACHE-II	21.9 ± 7.4	20.7 ± 7.0	25.3 ± 7.5	< 0.001
Interval time (hours)				0.062
<24	3991 (87.2)	2968 (87.7)	1023 (85.6)	
≥24	588 (12.8)	416 (12.3)	172 (14.4)	
CRRT, n (%)	353 (7.7)	171 (5.1)	182 (15.2)	< 0.001
Vasoactive drug, n (%)	2159 (47.2)	1441 (42.6)	718 (60.1)	< 0.001
Ventilation, n (%)	2457 (53.7)	1707 (50.4)	750 (62.8)	< 0.001
FI-Lab	0.5 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	< 0.001
ICU stay (days)	5.6 ± 6.5	5.3 ± 6.4	6.6 ± 7.0	< 0.001

Notes: Data are presented as mean ± standard deviation, median (interquartile range), or number (percentage) as appropriate.
Abbreviations: BMI, body mass index; SPO2, pulse oxygen saturation; APS, acute physiology score; SAPS, simplified acute physiology score; Oasis, oxford acute severity of illness score; SOFA, sequential organ failure assessment; APACHE, acute physiology and chronic health evaluation; Interval time: the interval between hospitalization (admission to general ward) and admission to the ICU; CRRT, continuous renal replacement therapy; FI-Lab, physiological and laboratory-based frailty index; ICU, intensive care unit.

Relationship Between the FI-Lab and Mortality Among Critical Care Patients with COPD

Univariate analysis showed a significant correlation between the FI - Lab and 30 - day mortality (hazard ratio [HR] = 1.57, 95% confidence interval [CI]: 1.50–1.64, P < 0.001), as well as 90 - day mortality (HR = 1.58, 95% CI: 1.52–1.65,

Table 2 Association of FI-Lab with Mortality. (Continuous Variable (per 0.1-Score))

Variable	30 Day			90 Day		
	HR	95% CI	P value	HR	95% CI	P value
Model 1	1.54	1.47–1.62	< 0.001	1.54	1.47–1.62	<0.001
Model 2	1.57	1.49–1.65	< 0.001	1.57	1.5–1.65	<0.001
Model 3	1.56	1.48–1.64	< 0.001	1.57	1.49–1.65	<0.001
Model 4	1.49	1.41–1.57	< 0.001	1.49	1.42–1.57	<0.001
Model 5	1.22	1.15–1.3	< 0.001	1.22	1.16–1.3	<0.001
PSM	1.15	1.08–1.23	< 0.001	1.22	1.15–1.3	<0.001

Notes: Model 1: Not adjusted. Model 2: Age, sex, BMI. Model 3: Model 2, race, marital status, and insurance. Model 4: Model 3, myocardial infarct, congestive heart failure, cerebrovascular disease, diabetes, renal disease, malignant cancer, severe liver disease, and sepsis. Model 5: Model 4, Charlson comorbidity index, APSIII, SAPSII, OASIS, SOFA, CRRT, ventilation, interval time and vasoactive drug. PSM: Model 5.
Abbreviations: HR, hazard ratio; Ref, Reference; CI, Confidence interval; FI-Lab, physiological and laboratory-based frailty index; PSM, propensity score matching.

P < 0.001) (Table 2). Subsequently, multivariate Cox regression analysis (Table 2) confirmed that the HR for the FI - Lab remained significant in all models (HRs ranging from 1.23 to 1.60, P < 0.001 for all). After adjusting for all the covariates listed in Table 2, a 23% rise in the risk of 30 - day mortality was found (HR = 1.23, 95% CI: 1.16–1.29, P < 0.001, Model 5). Similarly, for every 0.1 increase in the FI - Lab, a 23% increase in the risk of 90 - day mortality was noted (HR = 1.23, 95% CI: 1.17–1.29, P < 0.001, Model 5). These results indicate the stability of the models.

Kaplan–Meier Survival Curve Analysis

The Kaplan–Meier survival curves, shown in Figure 2, indicate that the cumulative survival time during hospitalization decreased significantly as the FI - Lab quartiles increased (log - rank test, P < 0.001).

Linear Relationship Between the FI-Lab and Mortality

RCS analysis revealed a linear relationship between the FI - Lab at the time of ICU admission and the risk of mortality in patients with COPD (P for non - linearity: 0.888). When the FI - Lab was 0.48, the HR was 1. As the FI - Lab increased, the mortality risk for COPD patients also increased, as shown in Figure 3.

Subgroup and Sensitivity Analyses

Subgroup analyses confirmed the robustness and reliability of the observed relationship. Specifically, the impact of the FI-Lab was more pronounced among older patients and those with a lower BMI. No other significant interactions were detected across subgroups (*P*-value for interaction > 0.05) (Figure 4).

Following PSM, the analysis included 1282 well-matched pairs. No notable disparities were detected in the key indicators among the matched groups (Table S1). The results remained consistent across Cox regression models, showing a 23% increase in 30-day mortality risk per 0.1 unit increase in the FI-Lab (HR = 1.23, 95% CI: 1.16–1.29, $P < 0.001$) and a similar 23% increase in 90-day mortality risk (HR = 1.23, 95% CI: 1.17–1.29, $P < 0.001$).

The stability of these findings was further confirmed through Cox regression models. When analyzed as a categorical variable, the FI-Lab demonstrated increasing HR across quartiles: Q2 (HR = 1.30, 95% CI: 1.08–1.56), Q3 (HR = 1.44, 95% CI: 1.20–1.73), and Q4 (HR = 1.88, 95% CI: 1.55–2.27), with a trend test indicating statistical significance ($P < 0.001$) for 30-day delirium. A similar trend was observed for 90-day delirium as well (Table 3).

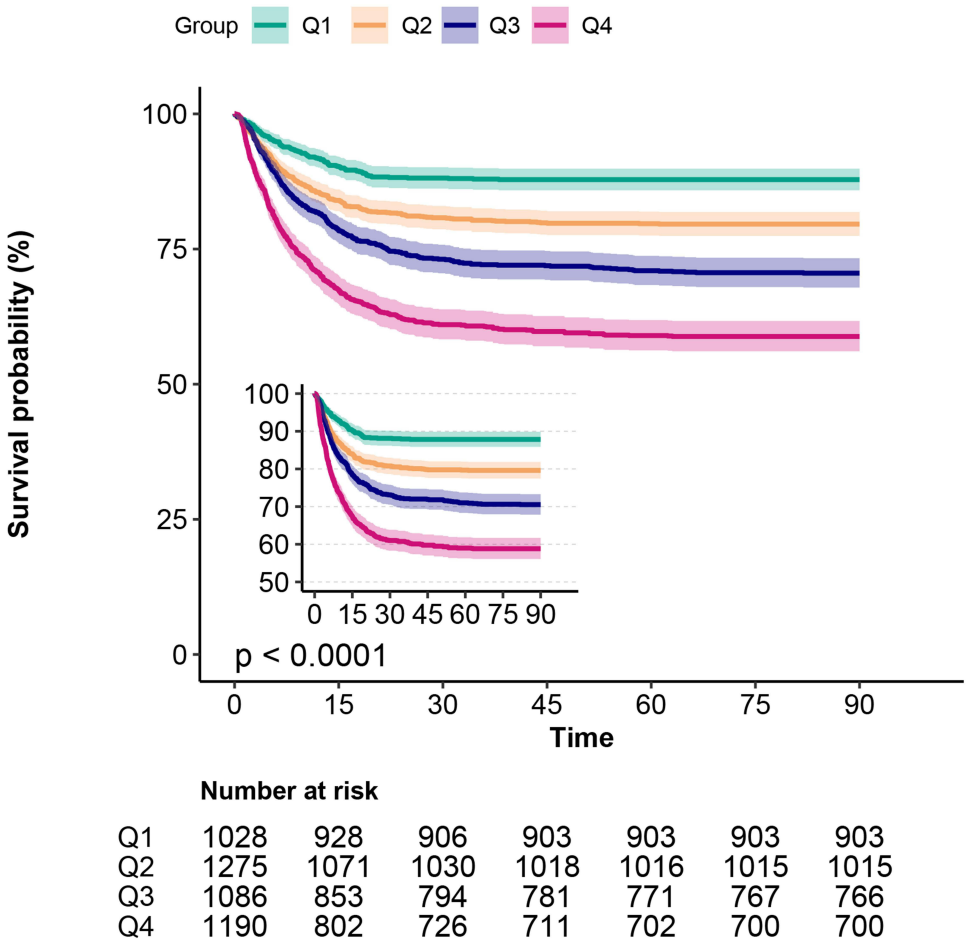

Figure 2 Kaplan–Meier survival curves, categorized by FI-Lab, for patients with COPD at day 90.

Discussion

Main Findings

Our research stands as the most comprehensive cohort investigation to date, delving into the influence of the FI - Lab on the mortality rate among ICU patients suffering from COPD. The results of our study clearly show that COPD patients with higher FI - Lab values are at a significantly greater risk of mortality both at 30 - day and 90 - day intervals. Importantly, these observations persist even after accounting for potential confounders through PSM and categorical variable analysis. Further validation of these findings comes from subgroup analyses and Kaplan–Meier survival curves. The RCS analysis reveals a linear correlation between the FI-Lab and mortality risk, suggesting an increase in the risk of death as the FI-Lab rises. Consequently, a significantly elevated FI-Lab in ICU patients with COPD can be used as an indicator of the patient's prognosis during their hospital stay.

Effects of the FI-Lab on Mortality in ICU Patients with COPD

The link between frailty and mortality is well-documented,[21,22] grounded in the shared pathogenesis of COPD and frailty and the prevalence of comorbidity in older patients.[23] Recent multi-observational studies have shown that when frailty is defined using the FI-Lab, a higher in-hospital mortality rate is observed for frail patients with COPD compared to that in non-frail patients with COPD.[15,24] However, these studies are limited by their relatively small sample sizes.

In our study, we used PSM as a balancing score to control for confounding factors.[25] Our research analyses indicate that the FI - Lab is linked to a higher mortality rate among patients suffering from COPD. Remarkably, this risk escalates as the FI - Lab values increase. Even after applying PSM and accounting for other potential confounding factors, this

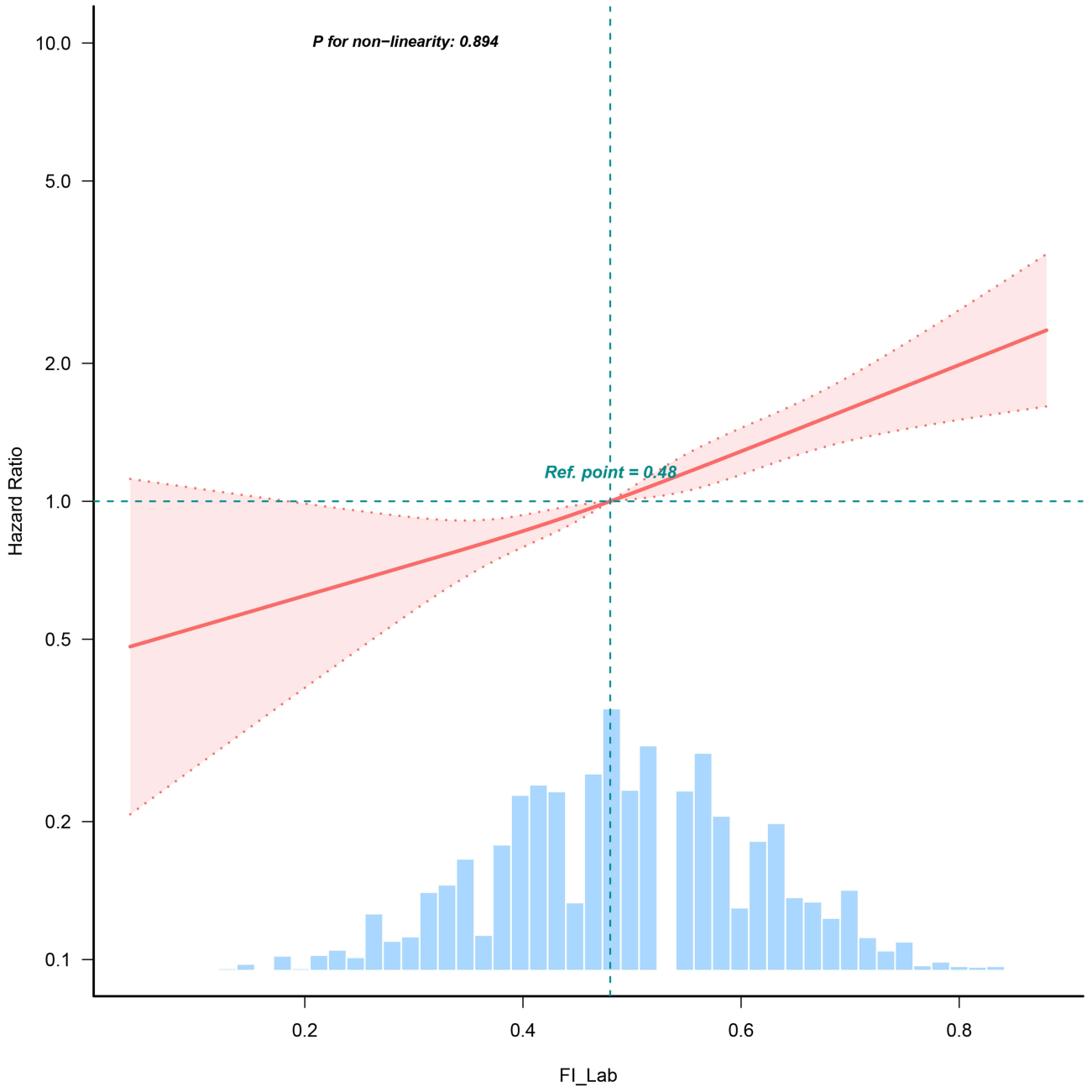

Figure 3 Spline curves showing the association of FI-Lab as a continuous variable with 30-day mortality. Spline curves were adjusted for all the factors of model 5 in multivariable Cox regression.

association remains significant. It is important to note that frailty is not an unchangeable condition. In fact, it can be effectively prevented and treated. Therefore, for patients with comorbid COPD, early identification and proper management of frailty are of utmost importance. Interventions such as regular physical activity and appropriate nutritional supplementation play a vital role in this process. By implementing these measures, we may improve the prognosis of these patients and potentially reduce the associated mortality risk.[26,27]

Recent research indicates that the FI-Lab allows the prediction of in-hospital mortality in critically ill patients. When combined with other frailty measures, it may aid in identifying critically ill patients at a higher risk of in-hospital death.[28] In older patients with community-acquired pneumonia, FI-Lab has been found to be a reliable predictor of 30-day mortality and has the potential to complement CURB-65 and the pneumonia severity index (PSI).[29] Moreover, the

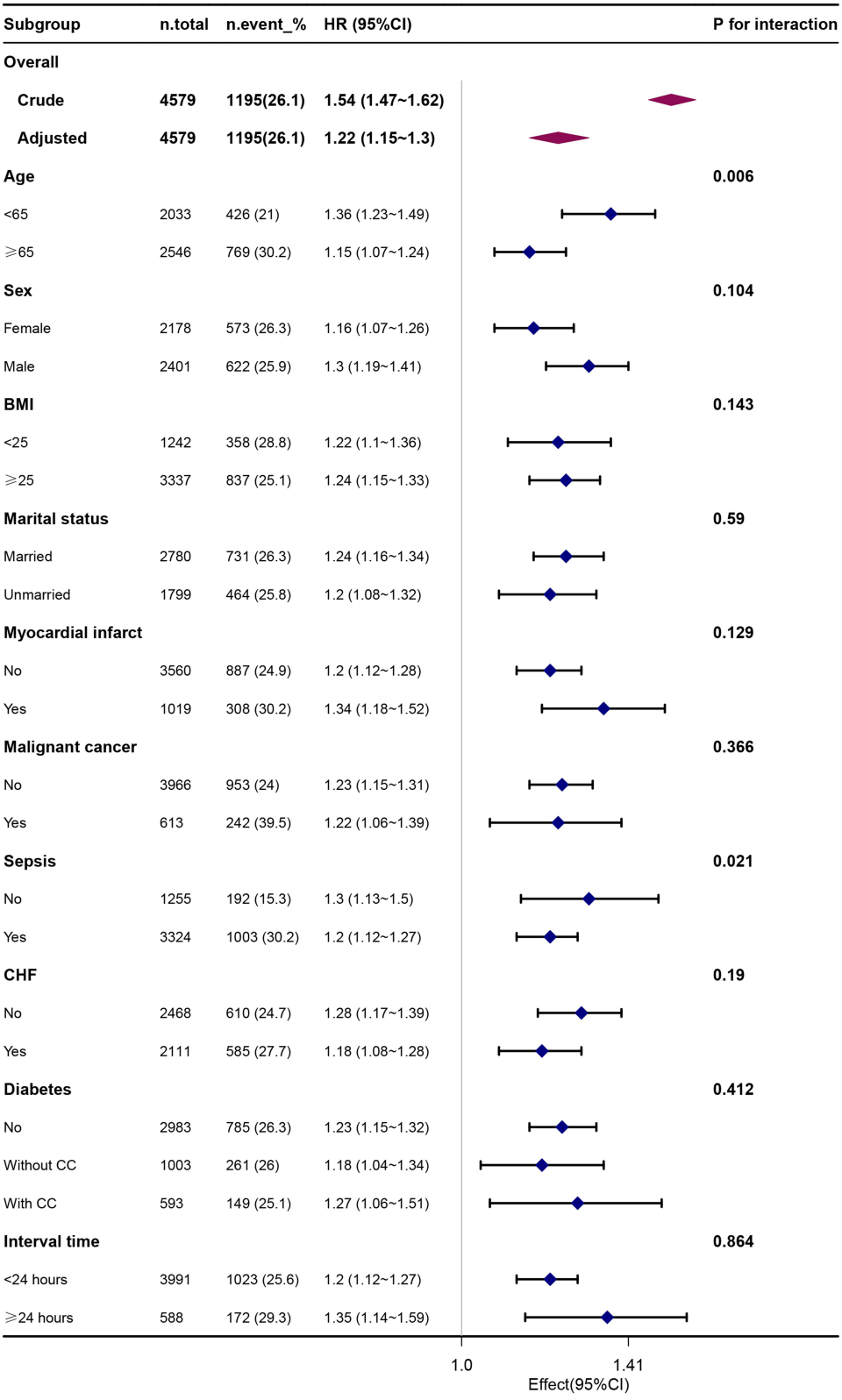

Figure 4 Association between FI-Lab and 30-day mortality based on baseline characteristics.

https://doi.org/10.2147/COPD.S518633

Table 3 Association of FI-Lab (as a Categorical Variable) with Mortality

Variable	N	30 Day				90 Day			
		Model 1		Model 2		Model 1		Model 2	
		HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
Q1	1028	1(Ref)		1(Ref)		1(Ref)		1(Ref)	
Q2	1275	1.7 (1.36~2.11)	<0.001	1.24 (0.99~1.55)	0.056	1.76 (1.42~2.18)	<0.001	1.31 (1.05~1.63)	0.016
Q3	1086	2.45 (1.98~3.03)	<0.001	1.5 (1.2~1.87)	<0.001	2.64 (2.15~3.25)	<0.001	1.61 (1.29~2)	<0.001
Q4	1190	3.92 (3.21~4.79)	<0.001	1.8 (1.44~2.25)	<0.001	4.1 (3.36~4.98)	<0.001	1.86 (1.49~2.31)	<0.001
Trend test			<0.001		<0.001		<0.001		<0.001

Notes: Model 1: Not adjusted. Model 2: Age, sex, BMI, race, marital status, insurance, myocardial infarct, congestive heart failure, cerebrovascular disease, diabetes, renal disease, malignant cancer, severe liver disease, sepsis, Charlson comorbidity index, APSIII, SAPSII, OASIS, SOFA, CRRT, ventilation, interval time and vasoactive drug.
Abbreviations: HR, hazard ratio; Ref, reference; CI, confidence interval.

disease severity scores derived from the FI - Lab that have been refined offer more accurate forecasts of both short - and long - term mortality among patients with acute severe myocardial infarction.[12] Therefore, it is worthy of further exploration to additionally adopt the FI - Lab as a supplementary measure alongside other commonly employed assessment tools.

Strengths of Our Study

Our study boasts several remarkable strengths. Firstly, we harnessed a comprehensive and publicly accessible database, which not only guarantees the reliability of our data but also ensures its easy accessibility for other researchers. Secondly, our research stands out as it is the first of its kind to delve into the influence of the FI - Lab on the mortality risk of ICU patients with COPD. Our findings provide compelling evidence that a higher FI - Lab value is significantly correlated with unfavorable outcomes in this specific patient group. Thirdly, to fortify the robustness and validity of our results, we employed multiple regression analysis and carried out PSM. This meticulous methodological approach enhances the credibility of our findings and ensures their internal consistency. Lastly, the FI - Lab presents itself as a more convenient option for the timely assessment of frailty in ICU patients with COPD. This convenience is particularly valuable in a clinical setting where prompt decision - making is crucial.

Limitations of Our Study

Although our research is currently the most thorough one regarding the application of the FI - Lab in ICU patients with COPD, it has several drawbacks. Firstly, the FI - Lab was evaluated solely at the time of ICU admission. We failed to take into account the possible changes that might occur during the patient's hospitalization. The dynamic pattern of the FI - Lab and how it relates to the outcomes of ICU patients remains an area that calls for future exploration. Secondly, we need to be cautious when generalizing the results of this study. The data used in this research were collected from just one ICU in the United States. This single - source data may not be representative of a broader population. Thirdly, certain factors that could potentially affect the mortality rate of COPD patients were not included in the dataset. These factors include appropriate antibiotic treatment, volume resuscitation, alcohol intake, and phosphorus levels. The absence of these data limits our capacity to analyze their influence on the outcomes. Lastly, since this is an observational study, it does not adopt the most ideal methodology for assessing the effects of the FI - Lab. Future randomized controlled trials would be a better approach for evaluating these effects. However, these limitations are somewhat compensated for by the large sample size of the study and the use of PSM.

Conclusions

The present study establishes a strong correlation between the elevated FI-Lab levels and an unfavorable prognosis in ICU patients with COPD. This finding underscores the importance of closely monitoring patients with COPD admitted to

the ICU with higher FI-Lab values. However, to validate the hypotheses proposed in this study, further randomized controlled trials are imperative.

Data Sharing Statement

The authors will make the raw data that backs the conclusions of this article accessible without any unnecessary restrictions.

Ethics Statement

The research studies involving human subjects underwent review and received approval from The Massachusetts Institute of Technology and Beth Israel Deaconess Medical Center. The legal guardians or next - of - kin of the participants provided written informed consent for the participants to take part in this study.

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Disclosure

The authors report no conflicts of interest in this work.

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