IMPACT OF DEMOGRAPHIC AND LIFESTYLE FACTORS ON THE OUTCOME OF NON-INVASIVE POSITIVE PRESSURE VENTILATION IN ACUTE EXACERBATION OF COPD: AN OBSERVATIONAL STUDY

Niraj Bam,[1] Tek Narayan Shrestha,[1] Santa Kumar Das,[1] Bibek Shrestha,[2]

ABSTRACT

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a significant contributor to morbidity and mortality globally. Non-invasive positive pressure ventilation (NIPPV) is a recognized treatment for acute exacerbation of COPD (AECOPD) accompanied by type 2 respiratory failure; nevertheless, treatment outcomes differ among individuals. Finding out what demographic and lifestyle factors affect the success or failure of NIPPV is very important for improving care, especially in places like Nepal where resources are scarce.

MATERIAL AND METHODS

This prospective observational study was carried out at Tribhuvan University Teaching Hospital, Kathmandu, involving 246 patients with AECOPD (≥ 40 years) who commenced BiPAP therapy. We used SPSS *v*26 to look at data on age, sex, smoking exposure, body mass index (BMI), functional status, previous hospitalizations, and long-term oxygen therapy (LTOT). NIPPV success was characterized by clinical enhancement without the necessity of intubation.

RESULTS

NIPPV worked for 84.5% of the patients. Failure was substantially correlated with advanced age ($p < 0.05$), increased pack-year smoking exposure ($p < 0.0001$), restricted activities of daily living ($p = 0.004$), previous hospital admissions ($p < 0.0001$), and long-term oxygen therapy (LTOT) utilization ($p < 0.0001$). The inhaler regimen showed no meaningful correlation with results.

CONCLUSION

Older age, high smoking exposure, limited daily activity, frequent prior hospitalizations, and LTOT use were independent predictors of NIPPV failure in patients with AECOPD and type 2 respiratory failure.

KEYWORDS

Chronic obstructive pulmonary disease; Morbidity; Mortality; Non-invasive positive pressure ventilation.

1. Tribhuvan University Teaching Hospital, Kathmandu, Nepal
2. Tribhuvan University Institute of Medicine, Kathmandu Nepal

https://doi.org/10.3126/jucms.v13i03.88822

For Correspondence
Dr. Niraj Bam
Department of Pulmonology and Critical Care Medicine
Tribhuvan University Teaching Hospital, Kathmandu, Nepal
Email: nirajbam19@gmail.com

INTRODUCTION

COPD is a significant global health issue and ranks as the third highest cause of mortality worldwide.[1,2] AECOPD dramatically increase morbidity, mortality, and the burden on healthcare systems, frequently leading to respiratory failure and necessitating hospitalization.[3] NIPPV, especially bilevel positive airway pressure (BiPAP), has changed the way we treat AECOPD with type 2 respiratory failure by making gas exchange better, lowering the number of intubations, and lowering the death rate. However, the results of NIPPV might be very different from one person to the next, depending on things like their age, smoking history, nutritional status, other health problems, and previous hospital stays.[4] In nations with low to intermediate incomes, like Nepal, where there aren't many resources for intensive care, it's really important to make the best use of NIPPV.[5] Knowing what demographic and lifestyle factors affect the success or failure of NIPPV can help doctors find high-risk patients early and adjust their care accordingly. Even though these predictors are used a lot in tertiary centers, there isn't much regional data on them.

This study seeks to evaluate the influence of demographic and lifestyle variables, including age, sex, body mass index (BMI), smoking exposure, functional status, previous hospitalizations, and long-term oxygen therapy, on NIPPV outcomes in patients with AECOPD and type 2 respiratory failure.

MATERIAL AND METHODS

This prospective observational cohort study was carried out at the Emergency Room, Respiratory Medicine Ward, High Dependency Unit, and Medical Intensive Care Unit of Tribhuvan University Teaching Hospital in Kathmandu, Nepal. The study sought to assess the impact of the timing and duration of NIPPV on clinical outcomes and to determine determinants of NIPPV success or failure in patients with AECOPD and type 2 respiratory failure. The Institutional Review Committee of the Institute of Medicine (Ref. No. 14(6-11) E2) gave its ethical approval, and all participants or their legal guardians signed written informed consent. Adult patients aged 40 years and older with a clinical diagnosis of AECOPD and type 2 respiratory failure ($PaCO_2$ >45 mmHg, pH <7.35) who commenced NIPPV in BiPAP mode during admission were included; those under 40 years, with prior home NIPPV use, post-extubation NIPPV, pregnancy, do-not-resuscitate (DNR) status, or refusal to consent were excluded. The diagnosis of COPD was based on clinical and radiological symptoms and corroborated by spirometry (FEV_1/FVC <70%) where available.

Using Cochran's formula and a 20% NIPPV failure rate from a prior study by Moretti et al. (2000), we computed the sample size.[6] We wanted a 95% confidence level and a 5% margin of error, which meant we needed 246 participants. Data were collected prospectively using a structured proforma that included demographic details (age, sex, BMI, duration of COPD), clinical and functional parameters (activity of daily living status, prior hospital admissions, long-term oxygen therapy use), and smoking-related variables (smoking status, pack-years, and cumulative exposure). Treatment-related data encompassed inhaler usage (LAMA, LABA + ICS, triple therapy, or none), NIPPV parameters (inspiratory and expiratory pressures, duration of the initial session, total daily hours, and timing of initiation), and hospital course variables including length of stay, requirement for invasive ventilation, and in-hospital outcome.

The principal outcome of the trial was the success or failure of NIPPV, characterized as clinical improvement with the avoidance of intubation and survival until discharge, or the necessity for invasive mechanical ventilation or in-hospital mortality. We put the data into Microsoft Excel and used SPSS version 26 to look at it. Continuous variables were reported as mean ± standard deviation (SD) and compared using the independent-sample t-test or Mann–Whitney U test. Categorical data were presented as frequencies and percentages and analyzed with the Chi-square or Fisher's exact test as applicable. A multivariate analysis was conducted to ascertain major predictors of NIPPV failure, including age, smoking pack-years, ADL limitations, previous hospitalizations, and long-term oxygen therapy utilization. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

The study comprised 246 patients with AECOPD who were treated with NIPPV. Participants had an average age of 70.7 ± 9.4 years, and most of them (43.9%) were between 71 and 80 years old. The percentage of females (57.3%) was a little greater than that of males (42.7%). The average BMI was 20.0 ± 2.5 kg/m², and the average length of time with COPD was 6.4 ± 4.6 years. Out of the total, 208 patients (84.5%) had good results with NIPPV, while 38 patients (15.5%) had bad results (Table 1 and Figure 1).

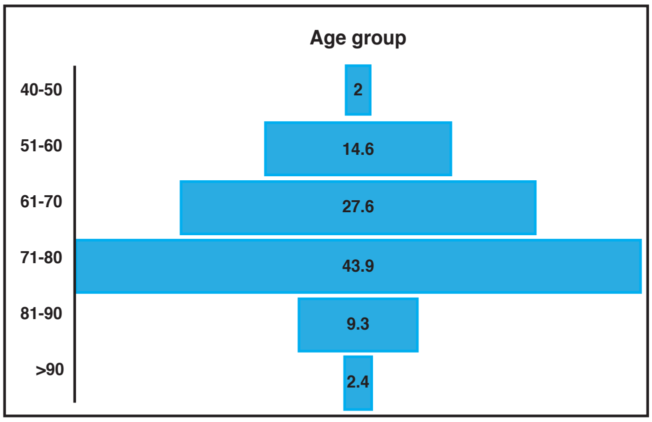

Figure 1. Age Group among the included participants

Table 1. Baseline Demographic Characteristics of Study Participants (n = 246)

Variables	Categories	Frequency (n)	Percentage (%)	Mean ± SD / *p*-value
Age (years)				70.7 ± 9.4
40–50		5	2.0	
51–60		36	14.6	
61–70		68	27.6	
71–80		108	43.9	
81–90		23	9.3	
> 90		6	2.4	
Sex	Male	105	42.7	
	Female	141	57.3	
BMI (kg/m²)				20.0 ± 2.5
COPD Duration (years)				6.4 ± 4.6
NIPPV Outcome	Success	208	84.5	
	Failure	38	15.5	

A vast majority (93.9%) of the study population were ever-smokers. The rate of NIPPV failure was higher among former smokers (89.6%) compared to current smokers (10.5%). A statistically significant association was noted between former smoking history and NIPPV failure (p = 0.035), while no significant relation was observed with current smoking status (p = 0.144). Moreover, the mean pack-year exposure was significantly higher in the failure group (24.2 ± 11.3) compared to the success group (16.3 ± 12.5; $p < 0.0001$) (Table 2 and Figure 2)

Table 2. Association of Smoking History with NIPPV Outcome

Smoking Variables	NIPPV Success (n = 208)	NIPPV Failure (n = 38)	Total (n = 246)	*p*-value
Ever Smoker	193 (92.8%)	38 (100%)	231 (93.9%)	0.074
Former Smoker	153 (73.6%)	34 (89.6%)	187 (76.0%)	0.035*
Active Smoker	40 (19.2%)	4 (10.5%)	44 (17.9%)	0.144
Pack-Years (Mean ± SD)	16.3 ± 12.5	24.2 ± 11.3	—	<0.0001*

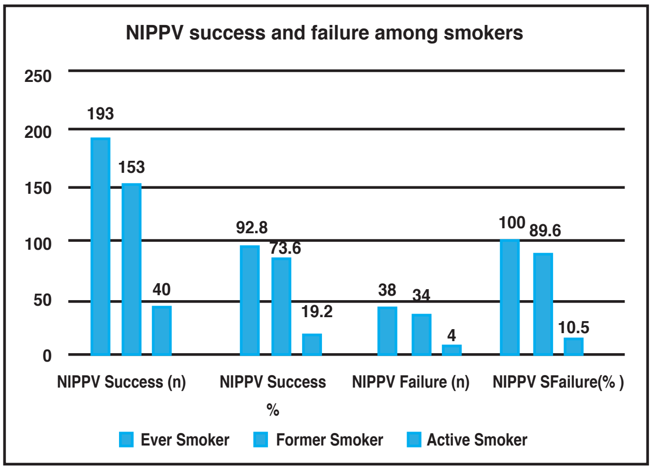

Figure 2. Association between smoking and NIPPV outcome

Functional capacity played a significant role in NIPPV outcomes. Patients without limitation in activities of daily living (ADL) showed a significantly higher success rate (87.0%) compared to those with limitation (71.0%; p = 0.004). Similarly, prior hospital admissions were strongly predictive of poor outcome—68.4% of the failure group had one or more admissions within the past year, compared to only 27.9% in the success group ($p < 0.0001$) (Table 3)

Table 3. Association of Functional Status and Prior Admissions with NIPPV Outcome

Parameters	NIPPV Success (n = 208)	NIPPV Failure (n = 38)	Total (n = 246)	*p*-value
Activity of daily living (ADL)				
No limitation	181 (87.0%)	22 (71.0%)	203 (82.5%)	0.004*
Limitation present	27 (13.0%)	12 (31.6%)	39 (15.9%)	
Admissions in previous 1 year				
None	150 (72.1%)	12 (31.6%)	162 (65.9%)	<0.0001*
≥ 1 Admission	58 (27.9%)	26 (68.4%)	84 (34.1%)	

LTOT use was significantly associated with NIPPV failure (60.5% vs. 22.1%; $p < 0.0001$), suggesting that chronic oxygen dependence correlates with reduced NIPPV efficacy. However, no significant differences were found in the distribution of inhaler medication patterns between groups, including single or combination use of long-acting muscarinic antagonists (LAMA), long-acting β_2-agonists (LABA), and inhaled corticosteroids (ICS) (Table 4)

Table 4. Association of Domiciliary O_2 and Inhaler Medications with NIPPV Outcome

Variable	NIPPV Success (n = 208)	NIPPV Failure (n = 38)	Total (n = 246)	*p*-value
Long-Term Oxygen Therapy (LTOT)	46 (22.1%)	23 (60.5%)	69 (28.2%)	<0.0001*
Medication Pattern				
LAMA only	7 (3.4%)	2 (5.2%)	9 (3.7%)	0.567
LABA + ICS	25 (12.0%)	3 (7.8%)	28 (11.6%)	0.440
LAMA + LABA + ICS	150 (72.0%)	29 (76.0%)	179 (72.8%)	0.593
None	26 (12.5%)	4 (10.5%)	30 (12.2%)	0.732

DISCUSSION

This prospective observational study assessed the impact of demographic and lifestyle characteristics on the outcomes of NIPPV in patients hospitalized with AECOPD and type 2 respiratory failure. The study showed that older age, more cumulative smoking exposure, trouble with daily activities, previous hospital stays, and LTOT use were all strongly linked to NIPPV failure. These results show that the response to NIPPV in AECOPD is affected by many factors, and they stress the need for a personalized patient assessment before starting treatment.

The total success rate of NIPPV in this study (84.5%) is very similar to what other investigations have found. Several studies indicate comparable success rates; for instance, A. Ozsancak Ugurlu et al (2014) identified a 73.9% NIV success rate, while V. K. Singh et al (2006) and D. Bhattacharyya et al (2011) documented patient improvement rates of 74% and 76%, respectively.[6–8] The positive response highlights the importance of NIPPV as a key part of treating AECOPD, as it lowers the requirement for invasive mechanical ventilation and increases survival.

Age significantly influenced outcomes, as elevated failure rates were noted among older persons. Older age leads to weaker respiratory muscles, more health problems, and less physiological reserve, all of which can make it harder to get used to and tolerate NIPPV.[9] MD Joanne Tsang et al (2022) explicitly showed that older persons (≥65) were less motivated to keep using NIPPV because they reported more discomfort with the mask and less overall improvement than younger patients.[10] A. Ozsancak Ugurlu et al (2016) discovered that the use of NIV escalated with age, rising from 22% in younger demographics to 49% in older populations, indicating both a growing necessity and possible difficulties.[6] Confalonieri et al and Mehta et al both found that older patients had lower success rates and longer hospital stays, which is similar to what was seen in other research. NIPPV is still useful in older people, but it is important to start it on time and keep a close eye on it to get the most advantages and avoid delayed intubation.[11]

A history of smoking, especially a higher pack-year exposure and previous smoking status, was another important factor that predicted NIPPV failure in this trial. Individuals who had smoked and were part of the failure group exhibited substantially greater cumulative exposure, suggesting permanent structural lung damage despite cessation of smoking. Research conducted by Boersma R et al, Yoshida T et al, and Moretti et al has established a correlation between a high smoking index and chronic hypercapnia, as well as suboptimal ventilatory mechanics, so corroborating our findings.[12-14] Chronic smoking causes changes in the airways and damage to the alveoli, which can make the lungs less flexible and lessen the benefits of NIPPV on alveolar ventilation.[13]

Functional status, indicated by ADL restriction, shown a substantial correlation with NIPPV outcomes. Patients who maintained daily activities exhibited elevated success rates, presumably indicative of superior baseline respiratory muscle function and overall health.[14] Previous research by Hope et al. underscored that frailty and suboptimal performance status forecast adverse outcomes in acute respiratory failure, aligning with the current findings.[15] This indicates that straightforward bedside evaluations of ADL can function as significant prognostic instruments in resource-constrained environments. Previous hospital admissions were significant indicators of NIPPV failure, indicating a more severe or unstable disease trajectory. Frequent exacerbations correlate with heightened airway inflammation, less lung flexibility, and compromised responsiveness to ventilatory assistance. [16,17] Our findings are consistent with those from worldwide populations, indicating that readmissions within one year are associated with increased mortality and suboptimal ventilatory outcomes.[18–20] Finding these high-risk patients early could make it possible to keep a closer eye on them and start treatment sooner. People who utilize LTOT are more likely to have NIPPV failure, which suggests that low oxygen levels and CO_2 retention make NIPPV less effective.

LTOT users frequently consist of individuals with severe COPD and chronic hypercapnia, which may attenuate ventilatory drive and restrict compensatory during exacerbations.[21,22] This underscores the necessity for proactive management measures, encompassing vigilant ABG monitoring and prompt ICU referral, within this subgroup. It is interesting that there was no strong link between the type of inhaler used (LAMA, LABA, or ICS combinations) and the NIPPV outcome. This indicates that acute treatment variables and baseline physiological status may have a more significant impact than maintenance medication during an exacerbation episode.[23] Still, making sure that people stick to the best inhaler therapy is still very important for stopping future flare-ups.

These findings collectively underscore that although NIPPV is highly successful in AECOPD, its efficacy is contingent upon various interacting factors, including patient demographics, lifestyle habits, functional reserve, and disease chronicity. By knowing these risk factors, doctors can figure out who is most likely to fail and take action quickly, including moving a patient to the ICU or using invasive breathing as necessary. These discoveries are also important for low- and middle-income nations like Nepal, where NIPPV is an important bridge therapy in hospitals with few resources.

CONCLUSION

Older age, high smoking exposure, limited daily activity, frequent prior hospitalizations, and LTOT use were independent predictors of NIPPV failure in patients with AECOPD and type 2 respiratory failure. Recognition of these factors can aid in patient selection, early intervention, and individualized ventilatory management, ultimately improving clinical outcomes in resource-constrained settings like Nepal.

ACKNOWLEDGEMENTS

None

CONFLICT OF INTEREST

None

REFERENCES

1 Hillas G, Perlikos F, Tzanakis N. Acute exacerbation of COPD: is it the "stroke of the lungs"? Int J Chron Obstruct Pulmon Dis. 2016 July 13;11(1):1579–86.

2. Brulotte CA, Lang ES. Acute Exacerbations of Chronic Obstructive Pulmonary Disease in the Emergency Department. Emerg Med Clin North Am. 2012 May 1;30(2):223–47.

3. Prediletto I, Giancotti G, Nava S. COPD Exacerbation: Why It Is Important to Avoid ICU Admission. J Clin Med. 2023 Jan;12(10):3369.

4. Ansari SF, Memon M, Brohi N, Tahir A, Ansari S, Memon M, et al. Noninvasive Positive Pressure

Ventilation in Patients with Acute Respiratory Failure Secondary to Acute Exacerbation of Chronic Obstructive Pulmonary Disease. Cureus. 2019 Oct 1 [cited 2025 Oct 18];11(10).

5. Bam N, Shrestha B. Pragmatic Pathways for Noninvasive Ventilation in Type 2 Respiratory Failure: From Global Evidence to Nepalese Experience. One Health J Nepal. 2025 Oct 10;5(10):63–7.

6. Ugurlu AO, Sidhom SS, Khodabandeh A, Ieong M, Mohr C, Lin DY, et al. Use and Outcomes of Noninvasive Positive Pressure Ventilation in Acute Care Hospitals in Massachusetts. CHEST. 2014 May 1;145(5):964–71.

7. Singh VK, Khanna P, Rao BK, Sharma SC, Gupta R. Outcome predictors for non-invasive positive pressure ventilation in acute respiratory failure. J Assoc Physicians India. 2006 May;54:361–5.

8. Bhattacharyya D, Prasad B, Tampi P, Ramprasad R. Early predictors of success of non-invasive positive pressure ventilation in hypercapnic respiratory failure. Med J Armed Forces India. 2011 Oct 1;67(4):315–9.

9. Comer DM, Oakes A, Mukherjee R. Domiciliary non-invasive ventilation in the elderly. Effective, tolerated and justified. Ulster Med J. 2015 Jan;84(1):22–5.

10. Joanne T, Calvin H H, Kuhokee K D, Kathleen R Y, Paul J C, Cynthia X P. How Do Hospitalized Patients Tolerate Non-Invasive Positive Pressure Ventilation: A Pilot Patient-Centered Survey. Int J Respir Pulm Med. 2022 Apr 30 [cited 2025 Oct 18];9(2).

11. Rathi NK, Haque SA, Nates R, Kosturakis A, Wang H, Dong W, et al. Noninvasivepositive pressure ventilation vsinvasive mechanical ventilation as first-line therapy for acute hypoxemic respiratory failure in cancer patients. J Crit Care. 2017 June 1;39:56–61.

12. Boersma R, Bakker JT, Vries M de, Raveling T, Slebos DJ, Wijkstra PJ, et al. Defining a phenotype of severe COPD patients who develop chronic hypercapnia. Respir Med . 2024 Nov 1;234.

13. Yoshida T, Tuder RM. Pathobiology of Cigarette Smoke-Induced Chronic Obstructive Pulmonary Disease. Physiol Rev. 2007 July;87(3):1047–82.

14. Moretti M, Cilione C, Tampieri A, Fracchia C, Marchioni A, Nava S. Incidence and causes of non-invasive mechanical ventilation failure after initial success. Thorax. 2000 Oct 1;55(10):819–25.

15. Hope AA, Adeoye O, Chuang EH, Hsieh SJ, Gershengorn HB, Gong MN. Pre-hospital frailty and hospital outcomes in adults with acute respiratory failure requiring mechanical ventilation. J Crit Care. 2018 Apr 1;44:212–6.

16. Perng DW, Chen PK. The Relationship between Airway Inflammation and Exacerbation in Chronic Obstructive Pulmonary Disease. Tuberc Respir Dis. 2017 Sept 4;80(4):325–35.

17. Thieme E-Journals - Seminars in Respiratory and Critical Care Medicine / Abstract.

18. Guerrero M, Crisafulli E, Liapikou A, Huerta A, Gabarrús A, Chetta A, et al. Readmission for Acute Exacerbation within 30 Days of Discharge Is Associated with a Subsequent Progressive Increase in Mortality Risk in COPD Patients: A Long-Term Observational Study. PLOS ONE. 2016 Mar 4;11(3):e0150737.

19. Lindenauer PK, Stefan MS, Shieh MS, Pekow PS, Rothberg MB, Hill NS. Outcomes Associated With Invasive and Noninvasive Ventilation Among Patients Hospitalized With Exacerbations of Chronic Obstructive Pulmonary Disease. JAMA Intern Med. 2014 Dec 1;174(12):1982–93.

20. Cavalot G, Dounaevskaia V, Vieira F, Piraino T, Coudroy R, Smith O, et al. One-Year Readmission Following Undifferentiated Acute Hypercapnic Respiratory Failure. COPD J Chronic Obstr Pulm Dis. 2021 Nov 2;18(6):602–11.

21. O'Driscoll BR. Safe use of emergency oxygen in chronic respiratory disease. Chron Respir Dis. 2011 Aug 1;8(3):159–61.

22. Owens RL, Derom E, Ambrosino N. Supplemental oxygen and noninvasive ventilation. Eur Respir Rev. 2023 Mar 22;32(167).

23. Chandra D, Stamm JA, Taylor B, Ramos RM, Satterwhite L, Krishnan JA, et al. Outcomes of Noninvasive Ventilation for Acute Exacerbations of Chronic Obstructive Pulmonary Disease in the United States, 1998–2008. Am J Respir Crit Care Med. 2012 Jan 15;185(2):152–9.