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Assessing the Impact of Nutrition Status as a Prognostic Factor in the Outcome of NIV therapy in Patients of Acute Exacerbation of Chronic Obstructive Pulmonary Disease

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Abstract

Introduction: Chronic obstructive pulmonary disease (COPD), a progressive and irreversible lung condition, poses a significant global health burden, especially due to acute exacerbations (AECOPD). A crucial technique for treating AECOPD, reducing the need for invasive mechanical ventilation, and enhancing patient outcomes is non-invasive ventilation (NIV). However, malnutrition, common in COPD patients, can affect the success of NIV. This study highlights the influence of nutritional status (BMI) on the outcome of NIV in AECOPD patients.

Methods: Patients with severe AECOPD and respiratory acidosis who were admitted to the Respiratory Medicine Department's High Dependency Unit (HDU) and receiving NIV were subjects of the current cross-sectional and observation study. The sample size of the study population was 71. Patients were categorized on the basis of body mass index (BMI) into various groups, along with their clinical outcomes, (SpO2, pH, pCO2, and HCO_3^- levels at t0, 24, 48, and 72 hours) as well as the duration of hospital stay (days) were recorded after NIV application. Statistical analysis was performed to determine associations between BMI and clinical outcomes.

Results: The study population exhibited a mean age of 63.10 years, with 68.6% males. Significant improvements in SpO_2, pH, $PaCO_2$ and HCO_3^- levels were observed across all BMI groups. The greatest SpO2 changes were seen at discharge, with 57.3% in underweight, 57.8% in normal weight, 33.1% in overweight, and 67.8% in obesity. The normal weight group showed the most rapid and consistent pH and HCO_3^- improvements (max. 2.1 and -28.1%, respectively), while PaCO2 decreased the most in normal weight (-45.6%). BMI didn't significantly influence the duration of hospital stay ($p = 0.387$).

Conclusion: Nutritional status, as assessed by BMI, influences the clinical outcomes in AECOPD patients undergoing NIV, showed significant improvements in SpO2, pH, PaCO2, and HCO_3^- levels across all BMI groups suggested that NIV therapy was effective regardless of BMI. The normal weight and underweight groups exhibited the fastest improvements, while the overweight and obesity groups showed delayed but substantial changes by discharge. Despite these differences, BMI did not significantly influence the overall SpO2 trajectory ($p > 0.005$) and the duration of hospital stay ($p = 0.387$).

Keywords: Chronic obstructive pulmonary disease, Acute exacerbation of chronic obstructive pulmonary disease, Non-invasive ventilation, Body mass index, Arterial blood gas, High dependency unit.

Introduction

COPD is among the top three causes of mortality globally, with 90% of fatalities occurring in low- and middle-income countries.[1,2] Inhaling harmful particles and gases from indoor and outdoor pollution, as well as other environmental[3,4] and host factors encompassing aberrant lung development and accelerated lung aging, acts as a contributing factor to COPD.

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Tobacco smoking is the primary environmental exposure that causes this condition.[5] An estimated 3 million deaths worldwide are attributed to COPD each year.[6] According to models, the number of people with COPD who are 25 years old or older will increase by 23% between 2020 and 2050, reaching 600 million people globally by that time.[7] Exacerbations of COPD are critical occurrences in the management of the condition since they negatively affect health status, hospitalization and readmission rates, along with disease progression.[8,9] Acute exacerbation of chronic obstructive pulmonary disease is a common reason for hospital admissions, adversely influencing patient's quality of life (QoL) and contributing to a deterioration in lung function. Non-invasive ventilation (NIV) is an essential technique for the "management of acute hypercapnic respiratory failure in individuals having COPD. NIV has been demonstrated to enhance oxygenation and correct acute respiratory acidosis, particularly by increasing pH and decreasing $PaCO_2$. NIV reduces respiratory rate, work of breathing, and intensity of dyspnea while also mitigating problems like ventilator-associated pneumonia and reducing hospital stay duration.[10] Establishment of respiratory intermediate care units has broadened utilization of NIV in AECOPD outside ICU.[10] In AECOPD, enhanced energy expenditure due to respiratory exertion may lead to malnutrition. Malnutrition affects the immune system, escalates disease progression, declines skeletal muscle mass and function and decreases diaphragm mass and thickness, potentially resulting in respiratory failure.[11]

Research was conducted to evaluate the utility of NIV in AECOPD subjects having different nutritional status (BMI) and determine how it influences the success and overall outcome of the therapy. It aimed to clarify the differences in response, specifically in SpO_2, pH level, $PaCO_2$ and HCO_3^- across various BMI categories. Such studies are rare, and there is a scarcity of published reports on NIV outcomes based on BMI.

Materials And Methods

A current cross-sectional and observational study was performed on the patients hospitalized in the High Dependency Unit (HDU) of the Respiratory Medicine Department, particularly those diagnosed with severe AECOPD and respiratory acidosis, who were receiving NIV. The sample size of the study population was 71. Patients more than 40 years and with AECOPD along with respiratory failure required NIV were included in this research. Subjects requiring invasive mechanical ventilation, cirrhosis, uncontrolled diabetes, chronic renal failure on dialysis, pre-existing neurological conditions, patients who received NIV after extubation, and any contraindication to NIV were not included in the study.

Methodology

Informed consent was obtained from all patients participating in the study following evaluation of inclusion and exclusion criteria. We divided the study population based on BMI classifications that have been adopted by the National Institute of Health (NIH) and the World Health Organisation (WHO)[12] into four groups: Group A-(Underweight)-BMI<18.5 Kg/m^2, Group B-(Normal weight)-BMI 18.5 to 24.9 Kg/m^2, Group C-(Overweight)-BMI 25 to 29.9 Kg/m^2, Group D-(Obesity)-BMI 30 to > 40 Kg/m^2.

Non-invasive Ventilation (NIV)

NIV was administered to subjects who, despite 1-hour of intensive medical treatment involving controlled oxygen therapy, inhaled bronchodilators, and systemic steroids, met one of the following criteria: pH<7.35 with $PaCO_2$>45 mmHg; dyspnea at rest accompanied by moderate-to-severe respiratory distress (RR>25 breaths/min) and the use of accessory respiratory muscles or paradoxical abdominal breathing.[13] Subjects were ventilated using NIV (Philips Respironics) with full-face masks in HDU. The first ventilator settings utilized were: BiPAP-S/T (pressure targeted) mode with an IPAP range of 16 to 30 cm H_2O, a respiratory backup rate of 16 breath/min, and a target volume of 5 to 7 mL/kg. The treating physician adjusted these parameters based on arterial blood gas readings, patient tolerance, oximetry, and patient-ventilator synchronization. NIV was originally administered as long as required to maintain a constant pH of > 7.35, followed by a gradual reduction in NIV usage duration over subsequent days.

Study Parameters

The following variables were recognized as possible predictors of NIV outcome: SpO_2, pH, $PaCO_2$, HCO_3^- (t0, 24, 48, and 72 hours), and duration of hospital stay (days). Arterial blood gases (ABG) were estimated before (t0) and after 24, 48, and 72 hours after the start of NIV having a blood gas analyzer. Response to NIV therapy will be seen as either:

- Absolute improvement (criteria)[14] -Decline in pCO_2 greater than 8 mmHg, enhancement in pH greater than 0.06, correction of respiratory acidosis.
- NIV failure: As either ETI or in-hospital death. NIV is directly discontinued without any weaning period.[15] Subjects successfully treated with NIV are kept under observation and then transitioned from HDU to the general ward. All the patients that survived were kept under observation for 2 to 3 days and were successfully discharged. By examining changes in SpO_2, pH, $PaCO_2$, and HCO_3^- levels over time, we aimed to identify the differential responses among patients categorized as underweight, normal weight, overweight and obese.

Results

The study analyzed 71 AECOPD cases successfully discontinued from NIV support. Mean age of subjects was 63.10 ± 10.98 years, ranging from 41 to 90 years, with a median age of 61.00 years (IQR: 55.25–71.75). 22 (31.4%) of the participants were aged 51 to 60 Years. The gender distribution revealed 68.6% males and 31.4% females,

reflecting higher COPD prevalence among males due to smoking and occupational exposures. Occupationally, 64.3% of participants were laborers, 15.7% were homemakers, 8.6% were farmers, and 5.7% each for drivers and unemployed individuals, indicating higher COPD prevalence among those from low socioeconomic backgrounds and those exposed to biomass. Among risk factors, 45.7% were current smokers, 27.1% were non-smokers, and another 27.1% were former smokers, with 28.6% exposed to biomass. Additionally, 14.3% of the participants reported being current hookah smokers, while 85.7% did not smoke a hookah. Beedi smoking was prevalent in 62.9% of the participants, with 37.1% not engaging in this habit. Only 2.9% of the participants reported tobacco intake.

In terms of symptoms, all participants experienced shortness of breath (100.0%), 94.3% had cough with sputum, 22.9% had fever, and 11.4% reported chest pain, consistent with typical AECOPD presentations. Hypertension and diabetes mellitus were each present in 7.1% of the participants, indicating common comorbidities in this population.

On general physical examination, pallor was observed in 15.7% of participants, whereas 84.3% were free of pallor. Icterus was absent in all participants. 4.3% of participants had cyanosis, and 2.9% showed signs of clubbing, with the majority (97.1%) not presenting these conditions. Edema was noted in 27.1% of participants, while 72.9% were without edema. All participants had normal jugular venous pressure (JVP).

Significant improvements in SpO_2, pH, $PaCO_2$, and HCO_3- levels were observed across all BMI groups. The greatest SpO_2 changes were seen at discharge, with 57.3% improvement in the underweight group, 57.8% in the normal weight group, 33.1% in the overweight group, and 67.8% in the obesity group. The normal weight group showed the most rapid and consistent improvements in pH (max. 2.1%) and HCO_3- (max. -28.1%), while $PaCO_2$ decreased the most in the normal weight group (-45.6%). BMI didn't significantly influence the duration of hospital stay (p = 0.387). Although normal-weight and underweight patients experienced earlier and more consistent benefits, overweight and obese patients showed substantial improvements later, particularly by discharge. Overall, BMI did not significantly influence the SpO2 trajectory (p >0.005) and the duration of hospital stay (p = 0.387).

Characteristics of the Study Population

The study included 71 participants with a mean age of 63.10 ± 10.98 years, ranging from 41 to 90 years. Most were male (68.6%) and laborers (64.3%) with significant risk factors, including current smoking (45.7%) and biomass exposure (28.6%). Common symptoms were shortness of breath (100%), cough with sputum (94.3%), and comorbidities like hypertension (7.1%) and diabetes mellitus (7.1%).

Comparison of the Four BMI Groups in Terms of Percent Change in SpO_2 (%) Over Time

The study observed significant improvements in SpO_2 levels over time in all BMI categories. The greatest changes were noted at discharge, with the highest mean percent change of 67.8% in the obesity group and the lowest (33.1%) in the overweight group. Despite these improvements, there was an insignificant difference between BMI groups in the percentage change of SpO_2 at each timepoint (p >0.05).

Table 1: Characteristics of study population

Parameter		*Median (IQR)*
1. Age	(Mean ± SD) =63.10 ± 10.98 (Min-Max) =41.00–90.00	61.00 (55.25–71.75)
2. Gender		
	Male	48 (68.6%)
	Female	22 (31.4%)"
3. Occupation		
	Laborer	45 (64.3%)
	Homemaker	11 (15.7%)
	Farmer	6 (8.6%)
	Driver	4 (5.7%)
	Unemployed	4 (5.7%)
4. Risk factors		
	Non-smoker	19 (27.1%)
	Current smoker	32 (45.7%)
	Former smoker	19 (27.1%)
	Biomass exposure	20 (28.6%)
5. Symptoms		
	Shortness of breath (SOB)	70 (100.0%)
	Cough with sputum	66 (94.3%)
	Chest pain	8 (11.4%)
	Fever	16 (22.9%)
6. Comorbidities		
	Hypertension	5 (7.1%)
	Diabetes mellitus	5 (7.1%)

Analysis of Percent Change in SpO2(%) Over Time

In the underweight group, significant SpO2 improvements were observed at 48 and 72 hours, and at discharge, with maximum percentage change noted at discharge (57.3%). In the normal weight group, significant SpO2 improvements were seen as early as 24 hours, with continued improvement at 48 and 72 hours and discharge with maximum percentage change noted at discharge (57.8%). The overweight group exhibited significant improvements at 72 hours and discharge, with maximum percentage change noted at discharge (33.1%). In the obesity group, a significant SpO_2 improvement was observed at discharge, with maximum percentage change being the highest among all groups at 67.8%. The overall comparison showed an insignificant difference in percent

Table 2: Comparison of the four BMI groups in terms of percent change in SpO_2 (%) over time

Timepoint comparison	*Percent change in SpO_2 (%) from t0 to follow-up timepoints*								*P-value for comparison of the four groups in terms of difference of SpO_2 (%) from t0 to follow-up timepoints"*
	BMI category: underweight		*BMI category: WNL*		*BMI category: overweight*		*BMI category: Obese*		
	Mean (SD) of percent change	*P-value of change within group*	*Mean (SD) of percent change*	*P-value of change within group*	*Mean (SD) of percent change*	*P-value of change within group*	*Mean (sd) of percent change*	*P-value of change within group*	
24 Hours - T0	18.2% (14.6)	0.319	27.6% (32.9)	0.031	15.2% (8.1)	0.761	43.3% (46.8)	0.797	0.290
48 Hours - T0	31.5% (29.1)	0.001	40.3% (42.0)	<0.001	22.8% (11.4)	0.125	55.5% (49.5)	0.210	0.448
72 Hours - T0	43.7% (37.0)	<0.001	52.8% (47.3)	<0.001	27.6% (15.2)	0.003	57.8% (45.1)	0.166	0.481
Discharge - T0	57.3% (42.7)	<0.001	57.8% (52.5)	<0.001	33.1% (18.9)	<0.001	67.8% (51.2)	0.005	0.592

Table 3: Comparison of the four BMI groups in terms of percent change in pH over time

Timepoint comparison	*Percent change in pH from T0 to follow-up timepoints*								*P-value for comparison of the four groups in terms of difference of ph from t0 to follow-up" timepoints*
	BMI category: underweight		*BMI category: WNL*		*BMI category: overweight*		*BMI category: obese*		
	Mean (SD) of percent change	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P-value of change within group*	
24 Hours - T0	0.7% (1.3)	0.442	0.9% (1.0)	0.042	1.1% (0.5)	0.340	0.9% (1.0)	0.665	0.774
48 Hours - T0	1.1% (1.2)	0.003	1.1% (1.2)	<0.001	1.4% (0.9)	0.181	1.4% (0.5)	0.260	0.912
72 Hours - T0	1.3% (0.9)	<0.001	1.6% (1.0)	<0.001	1.8% (0.8)	0.004	1.5% (0.7)	0.056	0.687
Discharge - T0	2.0% (0.7)	<0.001	2.1% (1.1)	<0.001	2.4% (0.2)	<0.001	1.7% (0.7)	0.030	0.584

change in SpO_2 between groups from T0 to follow-up time points (p >0.005). All BMI groups demonstrated significant SpO_2 improvements over time. The Normal weight and Underweight groups exhibited earlier and more consistent improvements, while the overweight and obesity groups showed more substantial changes later, particularly by discharge.

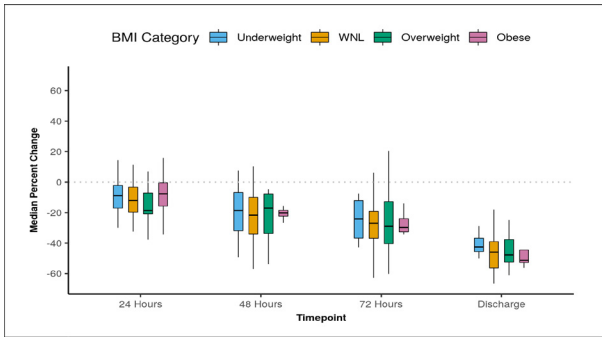

Figure 1: Comparison of difference of $PaCO_2$ (mmHg) between the T0 timepoint and the follow-up timepoints

Comparison of the Four BMI Groups in Terms of Percent Change in pH Over Time

The study found significant improvements in pH levels across all BMI groups over time. The most substantial changes were seen at discharge, with the highest mean percent change of 2.4% in the overweight group. Despite these improvements, there were insignificant differences between the BMI groups in percentage change of pH at each time point (p >0.05).

Analysis of Percent Change in pH Over Time

There was an insignificant difference between the four BMI groups in terms of the percentage change in pH from T_0 to any of the follow-up time points (p >0.05). The normal weight group showed the fastest and most consistent pH improvements, with significant changes starting from 24 hours, 48 and 72 hours, and discharge and maximum percentage change from T0 was observed at discharge (2.1%). The underweight group demonstrated consistent significant improvements from 48 hours and onwards, i.e., 48 and

Table 4: Comparison of the four BMI groups in terms of change in $PaCO_2$ (mmHg) over time.

Timepoint comparison	*Percent change in $PaCo_2$ (mmhg) from T0 to follow-up timepoints*								*P-value for comparison of the four groups in terms of difference of $PaCo_2$ (mmhg) from T0 to follow-up" timepoints*
	BMI category: underweight		*BMI category: WNL*		*BMI category: overweight*		*BMI category: Obese*		
	Mean (SD) of percent change	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	
24 Hours - T0	-7.8% (24.3)	0.510	-12.7% (15.7)	0.051	-15.0% (14.2)	0.761	-8.4% (20.6)	0.899	0.739
48 Hours - T0	-17.1% (19.2)	0.010	-23.1% (16.3)	<0.001	-15.9% (30.6)	0.761	-20.7% (4.6)	0.520	0.612
72 Hours - T0	-22.4% (17.9)	<0.001	-28.4% (15.2)	<0.001	-25.0% (27.3)	0.214	-26.9% (9.1)	0.260	0.673
Discharge - T0	-40.4% (7.8)	<0.001	-45.6% (12.9)	<0.001	-44.8% (12.3)	<0.001	-45.9% (14.2)	0.007	0.466

72 hours, and at discharge and maximum percentage change was observed at discharge (2.0%). The overweight and obese group showed significant improvement later, particularly by discharge, indicating a delayed response. The overweight group showed significant pH changes at 72 hours and discharge, and a maximum percentage change was observed at discharge (2.4%). The obesity group showed significant pH changes at discharge, and a maximum percentage change was observed at discharge (1.7%). Overall, the normal weight group had the most rapid pH improvements, followed by the underweight group.

Comparison of the Four BMI Groups in Terms of Change in $PaCO_2$ (mmHg) Over Time

The study observed significant reductions in $PaCO_2$ levels across all BMI groups over time. At discharge, the highest mean percent change was in the obese group (-45.9%) and the lowest in the underweight group (-40.4%). Significant within-group improvements were seen at various time points, particularly 72 hours and discharge. However, there were insignificant differences between the BMI groups in the percentage change of $PaCO_2$ at each time point ($p > 0.05$).

Analysis of Percent Change in $PaCO_2$ (mmHg) Over Time

There was an insignificant difference observed between the four BMI groups in terms of percentage change in $PaCO_2$ from T0 to any of the followed-up timepoints ($p > 0.05$) despite the significant improvement within each BMI group. The underweight group showed significant percentage decreases in $PaCO_2$ starting at 48 hours, continuing through 72 hours, and peaked at discharge with mean percent changes of -17.1, -22.4, and -40.4%, respectively. The normal weight group exhibited marginally significant changes at 24 hours, with significant improvements at 48, 72 hours, and at discharge with mean percent change-12.7, -23.1, -28.4, and -45.6%,

Table 5: Comparison of the four BMI groups in terms of percent change in HCO_3^- (mmol/L) over time

Timepoint comparison	*Percent change in HCO_3 (mmol/l) from T0 to follow-up timepoints*								*P-value for comparison of the four groups in terms of difference of HCO_3 (mmol/l) from T0 to follow-up timepoints*
	BMI category: underweight		*BMI category: WNL*		*BMI category: overweight*		*BMI category: obese*		
	Mean (SD) of percent change	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	*Mean (SD) of percent change*	*P value of change within group*	
24 Hours - T0	-6.4% (2.8)	0.056	-10.3% (4.9)	0.025	-4.2% (12.4)	0.987	-12.3% (7.8)	0.899	0.013
48 Hours - T0	-8.9% (4.6)	<0.001	-17.6% (8.3)	<0.001	-14.9% (10.3)	0.252	-23.4% (6.6)	0.380	<0.001
72 Hours - T0	-11.7% (6.4)	<0.001	-24.9% (8.8)	<0.001	-24.3% (11.0)	0.012	-30.7% (7.8)	0.030	<0.001
Discharge - T0	-14.5% (8.4)	<0.001	-28.1% (8.7)	<0.001	-29.1% (9.8)	<0.001	-31.7% (6.8)	0.007	<0.001

respectively and showed the highest improvement among all groups. The overweight group displayed significant changes only at discharge with a mean percent change of 44.8%. The obese group also showed significant changes only at discharge ($p = 0.007$) with a mean percent change -45.9%, suggestive of the slowest response among the groups.

Comparison of the Four BMI Groups in Terms of Percent Change in HCO_3^- (mmol/L) Over Time

The study observed significant reductions in HCO_3- levels across all BMI groups over time. The greatest reductions were seen at discharge, with the highest mean percent change of -31.7% in the obese group and the lowest (-14.5%) in the underweight group. Significant within-group improvements were noted at various time points, particularly 72 hours and discharge. However, significant differences between BMI groups in percentage change of HCO_3- at each timepoint was observed ($p < 0.05$).

Analysis of Percent Change in HCO_3^- (mmol/L) Over Time

A significant difference was observed between the four BMI groups in terms of the percentage change in HCO_3^- from T0 to any of the followed-up time points ($p < 0.001$). The normal weight BMI category normalizes HCO_3^- levels faster after NIV application (fastest and most consistent reductions in HCO_3^- with significant changes observed as early as 24 hours, and maximum change observed at discharge with mean percent change as -28.1% (8.7), followed by the underweight (significant reduction were observed from 48 hours onwards, with maximum change at discharge with mean percent change as -14.5 (8.4) and overweight groups significant reductions observed from 72 hours and onwards, with the maximum change at discharge with mean percent change as -29.1% (9.8). The obesity group showed improvement but at a slower rate significant reduction observed from 72 hours onwards, with maximum change at discharge with mean percent change as 31.7% (6.8).

Association Between BMI Category and Duration of Hospital Stay (Days)

The study revealed insignificant differences in hospital stay duration among the four BMI groups ($\chi 2 = 3.028$, $p = 0.387$).

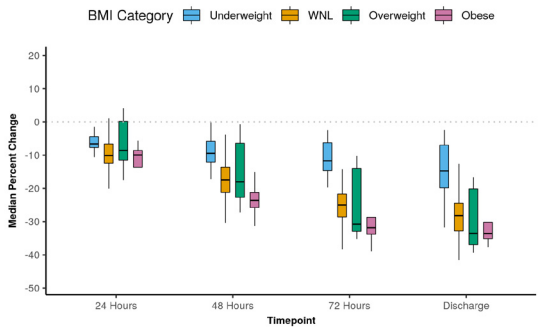

Figure 2: Comparison of difference of HCO_3- (mmol/L) between the T0 timepoint and the follow-up timepoints

The average hospital stay varied from 6.00 days in the overweight group to 7.24 days in the normal weight group. Despite these variations, BMI didn't significantly influence the duration of hospital stay for AECOPD subjects undergoing NIV treatment.

There was an insignificant difference between groups in terms of duration of hospital stay (Days) ($\chi 2 = 3.028$, $p = 0.387$). Strength of association (Kendall's Tau) = 0.04 (Little/No Association). This showed that BMI didn't significantly affect the duration of hospital stay for AECOPD individuals undergoing NIV treatment. Despite the lack of significant differences, the overweight group had the shortest mean hospital stay (6.00 days), indicating a potentially quicker recovery. However, the strength of association was minimal, suggestive of the limited impact of BMI on hospital stay duration.

Discussion

The present study was performed to examine the efficacy of NIV in AECOPD subjects with varying nutrition statuses (BMI) and aimed to assess how BMI impacts the success and overall outcome of therapy. It focused on assessing differences in response, specifically in SpO_2, pH, PaCO2, and HCO_3^- and duration of hospital stay (days) across different BMI categories.

NIV reduces endotracheal intubation (ETI) and mortality in severe AECOPD with respiratory failure, though improper patient selection can worsen outcomes. This study analyzed 71 AECOPD cases that were successfully weaned from NIV. The study participants with a mean age of 63.10 ± 10.98, aligned with the findings by Karan Sharma *et al.*[16], reported a mean age of 63.1 in stable COPD patients. Another study by Alexandru T Steriade *et al.*[17], evaluated the outcomes of NIV in participants with severe AECOPD and reported a mean age of 67.6, which was aligned with the present study. The study revealed that 68.6% of the participants were male, higher COPD prevalence in males was attributed to smoking and occupational exposures consistent with Lal Chen *et al.*[18] findings (male 68.1%). Laborers (64.3%) reflected higher COPD prevalence among low socioeconomic backgrounds, while homemakers (15.7%) were affected by biomass exposure. All participants experienced shortness of breath, cough with sputum (94.3%) and chest pain (11.4%). These findings were consistent with AECOPD. Hypertension and diabetes were present in 7.1% of the participants, and 45.7% were current smokers. Smoking remains a significant risk factor for AECOPD, though non-smokers are also susceptible due to smaller airways. A study by Parris J Williams *et al.*[19], showed participants who reported frequent exacerbation were more likely to smoke and were from lower socioeconomic status.

The study observed that all BMI groups showed significant SpO_2 improvements over time, with a noticeable increase observed particularly at discharge. The normal

Table 6: Association between BMI category and duration of hospital stay (Days)

Duration of hospital stay (Days)	*BMI category*				*Kruskal wallis test*	
	Underweight (A)	*Normal weight (C)*	*Overweight (D)*	*Obesity (D)*	*χ2*	*p-value*
Mean (SD)	6.94 (1.76)	7.24 (1.98)	6.00 (0.82)	7.00 (1.15)		
Median (IQR)	6 (6–8)	7 (6–9)	6 (5.5–6.5)	7 (6–8)	3.028	0.387
Min - Max	5 - 12	4 - 12	5 - 7	6 - 8		

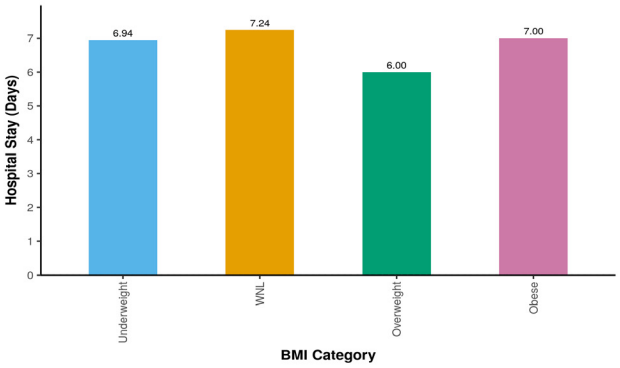

Figure 3: Bar graph depicts the association between BMI category and duration of hospital stay (Days)

weight and underweight groups exhibited earlier and more consistent improvements, while the obesity and overweight groups showed more substantial changes later, particularly by discharge. Maximum percentage change (67.8%) was observed among the obesity group. The overall comparison showed an insignificant difference in percent change in SpO_2 between BMI groups from t0 to the follow-up time points (p >0.005), suggesting that BMI did not significantly influence the overall SpO_2 trajectory. The study by Shiv Sagar Gupta *et al.*[20] concluded that there is an inverse relationship between BMI and SpO_2 in individuals with stable COPD. As the severity of COPD increases, both BMI and SpO2 values tend to decrease. Another study by Prativa Sangroula *et al.* [21] found that the number of underweight individuals was highest in COPD grade 4 and lowest in COPD grade 1, and the proportion of patients having underweight BMI and hypoxia with severe COPD (p <0.001).

The study observed that all BMI groups showed significant improvement in pH levels over time. The normal weight group experienced the fastest and most consistent changes (2.1%). The underweight group showed improvement starting at 48 hours, while the Overweight (p <0.001) and Obesity group(p = 0.030) showed significant changes at discharge. Despite these, there was an insignificant difference in the percent change in pH between BMI groups overall. These findings suggest that personalized NIV management strategies could optimize outcomes based on BMI, particularly focusing on the timing of interventions to maximize patient benefits. Similarly, Alexandru T. Steriade *et al.'s,*[17] study found no significant pH changes at three different time points, although early pH measurements (within 1–2 hours) were significant predictors of NIV duration (p <0.001). These findings suggested that while pH remains stable, early pH levels may help anticipate the required duration of NIV therapy.

The study found there was an insignificant difference observed between four BMI groups in terms of percentage change in $PaCO_2$ from T0 to any of the follow-up time points (p >0.05) despite the significant improvement within each BMI group. The normal weight group experienced the most rapid and consistent reductions, with significant changes beginning as early as 24 hours. The underweight group also showed early improvements starting at 48 hours. In contrast, the overweight and obese groups demonstrated delayed but substantial reductions primarily at discharge. Clinically, this suggests that normal-weight and underweight patients may respond more quickly to NIV, allowing for more aggressive management strategies early in treatment. For overweight and obese patients, a longer duration of NIV might be necessary to achieve optimal results. Future research should explore the underlying physiological mechanisms driving these differences in response to NIV across BMI categories. Alexandru T. Steriade *et al.*[17] reported no association between $PaCO_2$ and NIV failure, though $PaCO_2$ at timepoint t1 was a predictor of required mIPAP settings.

The study identified a significant variation in four BMI groups in terms of percentage change in HCO_3^- from T0 to any of the follow-up timepoints (p <0.001). The findings suggest that the Normal weight group benefits the most rapidly from NIV in terms of HCO_3^- normalization, followed by the Underweight group. In contrast, the Overweight and Obese groups show delayed but substantial improvements. Future studies should explore the physiological mechanisms driving the differential responses to NIV across BMI categories and investigate interventions that can enhance the rate of HCO_3^- -normalization in overweight and obese patients. The rapid normalization of HCO_3^- levels in normal-weight patients suggests that these individuals may benefit from more aggressive initial NIV settings. The slower rate of HCO_3^- -normalization in overweight and obese patients could

be attributed to factors such as higher levels of chronic inflammation, reduced chest wall compliance, and altered respiratory mechanics, which may impact the efficacy of NIV.

The study observed that the differences in hospital stay duration among the BMI groups were statistically insignificant ($\chi2=3.028$, $p = 0.387$), suggesting that BMI doesn't have a major impact on the duration of hospital stay for AECOPD patients treated with NIV. In contrast, Alexandru T. Steriade *et al.*,[17] research showed that NIV failure was related to longer LOS and identified NIV duration as an independent predictor of LOS (p <0.01). Future research should employ multivariate analysis and risk stratification models to enhance the prediction of outcomes, considering factors such as BMI and NIV performance in AECOPD cases. Research focusing on the impact of nutrition status as a prognostic factor in the outcome of NIV therapy for AECOPD patients is relatively rare. The specific influence of nutrition status on NIV outcomes is an emerging area of research, and there is a growing recognition of its importance in optimizing patient care.

Conclusion

The present study emphasizes the varied impact of BMI on the effectiveness of NIV among individuals experiencing AECOPD. While all BMI groups demonstrated significant enhancements in pH, SpO_2, $PaCO_2$, and HCO_3^- levels over time, the timing and magnitude of these improvements varied. Normal-weight and underweight patients experienced earlier and more consistent benefits, whereas overweight and obese patients showed substantial improvements later, particularly by discharge. Despite these differences, BMI did not significantly influence the overall SpO_2 trajectory (p >0.005) and the duration of hospital stay (p = 0.387). These findings underscore the importance of personalized NIV management strategies based on BMI to optimize patient outcomes. Future research should investigate the underlying physiological mechanisms and design targeted interventions to improve recovery rates in overweight and obese AECOPD patients. This study adds to the growing understanding of nutritional status as a key factor in the prognosis and management of AECOPD.

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