

Impact of Frailty on Activities of Daily Living and Length of Hospitalization in Acute Exacerbations of Chronic Obstructive Pulmonary Disease

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Purpose: The current study aimed to investigate the prevalence of pre-frailty and frailty for hospitalized patients with acute exacerbations of chronic obstructive pulmonary disease (AECOPD) and to quantify their relationship with Activities of Daily Living (ADL) and length of hospitalization.

Patients and Methods: We investigated frailty status, ADL ability, and length of hospitalization for 295 patients with AECOPD who were admitted to the respiratory department of a large tertiary care institution in Sichuan Province, China, between August 2022 and June 2023. Descriptive statistical methods were used to describe their demographic characteristics, frailty prevalence, ADL ability, and length of hospitalization. Following this, we developed two linear regression models to explore the cross-sectional association between different frailty statuses and ADL ability, as well as the longitudinal association between frailty status and length of hospitalization.

Results: Statistical evidence indicated that 39.3% and 46.1% of the patients exhibited pre-frailty and frailty, respectively. A multivariate linear regression model, which adjusted for significant variables, indicated that pre-frailty (coefficient [β] = 1.90, confidence interval [CI] = 0.76–3.04) and frailty (β = 2.02, CI = 0.84–3.20) were significantly associated with longer hospital stays, even in a fully adjusted model. Additionally, although pre-frailty (β = -4.79, CI = -8.98 to -0.60) and frailty (β = -4.48, CI = -8.81 to -0.15) were associated with worse ADL in a significant variable-adjusted model, the fully adjusted model indicated that no significant association was found between frailty and ADL.

Conclusion: Patients with AECOPD have a high prevalence of pre-frailty and frailty. More frail patients tend to have longer hospitalizations, and pre-frailty is associated with poorer ADL. However, the association of frailty with ADL requires further validation.

Plain Language Summary: Chronic obstructive pulmonary disease (COPD) is the third leading cause of death worldwide among chronic diseases. Patients with COPD often experience increased frailty, along with significant physical, psychological, and financial distress due to repeated and prolonged acute exacerbations. However, frailty in patients with acute exacerbation of COPD (AECOPD) is frequently overlooked in clinical practice. This unrecognized frailty can be linked to impaired physical functioning and may result in extended hospitalization. The current study analyzed the experiences of 295 patients with AECOPD in an economically underdeveloped area in northeast Sichuan Province, focusing on frailty, Activities of daily living (ADL), and length of hospitalization. The results revealed that 85.4% of patients displayed varying degrees of frailty, with 39.3% considered pre-frail and 46.1% classified as frail. Pre-frailty was frequently associated with ADL disabilities. Both pre-frailty and frailty were found to predict longer length of hospitalization. Consequently, incorporating frailty screening into clinical practice and considering a categorized management strategy for patients with AECOPD could effectively reduce the burden on these patients.

Keywords: frailty, AECOPD, ADL, length of hospitalization



Introduction

Frailty is an age-related clinical condition characterized by excessive vulnerability of individuals to stressors.^{1,2} It has been proven to be associated with various adverse health outcomes such as dementia,³ heart failure,⁴ hospitalizations,⁵ decline in quality of life,⁶ multimorbidity, and mortality.⁷ With the aging populations worldwide, frailty has emerged as one of the most serious public health issues of the 21st century.²

Chronic obstructive pulmonary disease (COPD) is a highly prevalent disorder caused by exposure to inhaled noxious particles.⁸ The burden of this disease is particularly severe in Sichuan Province, China. According to official Chinese government statistics, the prevalence of COPD among individuals over 40 in Sichuan Province has reached 16%, with a pronounced left-skewed age distribution. Additionally, COPD's economic burden ranks third among all chronic diseases, making COPD a priority for prevention and control in this area.⁹ Although evidence suggests that frailty and acute exacerbation of chronic obstructive pulmonary disease (AECOPD) share numerous risk factors and pathophysiological mechanisms,^{7,10–13} we found medical providers in the economically underdeveloped areas of Sichuan Province have often failed to recognize the importance of assessing frailty in the clinical management of patients with AECOPD. Therefore, we aim to raise local medical providers' awareness of frailty by emphasizing its association with key health factors among patients with AECOPD in this region.

The primary influencing factors are activities of daily living (ADL), as they are recommended for assessing health conditions in patients with AECOPD.¹⁴ These patients often rely on ADL,¹⁵ ultimately predicting a higher risk of mortality.¹⁶ Evidence indicates a high prevalence of frailty in patients with COPD^{17–19} and muscle loss,²⁰ which may increase their dependence on ADL. A previous study revealed that ADL performance is poorer in patients with COPD, whether they are in the pre-frailty or frailty stage, compared to those without frailty.^{21–23} These patients face a much higher risk of mortality.^{17–19} Therefore, patients with AECOPD are at an increased risk of ADL disability and frailty, making it essential to focus on their frailty and ADL performance.

The second influencing factor is the Length of Hospitalization. Studies have indicated that AECOPD accounts for more than 70% of the costs associated with COPD treatment. These exacerbations are linked to subsequent hospitalizations and longer hospital stays.^{19,24,25} An extended length of hospitalization is associated with worsening lung function, decreased quality of life, an increased risk of death, and a higher likelihood of readmission.^{24,26,27} However, there is limited and controversial evidence on whether frailty increases the length of hospitalization among patients with AECOPD. Kennedy et al indicated that patients with COPD and frailty experience an eight-day longer stay than their more robust counterparts.²⁸ Ushida revealed that the rate of extended duration of hospitalization was 15.4% higher in frail patients with COPD than in non-frail patients.²³ Additionally, Medina-Mirapeix conducted a five-repetition sit-to-stand test among patients with COPD, finding that pre-frail participants who performed poorly on the test displayed an extended hospitalization lasting 4.16 days longer. However, the difference was non-significant after adjusting for covariates.²⁹ This discrepancy may explain why some medical providers overlook the impact of frailty.

This study aimed to emphasize the significance of frailty in the clinical management of AECOPD by addressing the following three objectives. First, we sought to determine the prevalence of pre-frailty and frailty among patients with AECOPD from economically underdeveloped areas of Sichuan Province. Second, we aimed to assess the cross-sectional relationship between frailty and ADL. Third, we intended to evaluate whether frailty is associated with the length of hospitalization over time.

Methods

Study Design

The current study is an observational study that includes both a cross-sectional component to explore the association between frailty and ADL ability, as well as a longitudinal component to investigate the relationship between frailty and length of hospitalization among patients with AECOPD.

Settings

The participants were recruited from the respiratory department of a large tertiary care institution located in northeastern Sichuan Province, China.

Sample Size

We conducted a priori power analysis using G* Power (version 3.1.9.7; Heinrich-Heine-Universität Düsseldorf)^{30,31} to determine the required sample size. Based on the analysis of covariance and considering the potential impact of descriptive characteristics and covariates on the relationship between frailty, ADL ability, and length of hospitalization, we set a medium effect size ($f = 0.25$), a significance level (α) of 0.05, and a desired power ($1-\beta$) of 0.80. The analysis indicated a required sample size of 270 participants. To account for a 5% rate of incomplete responses, we aimed to recruit 284 patients.

Participants Recruitment

A professionally trained nurse started collecting information within 24 to 48 h of patient admission from August 2022 to June 2023. The following criteria were used for recruitment: (1) Previously diagnosed with COPD according to Global initiative for chronic obstructive lung disease (GOLD) guidelines;³² (2) diagnosed by the specialist respiratory team of AECOPD upon admission; (3) hospitalized for more than 24 h; (4) not diagnosed with of pulmonary fibrosis or heart failure class III or higher according to the New York Heart Association; (5) agreed to participate in the study and the ability to complete the survey.

Data Collection

Frailty

FRAIL scale³³ was used to measure frailty, consisting of five self-report questions related to fatigue, resistance, ambulation, illness, and weight loss. This scale has been well-established in previous studies.^{34–36} Each positive answer received a score of one point. The total score can range from 0 to 5 (0 as robust; 1–2 as pre-frailty; scores above 2 indicate frailty).³³

ADL

Barthel index for ADL³⁷ was used to assess the ADL ability. This index includes 10 activities, with a total score ranging from 0 to 100. Higher scores reflect greater ADL ability.³⁸

Length of Hospitalization

Length of hospitalization was extracted from the medical record system.

Descriptive Characteristics and Covariates

The baseline demographic, economic status, clinical data, and psychological data were collected.

Statistical Analysis

Descriptive statistics were employed to characterize the study population. Continuous variables with non-normal distributions were presented as medians along with interquartile ranges (25th–75th percentile), while categorical variables were reported as frequencies and percentages.

For the cross-sectional analysis, we used univariate and multivariate linear regression models to examine the relationship between frailty and ADL ability. This included univariate linear regression analysis, and covariates that were statistically significant ($P < 0.05$) in univariate analysis, as well as sensitivity analyses that incorporated all baseline variables to account for potential confounding factors.

In the longitudinal analysis examining the relationship between frailty and length of hospitalization, we applied the same methodology described above.

Additionally, we evaluated whether the models met the assumptions required for linear regression, which included the following: (1) Linearity of the relationships between predictors and outcome, evaluated using scatterplot matrices; (2) normality of the residuals, evaluated through histogram and P-P plot; (3) homogeneity of variances of the residuals, evaluated through residual versus fitted value plots; (4) independence of the residuals, evaluated through Durbin-Watson test; (5) influence and collinearity of predictors, evaluated using variance inflation factors ($VIF < 4$). All analyses were conducted using R (version 4.3.0) and IBM's Statistical Package for the Social Sciences (version 29.0.2.0; IBM Corp., Armonk, NY, USA).

Ethics Approval and Consent to Participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. This research was approved by the Medical Ethics Committee of the Affiliated Hospital of North Sichuan Medical College (Approval No. 2022ER444-1 and 2023ER324-1) and the Institutional Review Board of the University of Tsukuba (Approval No. 1841-1). Informed consent was obtained from all participants for participation in the study and publication of information.

Results

A total of 315 patients met the inclusion criteria. After excluding 20 patients with missing data using listwise deletion, 295 were included in the final analysis.

According to [Appendix Table 1](#), age, BMI, CCI, ADL, and length of hospitalization of the 295 patients with AECOPD are non-normally distributed. Among them ([Table 1](#)), the median values (25th and 75th percentiles) were 74.0 (69.0, 79.0), 21.2 (18.8,23.5), 1.0 (1.0,2.0), 60.0 (50.0,60.0), and 8.0 (7.0,11.0), respectively. Furthermore, 43 (14.6%) were classified as robust,

Table 1 Demographic Information (N=295)

| Items | Total | Robust (n=43) | Pre-Frailty (n=116) | Frailty (n=136) |
|----------------------------|-------------------|-------------------|---------------------|-------------------|
| Age, median (Q1, Q3) | 74.0 (69.0, 79.0) | 71.0 (61.0, 79.0) | 74.0 (69.0, 79.5) | 74.0 (69.0, 78.0) |
| Sex, n (%) | | | | |
| Male | 215 (72.9) | 33 (76.7) | 85 (73.3) | 97 (71.3) |
| Female | 80 (27.1) | 10 (23.3) | 31 (26.7) | 39 (28.7) |
| Educational status, n (%) | | | | |
| Primary School | 203 (68.8) | 26 (60.5) | 75 (64.7) | 102 (75.0) |
| Junior High School | 54 (18.3) | 7 (16.3) | 27 (23.3) | 20 (14.7) |
| High School | 26 (8.8) | 7 (16.3) | 10 (8.6) | 9 (6.6) |
| College and above | 12 (4.1) | 3 (7.0) | 4 (3.4) | 5 (3.7) |
| Living status, n (%) | | | | |
| Not alone | 265 (89.8) | 36 (83.7) | 105 (90.5) | 124 (91.2) |
| Alone | 30 (10.2) | 7 (16.3) | 11 (9.5) | 12 (8.8) |
| Residence, n (%) | | | | |
| Urban | 149 (50.5) | 30 (69.8) | 59 (50.9) | 60 (44.1) |
| Rural | 146 (49.5) | 13 (30.2) | 57 (49.1) | 76 (55.9) |
| Economic status, n (%) | | | | |
| Good | 212 (71.9) | 32 (74.4) | 87 (75.0) | 93 (68.4) |
| Not good | 83 (28.1) | 11 (25.6) | 29 (25.0) | 43 (31.6) |
| Smoke, n (%) | | | | |
| Never smoked | 83 (28.1) | 12 (27.9) | 31 (26.7) | 40 (29.4) |
| Former smoker | 186 (63.1) | 24 (55.8) | 75 (64.7) | 87 (64.0) |
| Current smoker | 26 (8.8) | 7 (16.3) | 10 (8.6) | 9 (6.6) |
| Alcohol consumption, n (%) | | | | |
| No daily | 290 (98.3) | 41 (95.3) | 116 (100.0) | 133 (97.8) |
| Daily | 5 (1.7) | 2 (4.7) | 0 (0.0) | 3 (2.2) |
| Exercise, n (%) | | | | |
| Active | 175 (59.3) | 35 (81.4) | 82 (70.7) | 58 (42.6) |
| Inactive | 120 (40.7) | 8 (18.6) | 34 (29.3) | 78 (57.4) |
| BMI, median (Q1, Q3) | 21.2 (18.8,23.5) | 22.1 (19.7,24.8) | 21.6 (19.5,24.1) | 20.4 (17.8,22.5) |
| CCI, median (Q1, Q3) | 1.0 (1.0,2.0) | 2.0 (1.0,3.0) | 2.0 (1.0,2.0) | 1.0 (1.0,2.0) |
| GOLD stage, n (%) | | | | |
| I | 132 (44.7) | 31 (72.1) | 60 (51.7) | 41 (30.1) |
| II | 90 (30.5) | 7 (16.3) | 30 (25.9) | 53 (39.0) |
| III | 65 (22.0) | 5 (11.6) | 25 (21.6) | 35 (25.7) |
| IV | 8 (2.7) | 0 (0.0) | 1 (0.9) | 7 (5.1) |

(Continued)

Table 1 (Continued).

| Items | Total | Robust (n=43) | Pre-Frailty (n=116) | Frailty (n=136) |
|--|------------------|------------------|---------------------|------------------|
| CAT, n (%) | | | | |
| Low impact | 25 (8.5) | 11 (25.6) | 8 (6.9) | 6 (4.4) |
| High impact | 270 (91.5) | 32 (74.4) | 108 (93.1) | 130 (95.6) |
| mMRC, n (%) | | | | |
| Mind | 10 (3.4) | 6 (14.0) | 2 (1.7) | 2 (1.5) |
| Severe | 285 (96.6) | 37 (86.0) | 114 (98.3) | 134 (98.5) |
| Oxygen therapy, n (%) | | | | |
| No | 157 (53.2) | 34 (79.1) | 63 (54.3) | 60 (44.1) |
| Yes | 138 (46.8) | 9 (20.9) | 53 (45.7) | 76 (55.9) |
| Course, n (%) | | | | |
| <5 years | 87 (29.5) | 24 (55.8) | 33 (28.4) | 30 (22.1) |
| ≥5 years | 208 (70.5) | 19 (44.2) | 83 (71.6) | 106 (77.9) |
| Anxiety, n (%) | | | | |
| No | 279 (94.6) | 43 (100.0) | 112 (96.6) | 124 (91.2) |
| Yes | 16 (5.4) | 0 (0.0) | 4 (3.4) | 12 (8.8) |
| Depression, n (%) | | | | |
| No | 275 (93.2) | 42 (97.7) | 110 (94.8) | 123 (90.4) |
| Yes | 20 (6.8) | 1 (2.3) | 6 (5.2) | 13 (9.6) |
| ADL, median (Q1, Q3) | 60.0 (50.0,60.0) | 60.0 (60.0,70.0) | 60.0 (50.0,60.0) | 55.0 (50.0,60.0) |
| Length of hospitalization, median (Q1, Q3) | 8.0 (7.0,11.0) | 7.0 (5.0,8.0) | 9.0 (7.0,11.0) | 9.0 (7.0,11.0) |

Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; GOLD, Global Initiative for Chronic Obstructive Lung Disease; CAT, COPD Assessment Test; mMRC, modified Medical Research Council; ADL, Activities of Daily Living; Q1, 25th percentile; Q3, 75th percentile.

116 (39.3%) were pre-frail, and 136 (46.1%) were frail. Most patients were males (72.9%). In terms of education, they completed primary school (68.8%). A majority lived with others (89.8%) and reported good economic status (71.9%). The smoking history indicated that 63.1% were ex-smokers, and most did not drink alcohol daily. About 59.3% were considered active, with 94.6% and 93.2% not experiencing anxiety and depression, respectively. Patients were predominantly classified as GOLD stage I (44.7%), with a high CAT impact (91.5%). Furthermore, 96.6% exhibited severe mMRC scores (96.6%) and demonstrated a COPD duration of more than five years (70.5%).

Cross-Sectional Analysis: Frailty and ADL Ability

Figure 1 illustrates the results of linear regressions between frailty and ADL. In the univariate model (Figure 1A), exercise, Body mass index (BMI), Charlson comorbidity index (CCI), GOLD stage, COPD Assessment Test (CAT), modified Medical Research Council (mMRC) dyspnea scores, oxygen therapy, and frailty were significantly associated with ADL. After adjusting for the significant variables in the univariate analysis (Figure 1B), pre-frailty (versus robust, coefficient [β] = -4.79; confidence interval [CI] = -8.98 to -0.60; standard error (SE) = 2.14; $P = 0.026$) and frailty (versus robust, $\beta = -4.48$; CI = -8.81 to -0.15; SE = 2.21; $P = 0.044$) were significantly associated with ADL. After adjusting for all included variables (Figure 1C), pre-frailty (versus robust, $\beta = -4.59$; CI = -8.98 to -0.20; SE = 2.24; $P = 0.042$) remained significantly correlated with ADL, while frailty (versus robust, $\beta = -4.14$; CI = -8.66 to -0.38; SE = 2.31; $P = 0.074$) was no longer significantly associated with ADL.

Longitudinal Analysis: Frailty and Length of Hospitalization

Figure 2 displays the results of linear regressions between frailty and length of hospitalization. Univariate analysis (Figure 2A) revealed that the length of hospitalization was significantly associated with various factors, including exercise ADL, GOLD, and CAT scores, oxygen therapy, and frailty. After adjusting for the significant variables in the univariate analysis (Figure 2B), the statistical evidence indicated that pre-frailty (versus robust, $\beta = 1.90$; CI = 0.76–3.04; SE = 0.58; $P = 0.001$) and frailty (versus robust, $\beta = 2.02$; CI = 0.84–3.20; SE = 0.60; $P < 0.001$) were significantly associated with the length of hospitalization. Furthermore, when all variables were adjusted (Figure 2C), the results

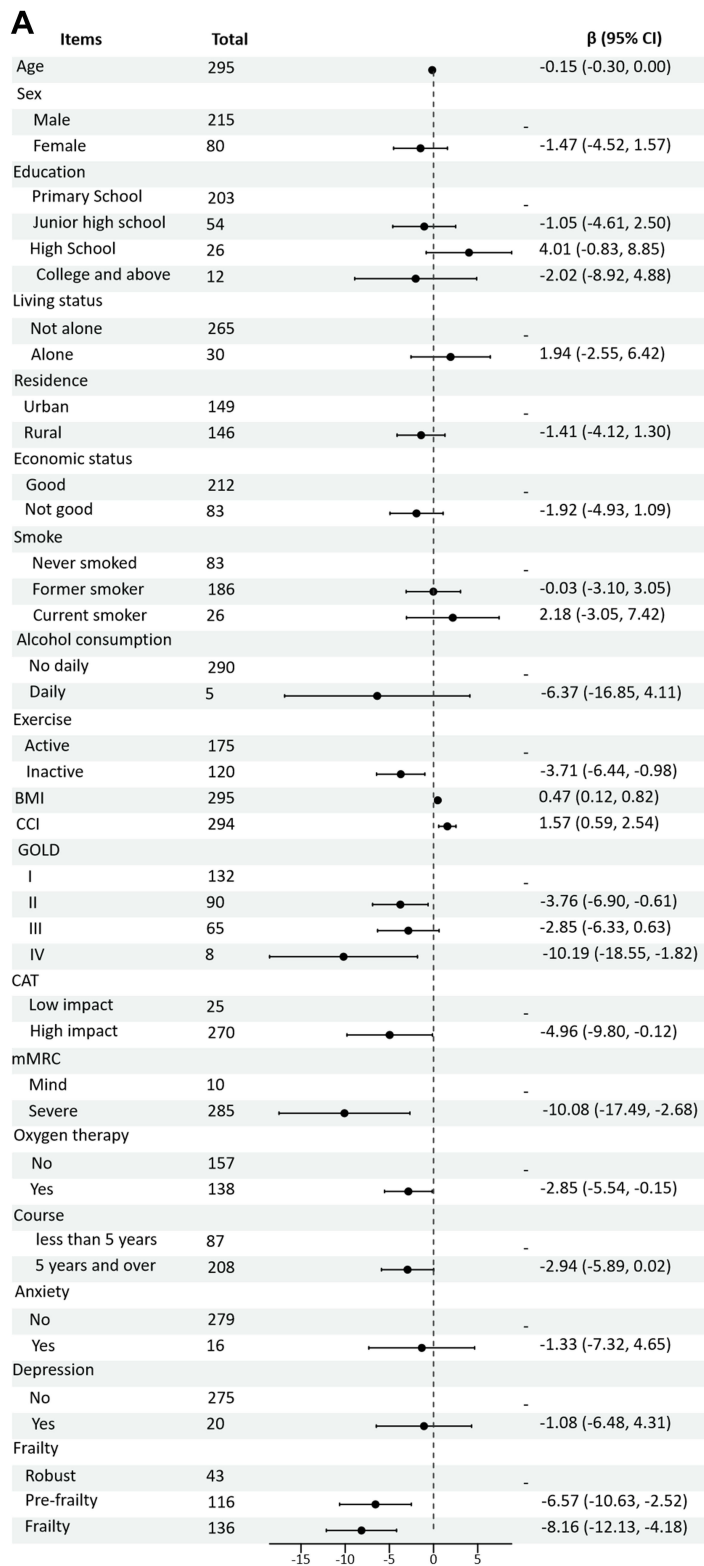


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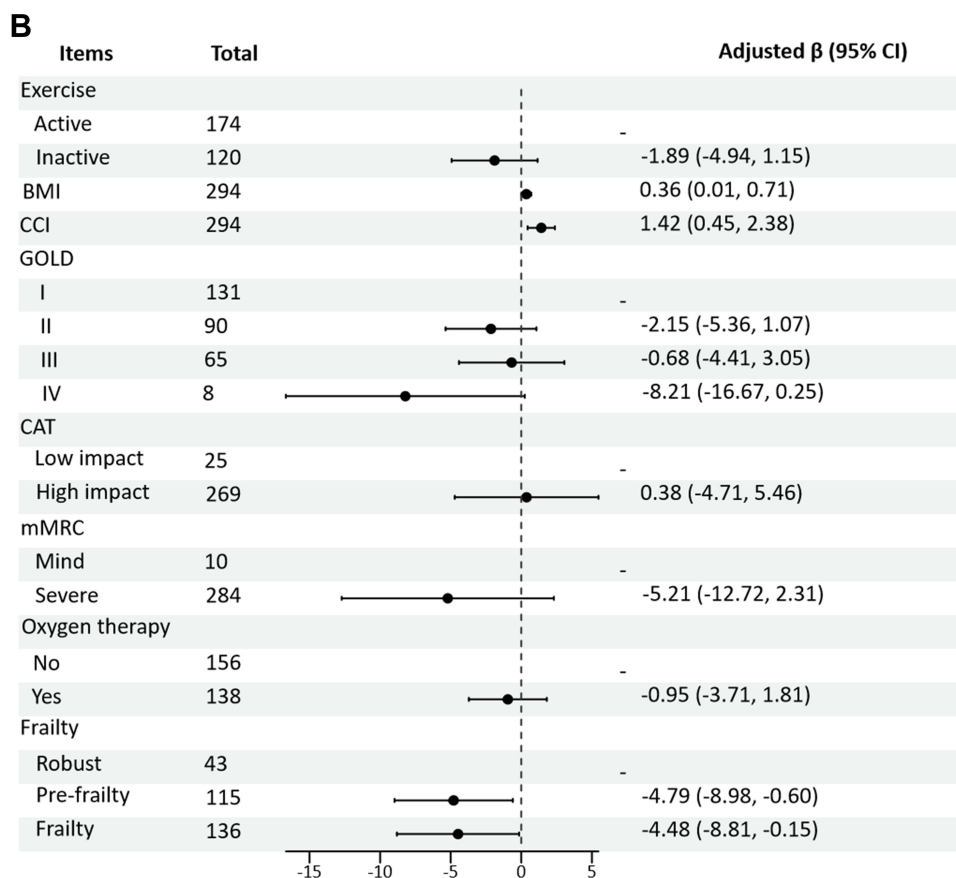


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remained consistent, with pre-frailty (versus robust, $\beta = 2.30$; CI = 1.09–3.51; SE = 0.62; $P < 0.001$) and frailty (versus robust, $\beta = 2.49$; CI = 1.24–3.73; SE = 0.64; $P < 0.001$) continuing to exhibit significant associations with the length of hospitalization.

Additionally, the linear relationships between the independent and dependent variables ([Appendix Figure 1](#)), normality of residuals ([Appendix Figures 2a-1](#), [a-2](#), [b-1](#), and [b-2](#)), homogeneity of variance of the residuals ([Appendix Figure 3a](#) and [b](#)), independence of residuals ([Appendix Table 2](#)), and the assessment of influence and collinearity of predictors ([Appendix Tables 3a](#) and [b](#)) were all in accordance with the assumptions of the linear regression model.

Discussion

This study investigated the prevalence of frailty among patients with AECOPD in an economically underdeveloped region of northeastern Sichuan Province. Subsequently, the cross-sectional association between frailty and ADL, as well as the longitudinal relationship between frailty and length of hospitalization, was examined. The findings indicated a high prevalence of frailty among these patients, with 39.3% classified as pre-frail and 46.1% as frail. Furthermore, pre-frailty was found to co-occur with poorer ADL ability, and both pre-frailty and frailty were associated with longer hospitalization periods.

Unsurprisingly, pre-frailty and frailty were highly prevalent in the current sample, which aligns with findings from previous studies conducted in other countries.¹² This is likely because frailty and COPD share the same pathophysiological mechanisms, including systemic inflammation and endocrine dysfunction.^{11,39} Moreover, acute exacerbations of COPD can exacerbate these issues. Although the prevalence of COPD has increased rapidly in females during the last 50 years,⁴⁰ there were more male patients (72.9%) in the current sample, which is consistent with findings from a previous

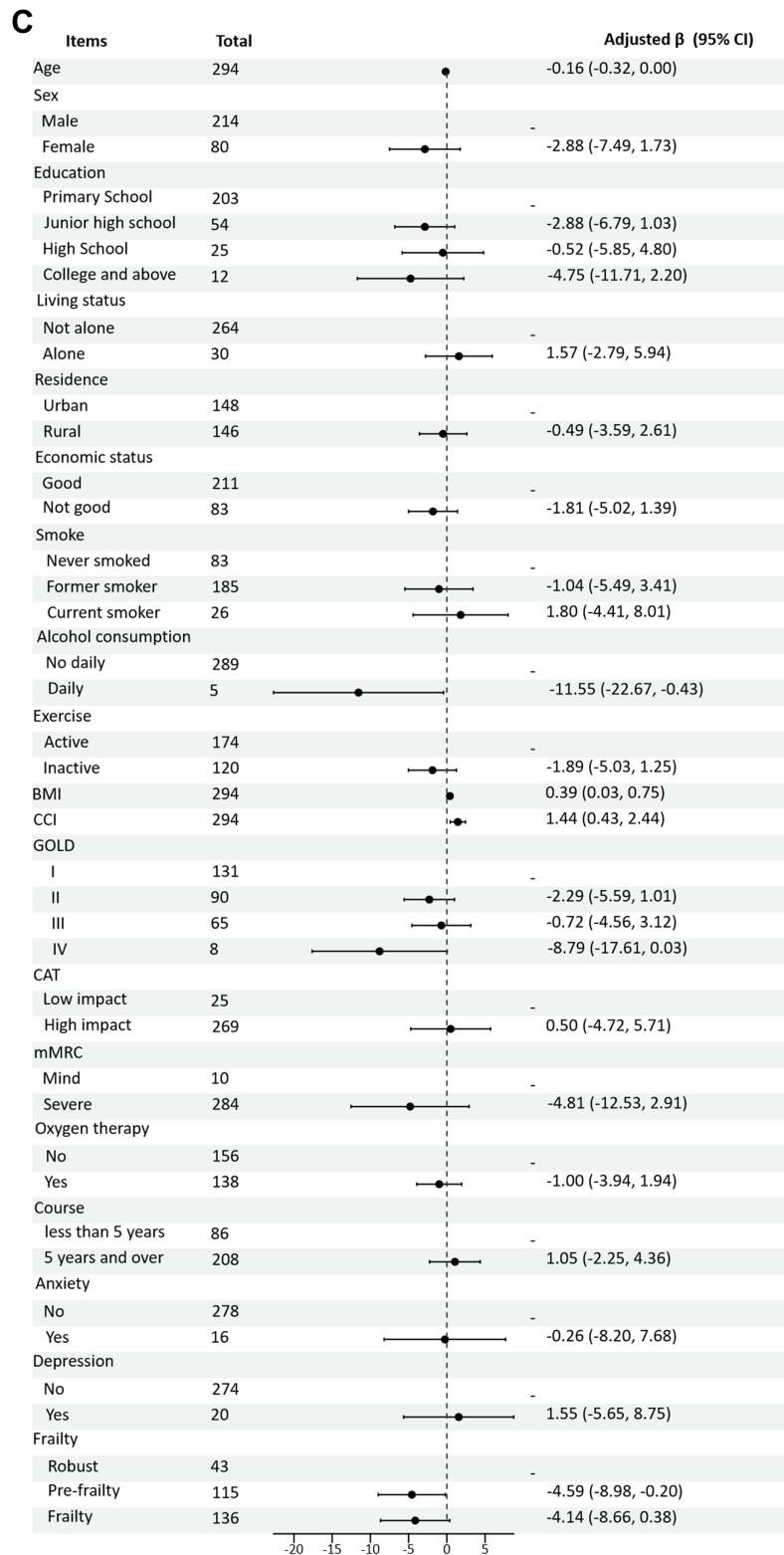


Figure 1 (A) Univariate linear regression models of frailty on ADL. (B) Significant adjusted multivariate linear regression model of frailty on ADL. (C) Full adjusted multivariate linear regression model of frailty on ADL ability.

Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; GOLD, Global Initiative for Chronic Obstructive Lung Disease; CAT, COPD Assessment Test; mMRC, modified Medical Research Council; ADL, Activities of Daily Living; CI, Confidence Interval.

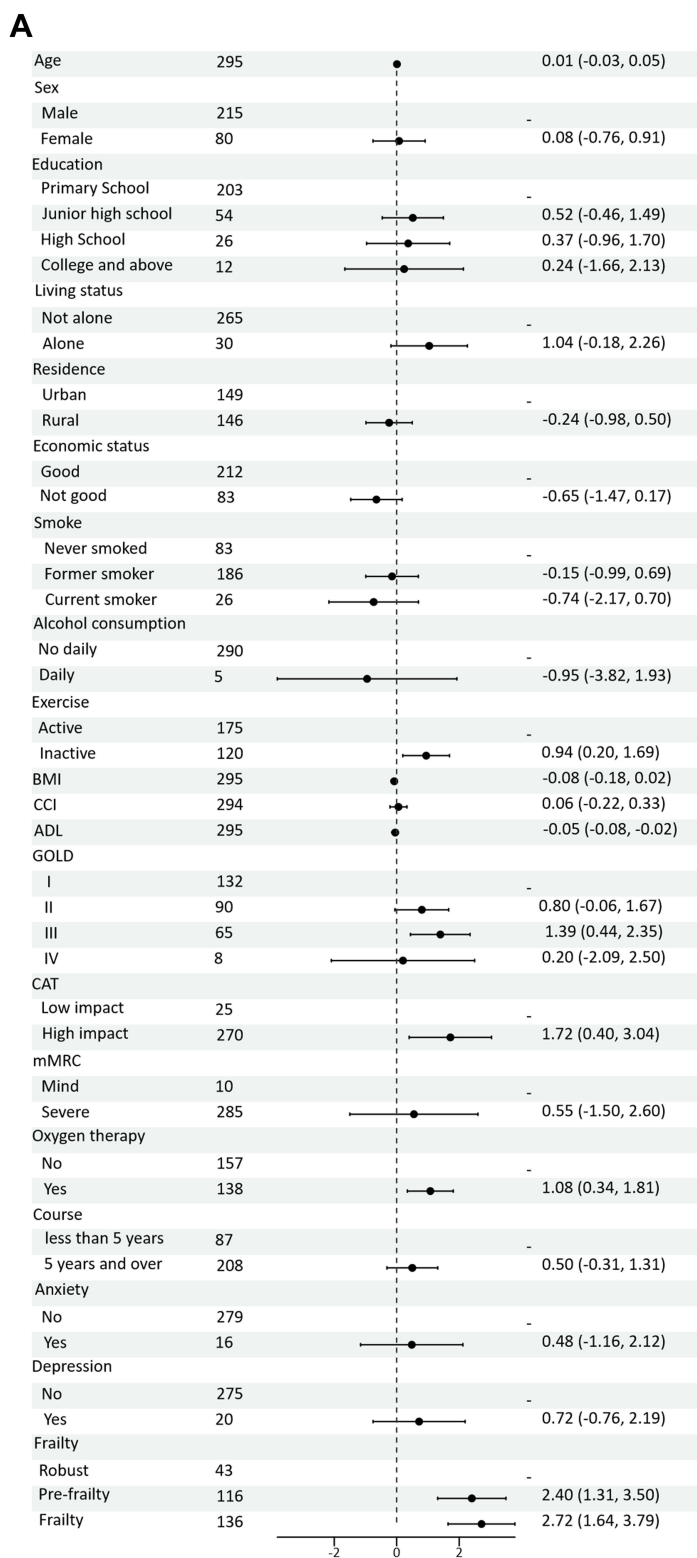


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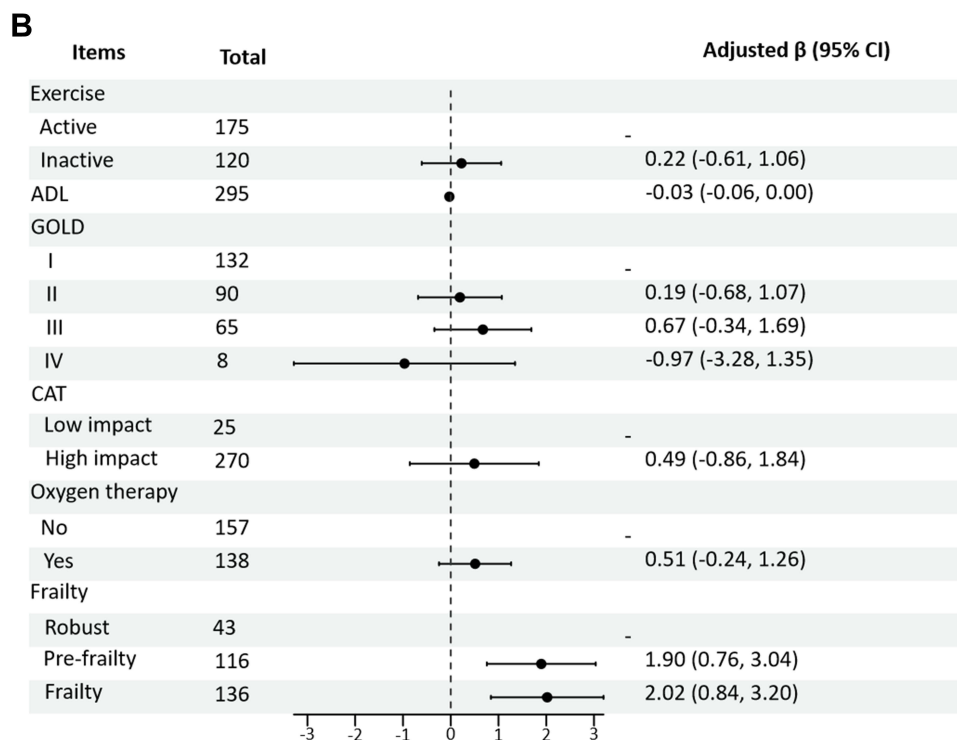


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study involving a Chinese population.⁴¹ This discrepancy may be attributed to differences in smoking rate and occupation. Notably, most patients reported that their economic status was not poor, with a relatively low educational level (primary school graduation). This categorization of economic status is based on the local government's minimum income standard. In addition, most patients without anxiety (94.6%) or depression (93.2%) may not be living alone (89.8%).⁴² These individuals also tended to have better CCI, GOLD, and CAT scores. However, more specific evidence is needed to explore the mental health of patients with AECOPD.

The current findings provide a quantitative analysis of the cross-sectional relationship between frailty and ADL, an advancement over previous studies that mainly illustrated a qualitative connection.^{21–23} In the univariate linear regression model between frailty and ADL, the statistical results indicated that, compared with robust patients, those classified as pre-frail exhibited a decrease of 6.57 points in ADL, while frail demonstrated a larger decline of 8.16 points. After adjusting for covariates, we found that lower ADL scores were still detectable in pre-frail patients. However, ADL decline became statistically non-significant in frail patients, likely due to the ceiling effect of the index, which limits its ability to detect changes in highly functional patients.⁴³ It is important to note that symptoms of COPD exacerbation, particularly fatigue and decreased exercise capacity, might mimic frailty.^{18,44} For instance, the fatigue and resistance components of the FRAIL scale may be influenced more by COPD-related symptoms than by actual frailty status, potentially leading to an overestimation of frailty prevalence in patients with AECOPD. Furthermore, research has revealed that COPD and frailty share common pathophysiological mechanisms, including systemic inflammation and skeletal muscle dysfunction.^{45,46} During acute exacerbations, these mechanisms may be intensified, potentially confounding frailty assessment.⁴⁶ While COPD may contribute to frailty development through systemic effects and physical inactivity,⁴⁵ frailty itself can worsen outcomes for patients with COPD.⁴⁷ Future research could focus on longitudinal assessments of these conditions, tracking changes in frailty before, during, and after acute exacerbations, and investigating their interactions using objective measures.

Linear regression between frailty and hospital stay duration indicated that patients with AECOPD who were classified as pre-frail or frail demonstrated longer length of hospitalization compared to those without frailty. Particularly, the average lengths of hospitalization were 2.40 days in pre-frailty and 2.72 days in frailty in the univariate analysis. When

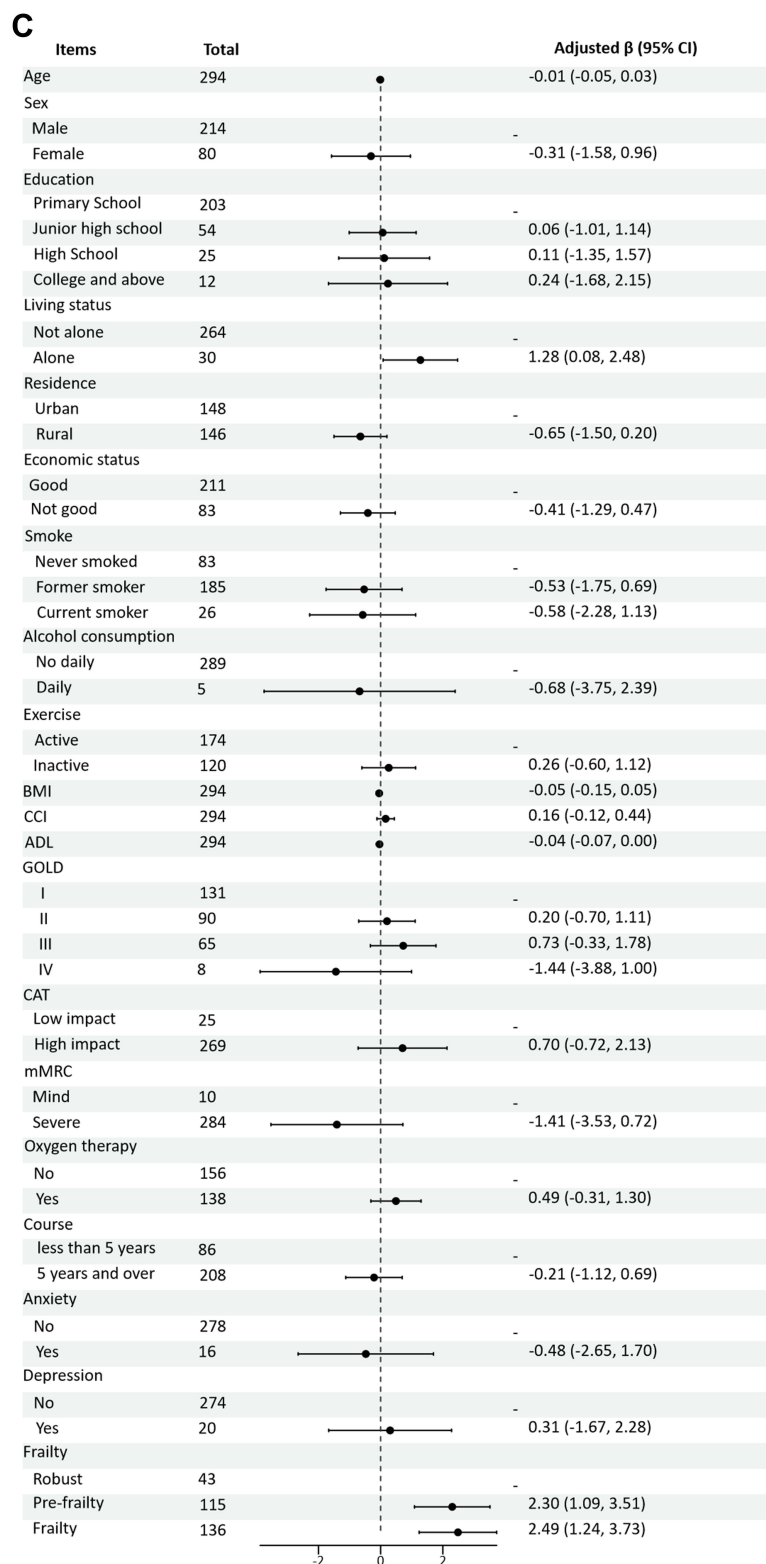


Figure 2 (A) Univariate linear regression model of frailty on Length of Hospitalization. (B) Significant adjusted multivariate linear regression model of frailty on Length of Hospitalization. (C) Full adjusted multivariate linear regression model of frailty on Length of Hospitalization.

Abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; GOLD, Global Initiative for Chronic Obstructive Lung Disease; CAT, COPD Assessment Test; mMRC, modified Medical Research Council; ADL, Activities of Daily Living; CI, Confidence Interval.

adjusted for significant variables, the lengths of stay were 1.90 days for pre-frailty and 2.02 days for frailty. In the fully adjusted model, these figures were 2.30 days for pre-frailty and 2.49 days for frailty. This finding aligns with previous studies.^{24,25} In contrast to the study by Medina-Mirapeix,²⁹ we found a significant correlation between frailty and hospital stay duration in the unadjusted and adjusted models. This discrepancy might be attributed to their use of the sit-to-stand test as a criterion for participant grouping. Besides, our results revealed that patients with AECOPD who were pre-frail or frail experienced approximately two days longer hospital stays than robust patients, which is notably shorter than the eight days reported by Kennedy et al.²⁸ Despite the differences in the measurement of frailty leading to varying effect sizes, it remains evident that pre-frailty and frailty in patients with AECOPD are associated with longer hospitalizations. Extended lengths of stay are associated with higher costs and poorer outcomes for patients with AECOPD.^{24,26} It has been reported that the average cost per serious exacerbation is €1711,⁴⁸ and the average cost per additional day of intensive care unit stay is \$302.89, significantly contributing to the financial burden on patients.

In the current study, hospitalized patients with COPD experiencing acute exacerbations frequently exhibited pre-frailty or frailty. This condition was associated with their dependence on ADL and a longer length of hospitalization. Consequently, screening for and preventing frailty is essential for managing patients with COPD. However, this study has several limitations. First, we evaluated patients' ADL using the Barthel Index, which may exhibit a ceiling effect in detecting changes in highly functional patients. Future research should utilize more sensitive measures of ADL to enhance accuracy. Second, this study excluded patients with very severe conditions, such as advanced heart failure, or those unable to participate. Accordingly, the findings may not be generalizable to the entire population of AECOPD; however, they are more applicable to patients with moderate severity and relatively good functional status in similar healthcare settings. Third, as a cross-sectional study, we cannot establish causal relationships between frailty, ADL, and the duration of hospital stays. The decline in ADL and the extended length of hospitalization may also reflect overall poor health status, with not all outcomes necessarily attributable to frailty. Fourth, data collection from a single tertiary care center may not fully represent the general situation of Northeastern Sichuan. Finally, the frailty measures used in this study were subjective and did not include objective assessments, potentially leading to biased results. Future studies should consider multicenter longitudinal designs using different tools for assessing ADL and incorporating objective measures of frailty, such as grip strength or gait speed. This approach would help clarify the factors influencing the extent of frailty in patients with AECOPD.

Conclusion

This study examined the frailty of patients with AECOPD in an economically underdeveloped area of northeastern Sichuan Province. It established a connection between frailty and the ability to perform ADL, as well as the length of hospitalization for this population. These findings emphasize the need for medical providers in this region to implement categorized management for patients with AECOPD based on their frailty classification during clinical treatment.

Abbreviations

BMI, body mass index; CAT, COPD Assessment Test; CCI, Charlson Comorbidity Index; COPD, chronic obstructive pulmonary disease; GOLD, Global Initiative for Chronic Obstructive Lung Disease; mCOPD-PRO, Modified COPD Patient-Reported Outcome; mMRC, modified Medical Research Council; ADL, Activities of Daily Living; SD, standard deviation; OR, odds ratio; CI, confidence interval.

Data Sharing Statement

The datasets are available from the corresponding author upon reasonable request.

Consent for Publication

Informed consent was obtained from all participants for participation in the study and publication of information.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests.

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