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Determinants and Short-Term Outcomes of Acute Exacerbations of COPD in A Sri Lankan Tertiary Care Centre – Prospective Study

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Abstract

Background

Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are a major cause of morbidity, mortality, and recurrent hospitalisation worldwide. In low- and middle-income countries such as Sri Lanka, limited regional data are available regarding exacerbating factors, inpatient outcomes, and short-term post-discharge deterioration following AECOPD. This study aimed to identify factors associated with acute exacerbations of COPD, evaluate the response to standard inpatient treatment, determine predictors of prolonged hospital stay, and assess short-term clinical outcomes over a three-month follow-up period.

Methodology

A prospective descriptive study was conducted among 50 patients admitted with AECOPD to Respiratory Unit 2, National Hospital Kandy, Sri Lanka, from August to December 2025 via consecutive non-probability sampling. Demographic characteristics, exacerbating factors, treatment interventions, and inpatient outcomes were recorded using interviewer-administered questionnaires and medical records. Patients were followed monthly for three months after discharge to evaluate symptom burden using the COPD Assessment Test (CAT) and modified Medical Research Council (mMRC) dyspnoea scale, lung function (FEV1), six-minute walk test (6MWT), and re-exacerbation rates. Statistical analysis was performed using SPSS.

Results

The cohort had a mean age of 69.6 ± 8.3 years and was predominantly male (88%, n=44). Most patients belonged to low socioeconomic groups (54%, n=27) and had significant smoking exposure (60%). The majority were classified as GOLD Group E (86%) with severe or very severe airflow limitation (58%). Respiratory tract infections were the most common exacerbating factor (62%), followed by exposure to air pollutants (52%) and climatic variations (32%). Poor medication compliance and incorrect inhaler technique were observed in 30% of patients. During admission, 38% required oxygen supplementation and 16% required non-invasive ventilation (NIV). All patients survived to discharge, although 24% required hospitalisation for ≥7 days. The Higher CAT scores were associated with prolonged hospital stay ($\rho = 0.279$, $p = 0.050$), while NIV requirement showed a strong association with increased length of stay ($H = 16.334$, $p < 0.001$), indicating that patients with

greater baseline symptom burden and more severe exacerbations required longer hospitalisation. At three-month follow-up, 60% experienced recurrent exacerbations. Clinically and statistically significant deterioration was observed in mean FEV1 (43.5% vs 37.6%, p<0.001), CAT score (21.5 vs 24.7, p<0.001), and mMRC score (2.53 vs 3.00, p<0.001) at three-month follow-up.

Conclusions

AECOPD in this Sri Lankan cohort predominantly affected elderly males with advanced disease, significant smoking exposure, and socioeconomic vulnerability. Respiratory infections and environmental exposures were major exacerbating factors. Although standard inpatient management achieved excellent short-term survival, substantial post-discharge deterioration and recurrent exacerbations were observed within three months. Strengthening preventive strategies, vaccination coverage, pulmonary rehabilitation, inhaler education, and structured post-discharge follow-up may help reduce recurrent exacerbations and progressive respiratory decline.

Keywords: *Short-Term Outcomes, Acute Exacerbations, COPD, Care Centre*

1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a progressive respiratory disorder characterised by persistent airflow limitation, chronic respiratory symptoms, and structural abnormalities involving both the airways and lung parenchyma. It remains a major global public health challenge and is currently among the leading causes of morbidity and mortality worldwide. Although COPD is largely preventable and treatable, the disease continues to impose a substantial burden on healthcare systems, particularly in low- and middle-income countries where nearly 90% of COPD-related deaths occur.

Acute exacerbations of COPD (AECOPD) represent a critical phase in the natural history of the disease. These episodes are characterised by acute worsening of respiratory symptoms, including dyspnoea, cough, and sputum production, frequently requiring additional medical therapy or hospitalisation. Recurrent exacerbations accelerate lung function decline, worsen health-related quality of life, increase healthcare expenditure, and contribute significantly to mortality. Furthermore, patients admitted with AECOPD frequently enter a cycle of recurrent exacerbations and hospital readmissions, resulting in progressive respiratory disability and poor long-term outcomes.

Recent international studies have identified several predictors of recurrent hospitalisation and poor outcomes in COPD. Lin et al., in a meta-analysis of over 169,000 Asian patients, reported that prior hospitalisations, multiple comorbidities, male sex, smoking exposure, high CAT scores, malnutrition, and severe airflow limitation were strongly associated with COPD readmissions, with rates increasing from 19% at 30 days to 42% within one year after discharge (1). Similarly, the ECLIPSE study by Müllerova et al. identified previous exacerbation-related hospitalisation as the strongest predictor of future admissions, while older age, worsening airflow limitation, elevated white blood cell counts, and emphysematous changes were associated with increased mortality risk (2). Hoogendoorn et al. further demonstrated that exacerbation frequency increases progressively with COPD severity, highlighting the substantial burden of advanced disease (3).

Respiratory tract infections and environmental exposures are major precipitating factors for AECOPD. De Miguel-Díez et al. demonstrated that colder temperatures, seasonal variation, and short-term exposure to pollutants including NO_2, O_3, CO, and PM_{10} significantly increased exacerbation risk (4). Choi et al. further reported increased exacerbation frequency and healthcare utilisation among COPD patients following COVID-19 infection, suggesting persistent disease destabilisation after viral illnesses (5). Additionally, Taddei et al. identified pathogens such as Haemophilus influenzae, Moraxella catarrhalis, and human rhinovirus as common exacerbation triggers in the Asia-Pacific region, emphasising the importance of microbiological evaluation and targeted antimicrobial therapy in COPD management (6).

The Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines emphasise prevention of exacerbations as a key therapeutic objective. Current GOLD recommendations advocate a multidimensional management strategy involving smoking cessation, vaccination, optimisation of inhaled pharmacotherapy, pulmonary rehabilitation, inhaler technique education, and early recognition of exacerbating triggers (7). Pharmacological management has increasingly shifted toward personalised treatment approaches based on symptom burden, exacerbation history, and eosinophilic phenotype. Additional interventions including phosphodiesterase-4 inhibitors, long-term macrolide therapy, pulmonary rehabilitation, and vaccination against respiratory pathogens have also demonstrated benefits in selected patient groups (7).

Hospitalisation due to AECOPD is closely associated with disease severity and adverse outcomes. Parikh et al. demonstrated that early administration of corticosteroids, antibiotics, and nebulised therapy improved symptom control and shortened hospital stay duration (8). Gavish et al. further showed that early pulmonology follow-up after discharge significantly reduced 90-day readmission rates, highlighting the importance of structured post-discharge care (9). In addition, biomarkers such as C-reactive protein (CRP), eosinophil counts, and procalcitonin have shown potential in predicting exacerbation severity and guiding personalised management strategies, although further validation is required (10).

In South Asian countries, including Sri Lanka, COPD commonly affects elderly individuals from lower socioeconomic backgrounds with prolonged exposure to tobacco smoke, occupational dust, and biomass fuel combustion. However, regional data regarding exacerbating factors, inpatient outcomes, determinants of hospital stay, and short-term post-discharge deterioration remain limited, and international findings may not be fully generalisable because of differences in environmental exposure, healthcare accessibility, and resource availability. Furthermore, hospital discharge following AECOPD does not necessarily indicate complete physiological recovery, as many patients continue to experience worsening symptom burden, declining lung function, recurrent exacerbations, and reduced functional capacity during the early post-discharge period, highlighting the importance of preventive strategies and structured follow-up care.

Therefore, this prospective study was conducted to identify factors associated with AECOPD among patients admitted to a tertiary care respiratory unit in Sri Lanka, evaluate responses to standard inpatient management, determine predictors of prolonged hospital stay, and assess short-term post-discharge outcomes over a three-month follow-up period. The findings aim to provide clinically relevant local evidence to improve preventive strategies, optimise follow-up care, and reduce recurrent exacerbations among COPD patients in Sri Lanka.

2. Methodology

This prospective descriptive observational study was conducted at Respiratory Unit 2 of the National Hospital Kandy, Sri Lanka, a major tertiary care referral centre to evaluate patients admitted with acute exacerbations of chronic obstructive pulmonary disease (AECOPD) and to assess their clinical course from hospital admission until three months following discharge.

The study population consisted of adult patients admitted with AECOPD between 1 August 2025 and 31 December 2025 recruiting patients using a non-probability consecutive sampling method. A total of 50 patients fulfilling the eligibility criteria were enrolled during the study period. Eligible participants included adults aged 40 years or older with an established diagnosis of COPD who required hospitalisation due to an acute exacerbation. Patients with asthma-COPD overlap syndrome, interstitial lung disease (ILD), active pulmonary tuberculosis, underlying malignancy, terminal illnesses, incomplete medical records, or inability to complete follow-up were excluded from the study.

Acute exacerbation of COPD was defined according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria as an acute worsening of respiratory symptoms, particularly dyspnoea, cough, and/or sputum production, occurring within 14 days and requiring additional medical treatment. Alternative causes of acute respiratory deterioration such as myocardial infarction, heart failure exacerbation, pneumothorax, and

pulmonary embolism were excluded clinically and with relevant investigations including electrocardiography and chest radiography.

Data were collected prospectively by the principal investigator using a structured interviewer-administered questionnaire together with information obtained from clinical records, bed-head tickets, laboratory reports, and clinic follow-up notes. Baseline assessment at admission included demographic characteristics such as age, sex, occupation, and socioeconomic status, as well as smoking history, vaccination status, comorbid illnesses, previous exacerbation history, and GOLD classification. Baseline symptom burden was assessed using the COPD Assessment Test (CAT) and the modified Medical Research Council (mMRC) dyspnoea scale. Functional respiratory status was evaluated using spirometric parameters including forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio. Six-minute walk test (6MWT) results were recorded where feasible. Potential exacerbating factors including respiratory tract infections, environmental air pollution, climatic variation, smoking exposure, medication non-compliance, and poor inhaler technique were also evaluated.

During hospitalisation, details regarding inpatient management were documented, including use of nebulisation therapy, oral or intravenous antibiotics, oxygen supplementation, requirement for non-invasive ventilation (NIV), intensive care unit (ICU) admission, and complications occurring during the hospital stay. Laboratory and radiological investigations performed during admission included full blood count, inflammatory markers such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), arterial blood gas (ABG) analysis, and chest radiography where clinically indicated.

At discharge, treatment response was assessed clinically, biochemically, and radiologically. Clinical response was defined as improvement in respiratory symptoms together with stabilisation of vital signs. Biochemical response was determined by improvement in inflammatory markers and arterial blood gas parameters, while radiological response referred to resolution or improvement of acute chest radiographic abnormalities. Duration of hospital stay and discharge outcomes, including the requirement for long-term oxygen therapy (LTOT), were also recorded.

All enrolled patients were followed monthly at the respiratory clinic for a period of three months following discharge. During follow-up visits, patients were reassessed for occurrence of further exacerbations, symptom burden using CAT and mMRC scores, spirometric parameters, and six-minute walk test performance where feasible. A further exacerbation was defined as worsening respiratory symptoms requiring systemic corticosteroids, antibiotics, emergency medical evaluation, or re-hospitalisation.

Severity of airflow limitation was categorised according to GOLD spirometric classification based on post-bronchodilator FEV1 values. Significant smoking exposure was defined as a smoking history of ≥10 pack years. Clinical deterioration during follow-up was assessed using Minimal Clinically Important Difference (MCID) thresholds, defined as an increase of at least one point in mMRC score, an increase of at least two points in CAT score, or a decline of at least 10% in FEV1 from baseline values.

Data were entered into Microsoft Excel and analysed using the Statistical Package for the Social Sciences (SPSS). Continuous variables were expressed as mean ± standard deviation, while categorical variables were summarised using frequencies and percentages. Paired t-tests were used to compare baseline and three-month follow-up values of FEV1, CAT score, and mMRC score. Spearman correlation analysis was used to assess associations between baseline clinical factors and length of hospital stay, while Pearson correlation analysis was applied for normally distributed continuous variables. The relationship between NIV requirement and duration of hospital stay was analysed using the independent-samples Kruskal–Wallis test. A p-value of less than 0.05 was considered statistically significant.

Ethical approval for the study was obtained from the Ethics Review Committee of the National Hospital Kandy (Ref No: NHK/ERC/66/2025). Permission to conduct the study was obtained from the hospital administration

and the Head of Respiratory Unit 2. Written informed consent was obtained from all participants prior to recruitment, and confidentiality of patient information was strictly maintained throughout the study.

3. Results

3.1 Baseline Cohort Characteristics

A total of 50 patients (N=50) meeting the inclusion criteria were recruited over 5 months at the respiratory unit 2 of the National Hospital, Kandy.

3.1.1 Demographic Characteristics

The study cohort consisted of 50 patients, predominantly elderly, with a mean age of 69.62 years (SD ± 8.32). A significant gender imbalance was observed, with 44 (88%) patients being male. The study population demonstrated significant socioeconomic vulnerability, with over half of the cohort (27; 54%) classified as low income and nearly 35 (70%) of the cohort working in high-exposure roles (construction/masonry, manufacturing, farming, transport services). (Table 1)

Table 1: Baseline demographics (N=50)

Characteristics	Frequency (n) / Mean ± SD	Percentage (%)
Age	69.62 ± 8.32	—
Gender		
Male	44	88%
Female	6	12%
Socioeconomic Status		
High	1	2%
Middle	22	44%
Low	27	54%
Occupation		
Farmer	8	16%
Construction/Mason	15	30%
Manufacturing/Processing	9	18%
Transportation/Drivers	3	6%
Other	15	30%

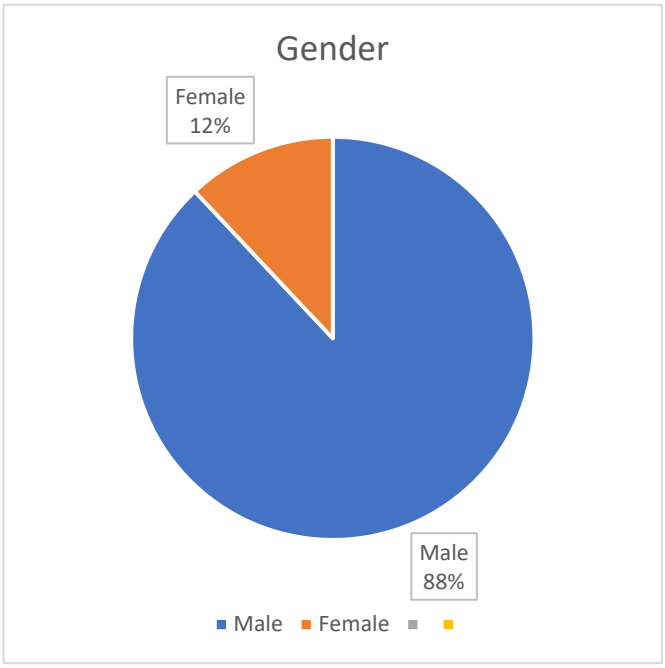

Figure 2 : Distribution of Gender

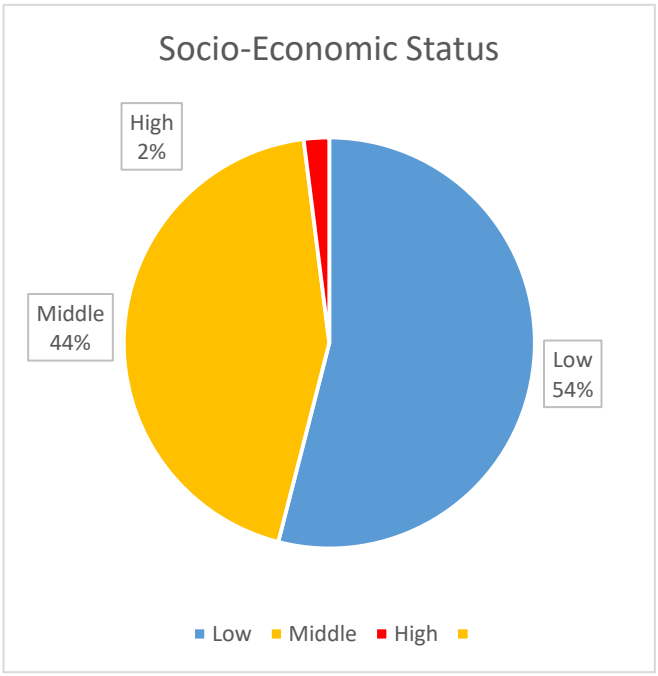

Figure 1: Socio-Economic Status of Patients

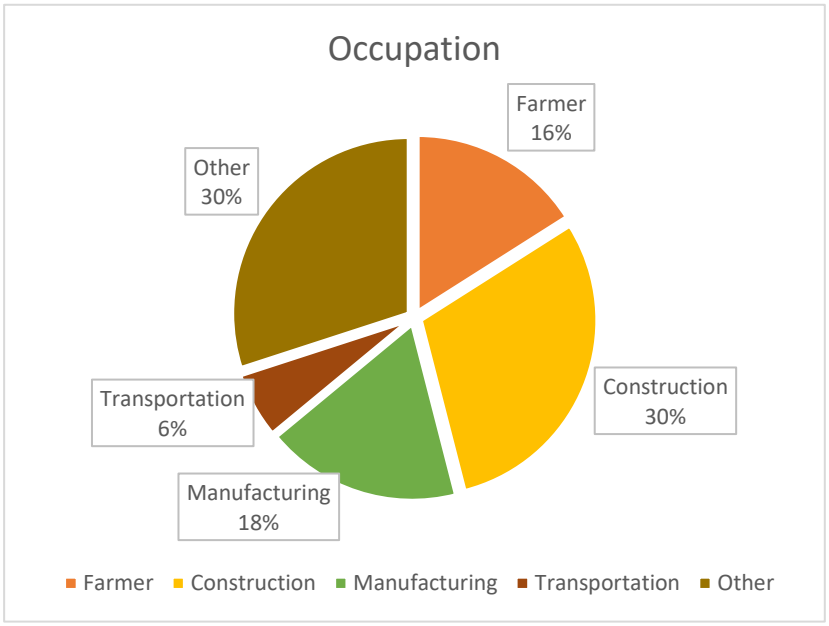

Figure 3: Occupation Category of Patients

3.1.2 Baseline GOLD COPD Category

Most patients were classified as GOLD Group E (86%, n=43). (Table 2)

Table 2: Baseline GOLD COPD categories of the Cohort (N=50)

GOLD COPD Category	Frequency (n)	Percentage (%)
Group A	0	0%
Group B	7	14%

GOLD COPD Category	Frequency (n)	Percentage (%)
Group E	43	86%

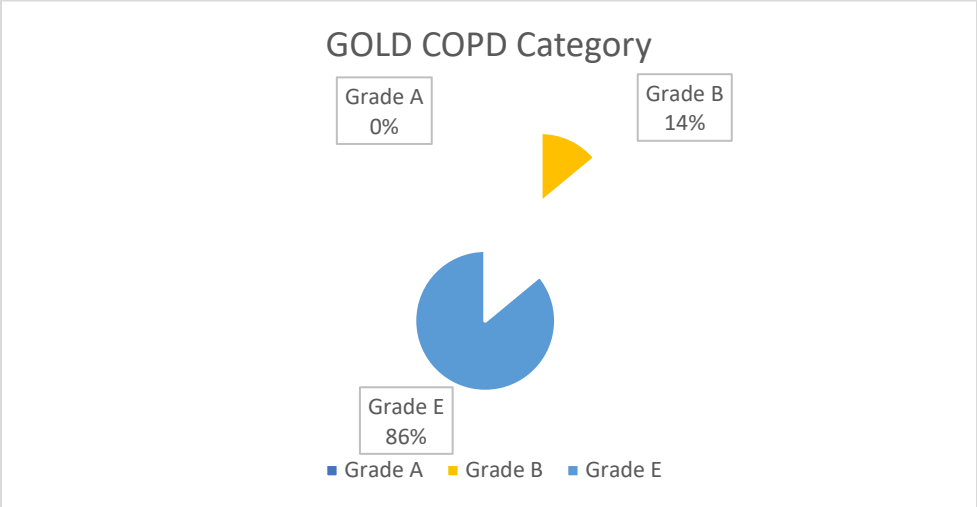

Figure 4: Baseline GOLD Category at Admission

3.1.3 Comorbidities

Thirty (60%) patients presented with at least one chronic comorbidity, with Hypertension 17(34%) and Ischemic Heart Disease 14 (28%) being the most prevalent. (Table 3)

Table 3: Comorbidities(N=50)

Comorbidities	Frequency (n)	Percentage (%)
Diabetes Mellitus	8	16%
Hypertension	17	34%
Ischemic Heart Disease	14	28%
Stroke	4	8%
Other	1	2%
None	20	40%

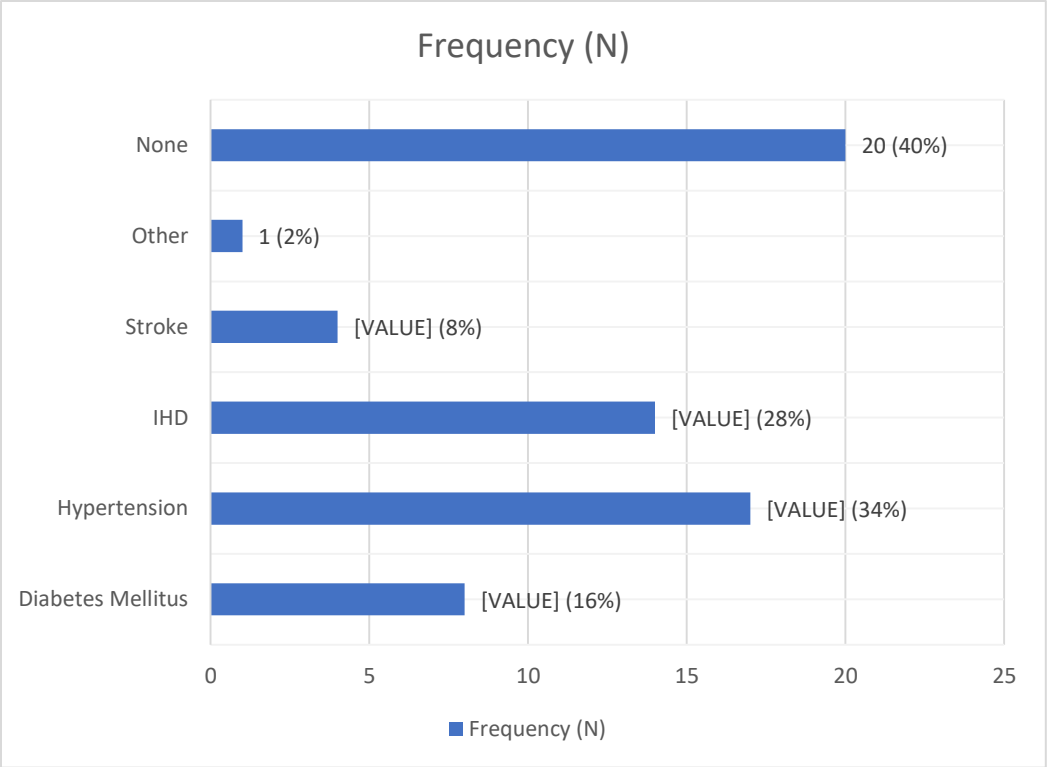

Figure 5: Comorbidities

3.1.4 Smoking pack Years

30 (60%) patients had Significant Smoking Pack Years (≥10), while the remaining 20(40%) were classified as having non-significant exposure. (Table 4)

Table 4: Smoking pack years (N=50)

Smoking Pack Years	**Frequency (n)**	**Percentage (%)**
Significant pack years (≥10 pack years)	30	60%
Not significant	20	40%

3.1.5 Baseline Symptom Burden

All patients (100%) of the cohort presented with significant symptoms (CAT score ≥10), with nearly half, 23(46%), experiencing a very high CAT score (CAT 21–40). The mMRC score mode is 2, which indicates functional breathlessness during daily walking. (Table 5)

Table 5: Baseline symptom burden(N=50)

Baseline Symptom Burden	**Frequency (n) / Mode**	**Percentage (%)**
mMRC Score	Mode = 2	—
CAT Score		
0–9	0	0%

10–20	27	54%
21–40	23	46%

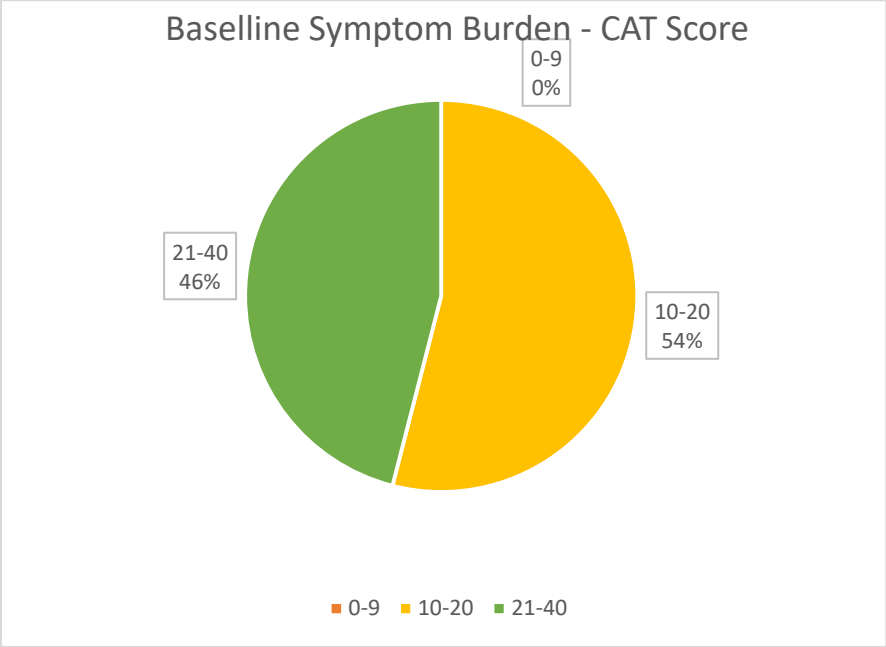

Figure 6: Baselline Symptom Burden - CAT Score

3.1.6 Baseline Functional Capacity

Mean FEV1 was 43.5%, with 38% classified as GOLD 3 and 20% as GOLD 4 airflow limitation. The clinical profile of the study cohort reflects a complete absence of mild disease, with 0% of patients falling into the GOLD 1 (Mild) spirometry category. In patients who were capable of baseline 6MWT (N=34), significant desaturation was evident in 4(8%) of the total cohort, a subgroup with critical functional impairment. (Table 6)

Table 6: Baseline Functional Capacity

Functional Capacity	**Frequency (n) / Mean**	**Percentage (%)**
Lung Function Test – FEV1 (Mean) (N=48)	43.5%	—
GOLD Spirometry Grades (N=48)		
Mild (FEV1 ≥80% predicted)	0	0%
Moderate (50% ≤ FEV1 <80% predicted)	19	38%
Severe (30% ≤ FEV1 <50% predicted)	19	38%
Very Severe (FEV1 <30% predicted)	10	20%
6MWT (N=34)		
Significant desaturation present	4	8%
Significant desaturation not present	30	60%

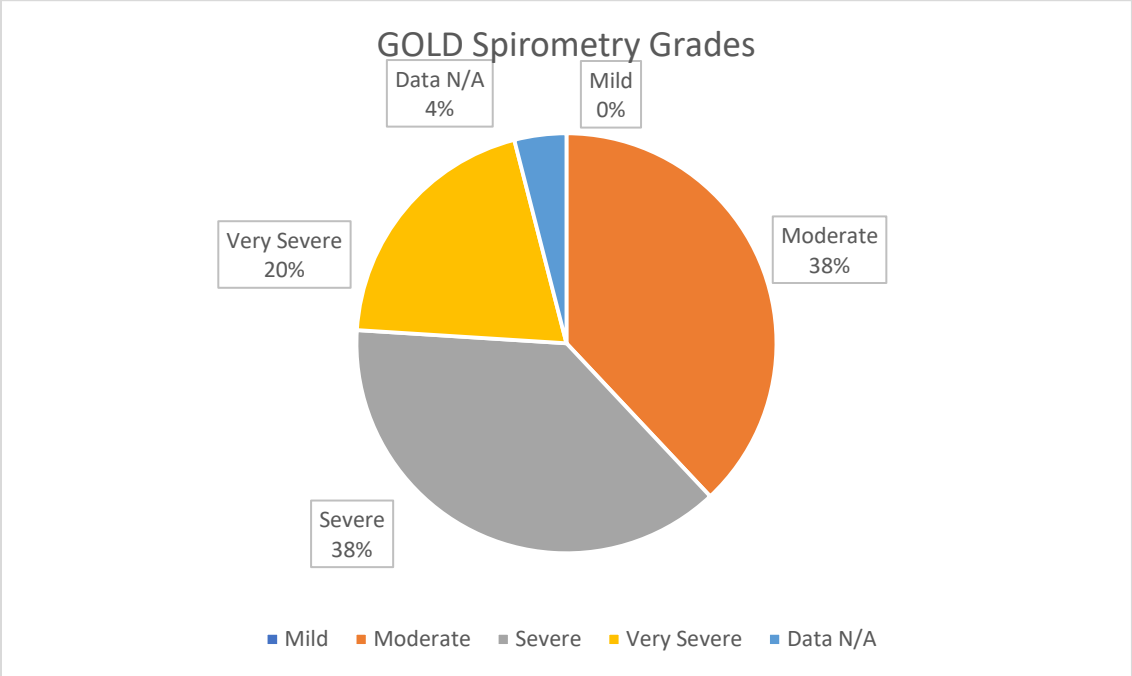

Figure 7: GOLD Spirometry Grades

3.1.7 Preventive Measures

A substantial majority of the study population, 34 (68%), had not received any preventive vaccinations, with only 2 (4%) being fully immunised against both pneumococcus and influenza. (Table 7)

Table 7: Preventive measures(N=50)

Vaccination Status (Preventive Measures)	Frequency (n)	Percentage (%)
Taken both pneumococcal and influenza vaccines	2	4%
Has taken either pneumococcal or influenza vaccine	14	28%
Not vaccinated	34	68%

3.2 Exacerbating Factors

The frequencies of these self-reported and clinically-assessed factors are presented in Table 08.

A history of ≥1 previous exacerbations leading to hospitalization is present in 42 (84%), and respiratory tract infections are the leading acute trigger, identified in 31 (62%) of all hospital admissions. Over half of the patients (26, 52%) had exposure to air pollutants as a trigger, while 16 (32%) were affected by weather and climate changes. Thirty (60%) of the participants had a significant smoking history exceeding 10 pack-years. The cohort is characterized by a significant financial burden, with 27 (54%) belonging to the low-income group and 22 (44%) to the middle-income group. Fifteen (30%) of exacerbations were associated with poor medication compliance and incorrect inhaler techniques, which are modifiable risk factors.

Table 08: Exacerbating factors associated with AECOPD

Exacerbating Factors Associated with AECOPD	Frequency (n)	Percentage (%)

Exacerbating Factors Associated with AECOPD	Frequency (n)	Percentage (%)
Respiratory tract infections	31	62%
Exposure to air pollutants	26	52%
Weather/Climate changes	16	32%
Significant smoking pack years (>10 PY)	30	60%
Poor compliance and poor inhaler technique	15	30%
Socioeconomic Status		
Low income	27	54%
Middle income	22	44%
High income	1	2%
Previous exacerbations (≥1 hospitalisation/year)	42	84%

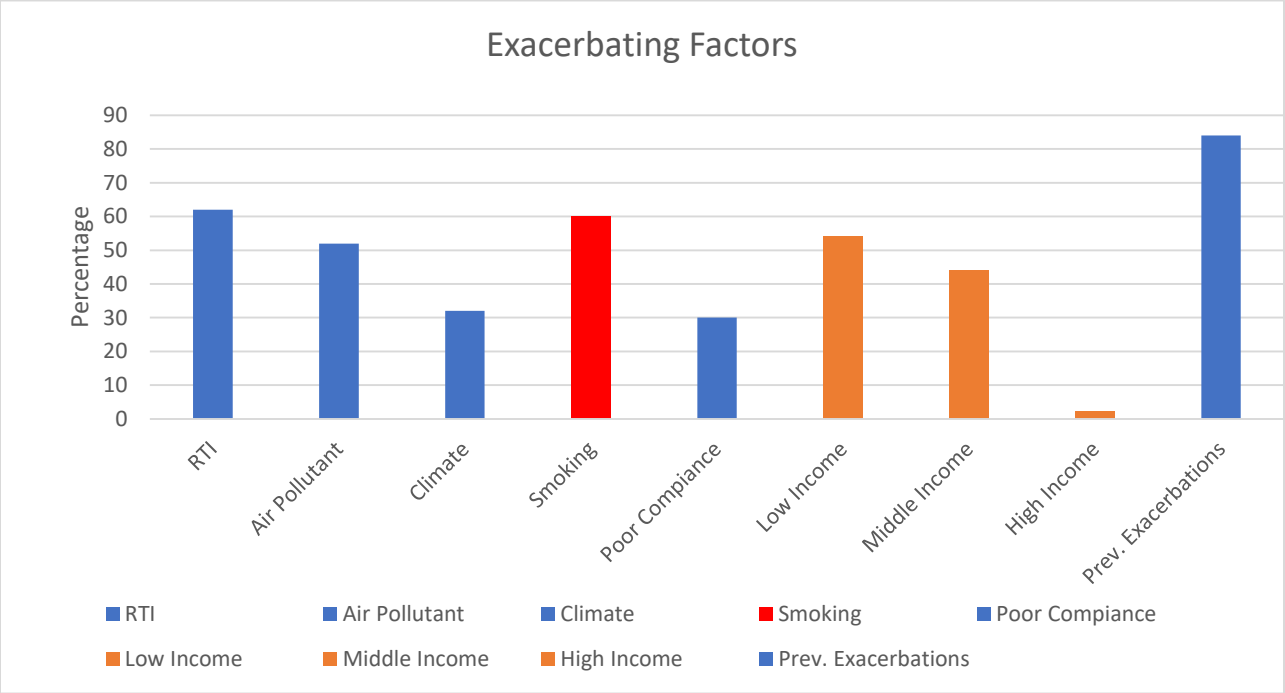

Figure 8: ***Exacerbating Factors***

3.3 In hospital Therapeutic Management and Complications

3.3.1 in hospital therapeutic management

All the patients universally got nebulization therapy, reflecting the standard of care for acute symptom relief during hospitalization, while 42(84%) necessitated antibiotic treatment. Respiratory support was a significant requirement, with 19(38%) requiring supplemental oxygen and 8(16%) utilizing non-invasive ventilation (NIV); only 1(2%) required ICU admission. (Table 09)

Figure 8: Exacerbating Factors

Table 09: In hospital therapeutic management

Inpatient Therapeutic Interventions	Frequency (n)	Percentage (%)
Nebulization	50	100%
Received oral/IV antibiotics	42	84%
Received oxygen supplementation	19	38%
Required non-invasive ventilation (NIV)	8	16%
Required ICU admission	1	2%

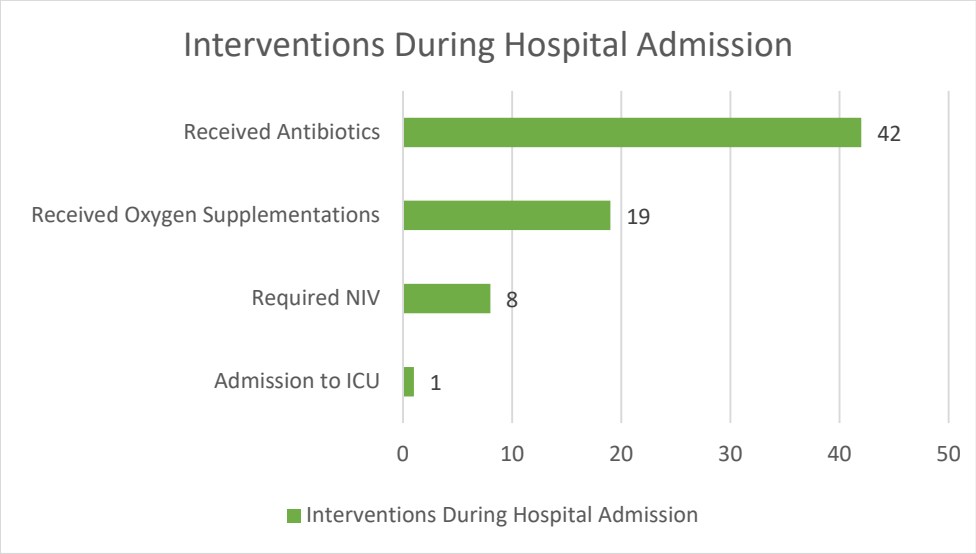

Figure 9:Interventions During Hospital Admission

3.3.2 Complications during hospital stay

During the inward stay, 34(68%) of patients had no acute complications; however, significant morbidity was noted through sepsis 6 (12%) and myocardial infarction 5(10%), with heart failure and stroke each affecting 2 (4%) of the study population. (Table 10)

Table 10: Complications during hospital stay

Complications During Hospital Stay	Frequency (n)	Percentage (%)
Sepsis/Septic shock	6	12%
Pneumothorax	0	0%
Myocardial infarction (MI)	5	10%
Heart failure exacerbation	2	4%
Stroke	2	4%
Other	1	2%
None	34	68%

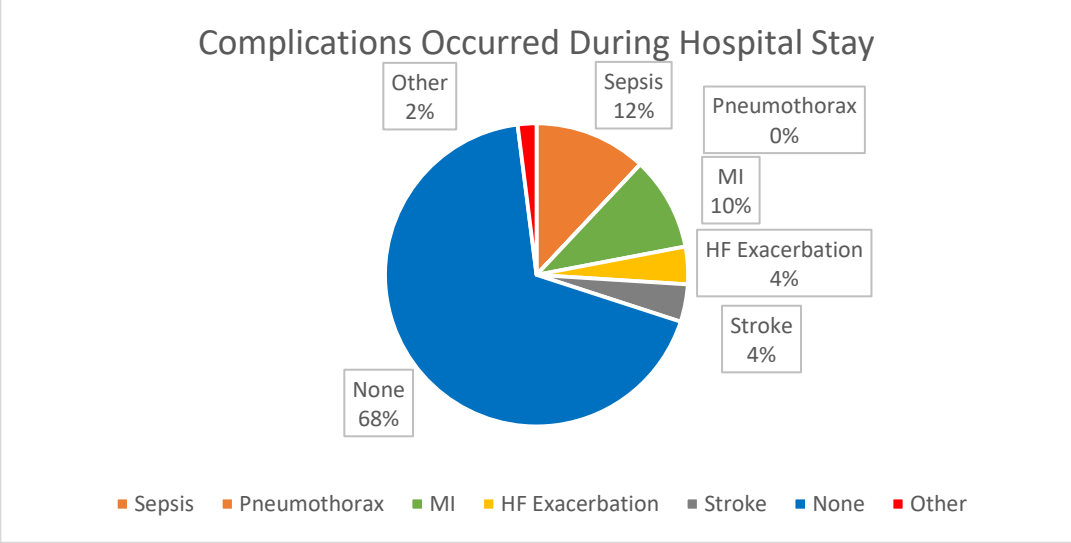

Figure 10: Complications Occurred During Hospital Stay

3.4 Clinical outcome of Hospital management

3.4.1 Response to Standard Treatment

A substantial majority of the cohort achieved a clinical response 47 (94%), and biochemical response was observed in 30(60%) of the patients, reflecting a normalisation of inflammatory markers. However, a radiological response was evident in only 16(32%) of the cases. Notably, there were no instances (0%) of non-response to the standard treatment of AECOPD, which was given at the inward setting. (Table 11)

Table 11: Response to standard treatment

Response to Standard Treatment	Number of Patients (n)	Percentage (%)
Clinical response	47	94%
Radiological response	16	32%
Biochemical response	30	60%
No response	0	0%

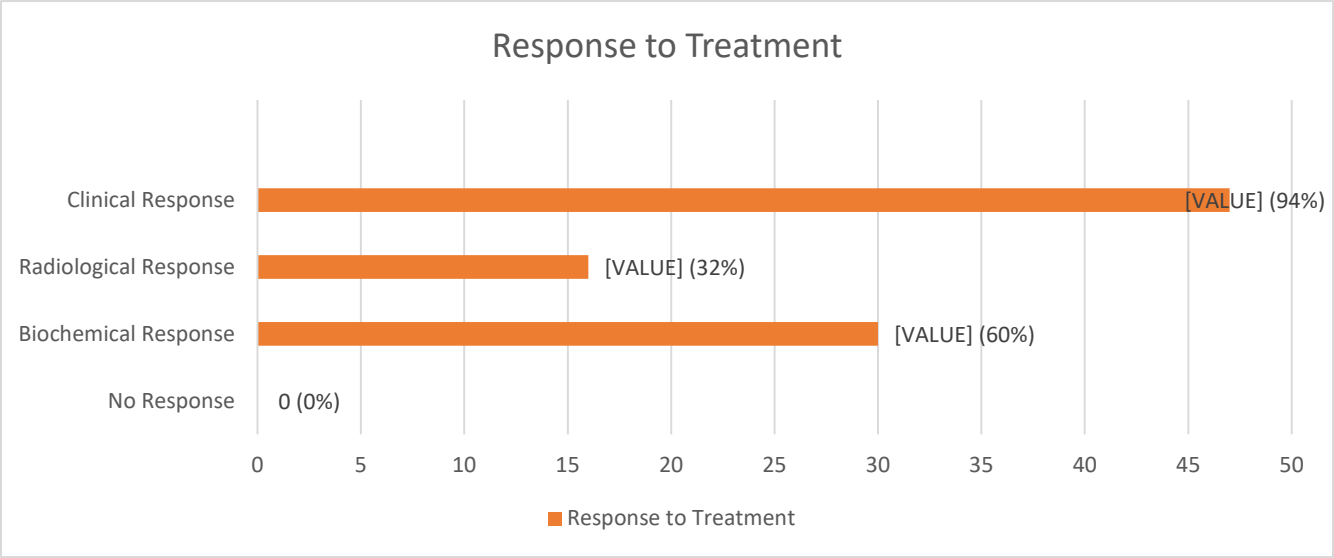

Figure 11: Response to Standard treatment

3.4.2 Duration of Hospital stay

The majority of the cohort, comprising 38 (76%) of the patients, required a hospital stay of less than 7 days. However, a significant minority of 12(24%) experienced a prolonged hospital stay of 7 days or more. (Table 12)

Table 12: Duration of hospital stay

Duration of Hospital Stay	Frequency (n)	Percentage (%)
≥7 days (prolonged stay)	12	24%
<7 days	38	76%

3.4.3 Clinical Outcome

In terms of final clinical outcomes, the study recorded a 100% survival rate (0% mortality) during the hospital admission period. The vast majority of the cohort 44(88%) were successfully discharged following acute stabilisation, while 6(12%) of the patients required discharge with Long-Term Oxygen Therapy (LTOT) due to persistent chronic respiratory failure. (Table 13)

Table 13: Clinical outcome

Clinical Outcome	Number of Patients (n)	Percentage (%)
Discharged	44	88%
Discharged with long-term oxygen therapy (LTOT)	6	12%
Deaths	0	0%

3.5 Post-discharge short-term outcome at 3 months' follow-up

The short-term outcome at 3-month follow-up after discharge of all 50 patients (N=50) was collected (Table 14). According to the findings, during the short-term follow-up period, a considerable number of patients 30 (60%) experienced further exacerbations. There was a marked increase in symptom severity; the mMRC mode shifted from 2 to 3, with 90% of patients scoring a 3 at three months. Similarly, the proportion of patients in the high-impact CAT category (21–40) rose from (23)46% to (41)82%. The mean FEV1 decreased from 43.5% to 37.6%. This physiological decline was reflected in the GOLD Severity grading, where patients in the "Severe" category increased from 19 (38%) to 25 (50%), and those in the "Very Severe" category increased from 10

(20%) to 17 (34%). Functional capacity showed further impairment during the 6-Minute Walk Test, with the prevalence of significant oxygen desaturation doubling from 4 (8%) to 8 (16%).

Table 14: Post discharge short term outcome at 3 months' follow-up

Post-Discharge Short-Term Outcomes at 3-Month Follow-Up	Baseline	3-Month Follow-Up
Occurrence of further exacerbations	—	30 (60%)
Symptom Burden Scores		
• **mMRC Score**	Mode = 2	Mode = 3
Grade 0	0	0
Grade 1	0	0
Grade 2	25 (50%)	2 (4%)
Grade 3	24 (48%)	45 (90%)
Grade 4	1 (2%)	2 (4%)
• **CAT Score**		
0–9	0	0
10–20	27 (54%)	9 (18%)
21–40	23 (46%)	41 (82%)
• **Spirometry GOLD Grades**		
Mild	0	0
Moderate	19 (38%)	6 (12%)
Severe	19 (38%)	25 (50%)
Very Severe	10 (20%)	17 (34%)
• **Lung Function**		
Mean FEV1	43.5%	37.6%
• **6-Minute Walk Test (6MWT)**		
Significant desaturation present	4 (8%)	8 (16%)
Significant desaturation not present	30 (60%)	25 (50%)

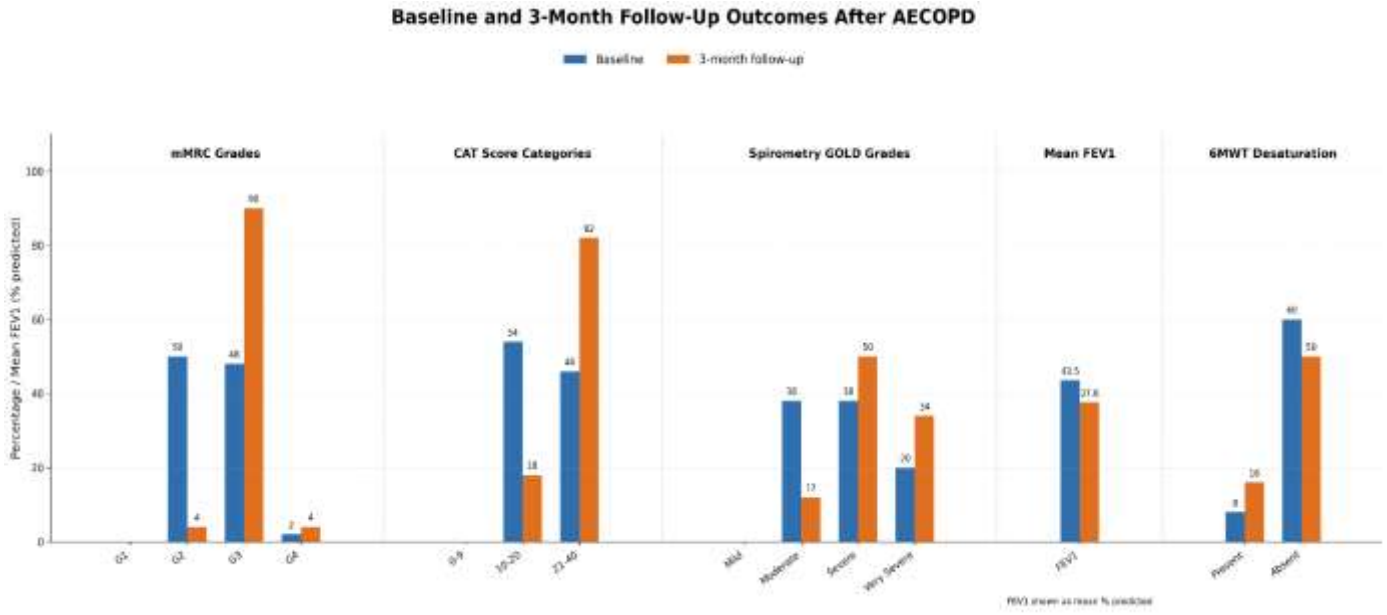

Figure 12: Baseline and 3-Month follow up outcomes after AECOPD

3.5.1 Overall Outcome of Patients

A statistical analysis using paired t-tests was performed to evaluate the mean differences between baseline and the 3-month follow-up for three key parameters: FEV1, mMRC, and CAT score. The results confirmed a universal and statistically significant deterioration across all metrics ($p < 0.001$). Specifically, the mean FEV1 decreased by 5.90% (from 43.50% to 37.60%), while the mean mMRC score increased by 0.47 (from 2.53 to 3.00) and the mean CAT score increased by 3.18 points (from 21.52 to 24.70). These significant changes were supported by high test-retest reliability (FEV1: r=0.943; CAT: r=0.863), underscoring the progressive clinical and physiological decline within the cohort over the short-term period.

Table 15: Mean of 3 Key parameters at baseline and at 3 month Follow up

Parameter	n	Mean	Standard Deviation (SD)	Standard Error (SE)
mMRC Score (Baseline)	49	2.53	0.544	0.078
mMRC Score (3-Month Follow-Up)	49	3.00	0.289	0.041
CAT Score (Baseline)	50	21.52	5.052	0.714
CAT Score (3-Month Follow-Up)	50	24.70	5.943	0.840
FEV1 % Predicted (Baseline)	48	43.50%	14.41%	2.08%
FEV1 % Predicted (3-Month Follow-Up)	48	37.60%	13.00%	1.88%

Table 16: Paired T Test applied to the mean difference of 3 key parameters at baseline and at 3-month follow-up

Comparison (Baseline vs 3-Month Follow-Up)	Mean Difference (Δ)	Standard Deviation (SD)	95% Confidence Interval	t (df)	p-value
mMRC Score	-0.469	0.544	-0.626 to -0.313	-6.040 (48)	<0.001
CAT Score	-3.180	3.008	-4.035 to -2.325	-7.475 (49)	<0.001
FEV1 % Predicted	+5.90%	4.85%	+4.49% to +7.30%	+8.426 (47)	<0.001

Paired t-tests between Baseline status and at 3 month follow up readings for the following confirmed universal deterioration (n=48-50):

- mMRC: +0.47 (t=-6.04, P<0.001)
- CAT: +3.18 (t=-7.48, P<0.001)
- FEV1: -5.90% (t=+8.43, P<0.001)

High test-retest reliability: FEV1 r=0.943, CAT r=0.863 (P<0.001).

3.5.2 Study of Individual changes of short-term outcome at 3 months for separate key parameters using MCID (Minimal Clinically Important Difference)

To determine whether the observed changes in the study population represented a meaningful clinical impact on the patients' lives, the results were evaluated against established “Minimal Clinically Important Difference” (MCID) thresholds. The MCID represents the smallest change in a treatment outcome that a patient would identify as important, serving as a vital link between statistical significance and clinical reality.

The following table outlines the specific key domains and thresholds used to define clinical worsening in this cohort (table 17)

Table 17: MCID for Key parameters

Domain	Worsening Threshold (MCID)	Reference
mMRC Dyspnoea Scale	Increase ≥1 point	GOLD 2025; Meguro et al., 2012
CAT Symptom Score	Increase ≥2 points	Jones et al., 2009
FEV1 % Predicted	Decline ≥10% from baseline	ATS/ERS, 2019

3.5.3 Short-term outcome of MMRC Score Using MCID

Individual changes in mMRC Dyspnea Scale scores provide a clear view of symptomatic progression within the cohort at the three-month mark. Nearly half of the participants 24(48%) experienced a worsening of at least +1 point, meeting the established MCID threshold for significant clinical deterioration in breathlessness. An equal proportion of the cohort 24(48%) remained stable with no change in their baseline score, while only a minimal of 1(2%) showed any Symptomatic improvement. (Table 18)

Table 18: Short term outcome of mMRC Score using MCID

Change in mMRC Score – Clinical Outcome	Frequency (%)
+1 – Worsened	24 (48%)
0 – No change	24 (48%)
-1 – Improved	1 (2%)

3.5.4 Short-term outcome of CAT Score Using MCID

The evaluation of health status using the CAT score relative to the Minimal Clinically Important Difference (MCID) of ≥2 points reveals significant short-term deterioration. A substantial 38 (76%) of the cohort experienced clinical worsening (a score increase of +2 or more), with 16 (32%) showing mild worsening (+2 to +3 points) and 22 (44%) demonstrating more severe symptomatic escalation (+4 to +11 points). In contrast, only 8 (16%) of the patients maintained a stable score, and a small minority of 4 (8%) exhibited clinical improvement.

Table 19: Short term outcome of CAT Score Using MCID

Change in CAT Score – Clinical Outcome	Frequency (%)
-6 to -1 (Improved/Outlier)	4 (8%)
0 to +1 (No change)	8 (16%)
+2 to +3 (Mild worsening)	16 (32%)
+4 to +5	14 (28%)
+6 to +7	5 (10%)
+8 to +9	1 (2%)
+10 to +11	2 (4%)

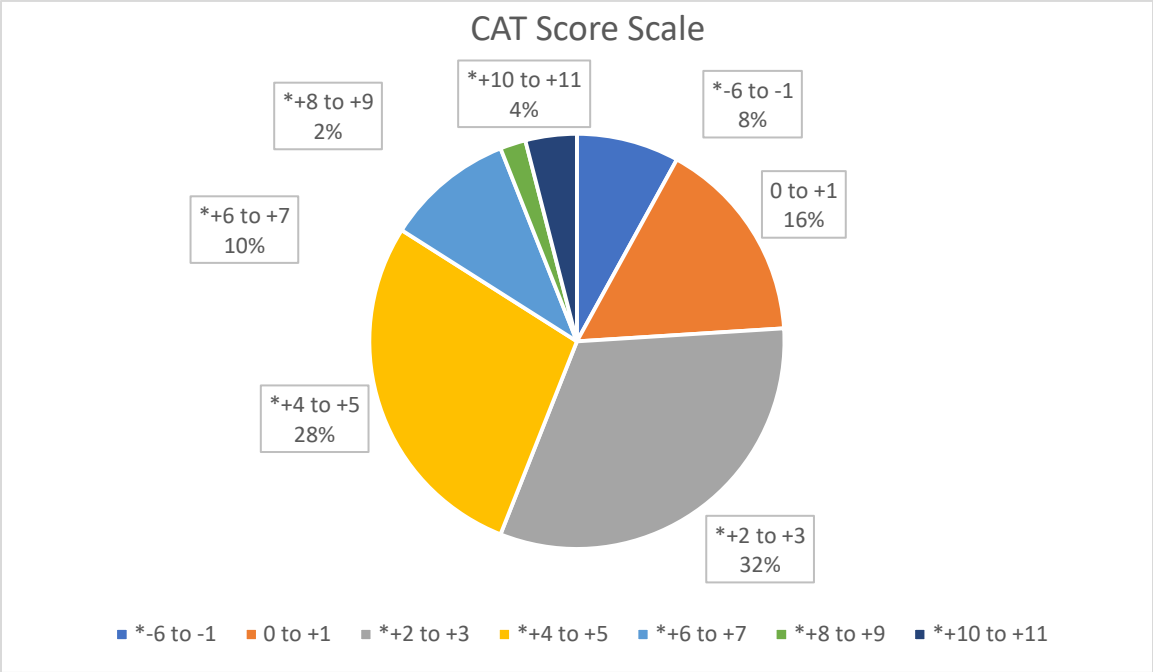

Figure 13: CAT Score Scale

3.5.5 Short term outcome of FEV1 Using MCID

The physiological progression of lung function was assessed by measuring the change in FEV1 % Predicted relative to the MCID threshold of a ≥10% decrease. The analysis reveals a significant trend toward respiratory decline. Nine (18%) patients in the cohort experienced a 10% or greater drop in FEV1 %, meeting the strict ATS/ERS criteria for a significant physiological decline. The vast majority of patients, 38 (76%), showed a 0% to 9% decrease in lung function. While these figures fall below the formal 10% MCID threshold for an individual, they represent a widespread decline in respiratory function across the group. Only 3 (6%) of the participants showed any improvement in their FEV1 values. (table 20)

Table 20: Short term outcome of FEV1 using MCID

Change in FEV1 % Predicted – Clinical Outcome	**Frequency (%)**
-19% to -10% (Significant decline)	9 (18%)
-9% to 0% (Mild decline/No significant change)	38 (76%)
+1% to +10% (Improved)	3 (6%)

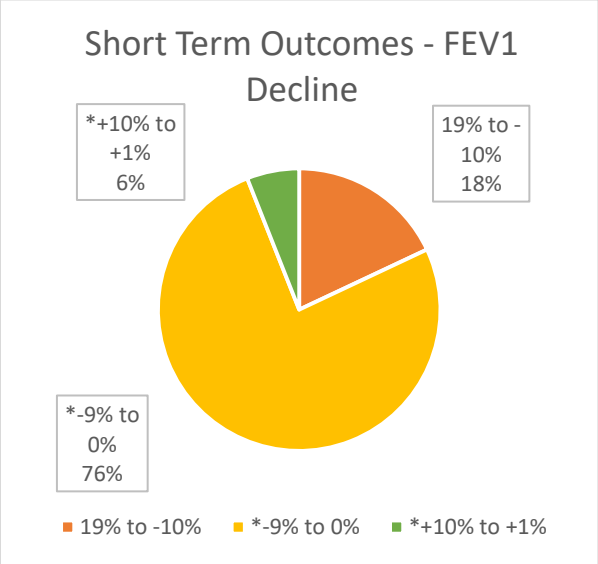

Figure 14: Short Term Outcomes - FEV1 Decline

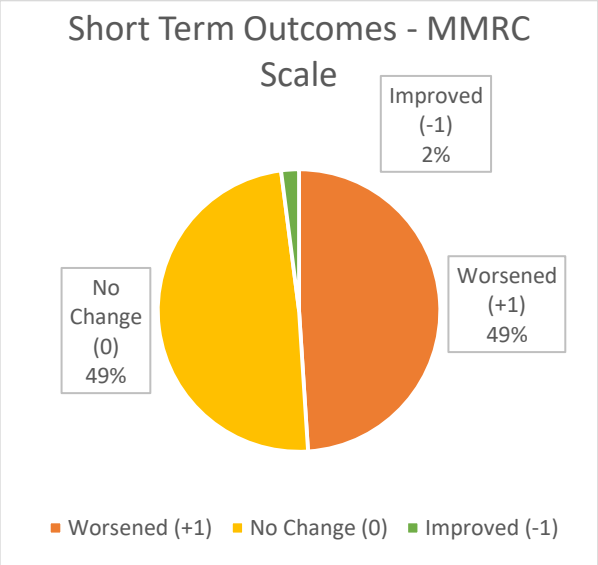

Figure 15: Short Term Outcomes - MMRC Scale

3.6 Analysis of Determinants associated with prolonged duration of hospital stay (≥7 days)

Correlation analysis using Spearman's rho was utilised to identify baseline factors associated with the length of hospital stay (LOS). CAT score showed a weak positive correlation with prolonged hospital stay ($\rho = 0.279$, $p = 0.050$), indicating that patients with a higher baseline symptom burden were more likely to have a prolonged stay of 7 days or more. While comorbidity count showed a notable trend toward longer hospitalization ($\rho = 0.266$, $p = 0.062$), factors such as age, mMRC score, and baseline FEV1 did not show significant correlations with the duration of hospital stay. (Table 21)

Table 21: Spearman correlations (ρ) applied for the analysis of determinants associated with prolong hospital stay

Baseline Factor	Correlation with Length of Hospital Stay (LOS)	p-value	n
Spearman Correlation (ρ)			
mMRC Score	0.204	0.155	50
CAT Score	0.279	0.050	50
Baseline FEV1 Value	-0.129	0.381	48
Comorbidity Count	0.266	0.062	50
Pearson Correlation (ρ)			
Age	-0.080	0.582	50

**. Correlation is significant at the 0.01 level (2-tailed).

Age is calculated via Pearson correlation given that both parameters are linear and not skewered with extreme outliers

3.6.1 NIV Requirement Vs Length of Hospital stay

The analysis Independent-Samples Kruskal-Wallis Test)demonstrated a statistically significant association between the use of Non-Invasive Ventilation (NIV) and the length of hospital stay (LOS) (H=16.334, p < 0.001). (Table 22)

Table 22: Independent-Samples Kruskal-Wallis test applied for analysis of use of NIV vs LOS (length of stay)

Independent-Samples Kruskal-Wallis Test Summary	
Total N	50
Test Statistic	16.334[a,b]
Degree Of Freedom	1
Asymptotic Sig.(2-sided test)	.000
a. The test statistic is adjusted for ties.	
b. Multiple comparisons are not performed because there are less than three test fields.	

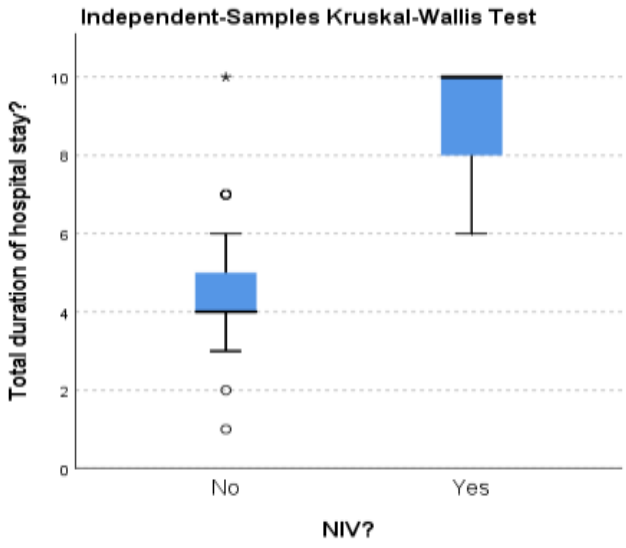

Figure 16: Box-Plot Chart of LOS vs NIV Usage

4. Discussion

The study cohort comprised 50 patients with AECOPD, of whom male predominance and advanced age were unique, as expected. Additionally, they come from low socioeconomic backgrounds, namely farming, masonry, driving, and manufacturing occupations. High pack years of smoking denote causative understanding of COPD in Sri Lanka, and the lack of vaccination against both influenza and pneumococci is an eye-opener for the authorities to commence the vaccination programme that will be cost-effective in the end. Assessment of severity on admission using the CAT score, mMRC score, and GOLD spirometry grades in the study cohort identified exacerbation severity. In keeping with the study's main objective, the identification of respiratory tract infections, exposure to air pollutants, and weather/climate changes as exacerbating factors is the main highlight. Furthermore, prompt in-hospital management with standard care, including noninvasive ventilation, led to satisfactory recovery in all patients despite varying hospital stay durations. The cohort follow-up on an individual patient basis revealed further deterioration in patients' respiratory reserve, a novel finding in this study.

4.1 Demography & exacerbating factors

The demographic profile of this cohort, predominantly comprising elderly males with significant smoking exposure, is consistent with regional and global COPD trends and reflects historical smoking patterns in Sri Lanka. National epidemiological data indicate that COPD disproportionately affects older males who carry the cumulative burden of prolonged tobacco exposure established prior to modern tobacco control measures (11).

A notable feature of this cohort was the high proportion of patients engaged in physically demanding occupations, particularly construction work (30%) and farming (16%). COPD in these individuals is likely multifactorial, reflecting an "occupational double hit" from prolonged tobacco exposure combined with chronic inhalation of occupational organic and inorganic particles. Sijapati et al. demonstrated that such workplace exposures independently accelerate respiratory function decline, even beyond the effects of smoking alone (12).

As many patients come from low socioeconomic backgrounds, the patients tend to substitute effective treatments with cheaper, less potent oral alternatives. In addition, financial constraints are likely associated with a lack of proper follow-up and lower health literacy, as well as poor inhaler techniques, leading to the majority of patients receiving only suboptimal management. As noted by Dassanayaka et al. (2020), these economic barriers are not merely financial constraints; they are primary drivers of the clinical instability and frequent hospital readmissions seen in this population. (13)

This cohort demonstrated a high baseline symptom burden and markedly impaired functional capacity, with 86% classified as GOLD Group E, a mean baseline FEV1 of 43.5%, mMRC mode of 2, and mean CAT score of 21.52, consistent with the "frequent exacerbator" phenotype. The combination of advanced age, severe airflow limitation, and high symptom burden likely contributed to the observed 60% re-exacerbation rate during follow-up.

Respiratory tract infections were the predominant precipitating factor for AECOPD, consistent with global evidence identifying viral and bacterial pathogens such as influenza and H. influenzae as major triggers of acute airway inflammation (14). A major concern in this cohort was the low vaccination coverage, with 68% remaining unvaccinated despite evidence that influenza vaccination can reduce severe illness and mortality in COPD patients by nearly 50% (15). Pneumococcal vaccination similarly reduces the risk of community-acquired pneumonia, a common trigger of respiratory failure in AECOPD, making the low vaccination uptake in this vulnerable cohort a significant gap in preventive care (15).

In this cohort, 52% of patients reported significant exposure to air pollution as a precipitating factor for AECOPD, consistent with evidence linking pollutants such as SO_2 and PM_{10} to increased COPD-related hospital admissions, particularly during cooler seasons (16). These findings suggest marked airway susceptibility to environmental changes, with studies showing that short-term increases in AQI pollutants such as $PM_{2.5}$ and NO_2 are associated with a rise in COPD-related hospitalisations within 0–5 days of exposure (17). In many Sri Lankan homes, burning firewood releases high levels of particulate matter and carbon monoxide, causing airway damage as destructive as tobacco smoke. (18) This specific pathology, marked by thicker airway walls and pigment deposits, may make patients less responsive to standard inhalers. (16)

Previous hospitalisation is recognised as a strong predictor of future readmissions, reflecting persistent clinical instability and inadequate support systems, a phenomenon often described as the "frequent flyer" effect (19). In this cohort, 84% of patients had a prior history of exacerbations, which was further reflected by the high 3-month re-exacerbation rate of 60% following discharge.

4.2 Inpatient health care: Response to standard treatment, predictors of length of stay (LOS)

The favourable response to standard inpatient treatment in this cohort, with no acute-phase mortality and universal clinical, radiological, or biochemical improvement, reflects the effectiveness of established AECOPD management protocols within the tertiary care setting. All patients required nebulisation therapy, while most received oral or intravenous antibiotics (84%) and 38% required oxygen supplementation. Although the

majority were stabilised with standard pharmacological and oxygen therapy, 16% required non-invasive ventilation (NIV), and only 2% required ICU admission, indicating that early ward-based intervention and NIV were largely effective in controlling exacerbation severity. These findings support the effectiveness of standard AECOPD management protocols in the tertiary care setting.

Requirement for non-invasive ventilation (NIV) was a significant predictor of prolonged hospital stay ($H=16.334$, $p<0.001$), reflecting greater exacerbation severity and the presence of hypercapnic respiratory failure requiring slower clinical recovery. This observation is consistent with findings by Steer et al., where severe dyspnoea and acidaemia, key components of the DECAF score, were identified as strong predictors of prolonged hospitalisation and adverse outcomes in AECOPD (20).

Comorbidities were associated with a trend toward prolonged hospital stay ($p = 0.062$), suggesting the impact of multimorbidity on clinical recovery. As described by Roberts et al., coexisting conditions such as hypertension, dyslipidaemia, and diabetes complicate AECOPD management by increasing the likelihood of concurrent cardiac and respiratory instability, thereby prolonging stabilisation and recovery time (21). Furthermore, ischemic heart disease shares common inflammatory pathways with COPD and may itself be precipitated during exacerbations, contributing to poorer clinical outcomes (22).

A key finding of this study was that higher CAT scores significantly predicted prolonged hospital stay ($p = 0.050$), indicating that patients with greater baseline symptom burden, including chronic cough, sputum production, and sleep disturbance, required longer recovery periods, often exceeding seven days. While factors such as age, baseline FEV1, and mMRC score are standard markers of severity, their lack of statistical significance here may be attributable to our limited sample size.

These findings suggest that prolonged hospital stay is driven more by baseline symptom burden and exacerbation severity than by age or baseline lung function alone, highlighting the CAT score as a useful predictor of hospital stay duration. Although only one patient required ICU admission and survived, previous studies indicate that ICU-level exacerbations are associated with poorer long-term prognosis despite favourable short-term survival when reversible causes are appropriately treated (23).

4.3 Outpatient follow-up: Deterioration of respiratory reserve

The most critical finding of this study is the decline of respiratory function (FEV1, mMRC, and CAT scores) observed in patients three months post-discharge. While these individuals achieved enough clinical stability to be discharged, the follow-up data reveal a statistically significant decline in both their lung function and overall health status. Wedzicha *et al.* 2017 describe the post-exacerbation period as a distinct and "unstable" phase characterised by a physiological recovery that lags considerably behind the initial clinical improvement. (24) This phenomenon is well-documented. The "clinical cure" leading to hospital discharge often masks persistent airway inflammation and underlying systemic stress, resulting in a false perception of clinical stability at discharge despite incomplete physiological restoration. (24)

Our findings align with the "failure to recover" model, which suggests that a significant number of COPD patients do not regain their pre-exacerbation health status. According to Perera et al. (2025), these acute exacerbations lead to a permanent stepwise decline in lung function that remains throughout the long-term course of the disease. (25)

Also, according to Gaude et al. (2015), patients requiring hospitalisation for an acute event exhibit a significantly higher mortality risk relative to those managed in a community setting. This increased risk of mortality persists for several months following the initial exacerbation episode, highlighting the prolonged physiological fragility. (26)

4.4 The post-discharge deterioration: Mechanisms of decline

In this cohort, the short-term mean FEV1 decline of 5.9% (t=+8.43, P<0.001) within just three months is a significant finding. Longitudinal evidence from the ECLIPSE study demonstrates that patients who frequently experience exacerbations undergo a more rapid decline in lung function, approximately 40ml/year, compared with 30ml/year in those without exacerbations. (27) This accelerated physiological decline is likely driven by small airway involvement and increased air trapping initiated during the acute phase. Wedzicha and Seemugal (2007) suggest that the inflammatory cascade triggered by an exacerbation frequently persists in the distal airways, maintaining significant airflow limitation even after central airway symptoms have resolved. (28)

Worsening of CAT scores in our cohort in the short-term outcome, marked by a mean increase of 3.18 points (t=-7.48, P<0.001), reflects the failure of health-related quality of life to recover. As noted by Gunasekera et al. (2025), the psychological impact paired with physical deconditioning during hospital stay ensures that symptom perception remains high long after the acute exacerbation has resolved. This confirms that true recovery from exacerbation requires addressing both the physical and functional aspects of the illness. (11)
Notably, the deterioration observed across all key parameters, including the 5.9% decline in mean FEV1, the 3.18 points rise in mean CAT score, and the mean increase in mMRC, was statistically significant. ($p < 0.05$).

With 42(84%) of our patients reporting a history of prior events, this cohort predominantly represents the 'frequent exacerbator' phenotype. The literature confirms that this is a stable, distinct trait, in which patients who experience frequent exacerbations are highly likely to follow the same pattern in the future, independent of their GOLD stage severity (29). This was validated by our findings, which showed a significant 30 (60%) re-exacerbation rate within 3 months.

However, it is important to recognise that this cycle of deterioration is not solely determined by respiratory function. As Hurst et al. (2010) established, this susceptibility is also driven by systemic predispositions such as a history of gastroesophageal reflux (GERD), a lower baseline quality of life, and higher white cell counts. (29) Thus, it becomes a necessity that the management strategy should extend beyond the respiratory system to address the patient's total health profile.

The existing literature suggests that persistent deterioration across all key parameters indicates that a COPD exacerbation is a systemic rather than a localised respiratory event. Hurst et al. (2022) describe that inflammatory biomarkers such as Fibrinogen and IL-6 frequently remain elevated in patients with recurrent exacerbations, and also acute exacerbations trigger a "spillover" of inflammatory mediators, including TNF-alpha and IL-8, into the systemic circulation, leading to overall functional decline, which goes beyond the respiratory decline. (30)

4.5 Obstacles to optimal follow-up in Sri Lanka

The short-term post-discharge deterioration and high re-exacerbation rates documented in this study must be viewed in parallel to the structural and economic challenges within the Sri Lankan healthcare system. While international GOLD guidelines provide a standard for the management, a significant "implementation gap" exists.

Preventive care is severely hindered by the lack of availability. GOLD guidelines advocate for a set of vaccines for COPD patients, including Influenza, Pneumococcal, COVID-19, Pertussis, shingles, and RSV vaccines as a first line of defence. However, these are not readily available within the government sector. These patients, many of whom are from low-income backgrounds, cannot afford vaccines at cost, making them vulnerable to infectious triggers that drive 30- 60% of hospital re-admissions.

The discordance between global standards and local availability is most evident in inhaler therapy. The dual bronchodilator combinations (LAMA/LABA) recommended as the standard for frequent exacerbators are not currently available in Sri Lanka. Currently, the government sector primarily provides ICS/LABA (Inhaled Corticosteroid / Long-Acting Beta-Agonist) and separate LAMA (Long-Acting Muscarinic Antagonist)

combinations. While these are available, they are often not the ideal first-line choice for all COPD phenotypes. Because these fixed-dose combinations often contain a higher ICS dose than what is typically recommended for COPD, patients may be paradoxically made more prone to developing pneumonia. This is a significant concern for a population of frequent Exacerbators.

Sri Lanka's public health system offers commendable support in some areas, yet gaps remain for the most severe cases of COPD. Long-term Oxygen Therapy (LTOT) and Pulmonary Rehabilitation are provided free of charge in the government sector, offering pivotal support for many patients with COPD. In contrast, Non-Invasive Ventilation (NIV) for stable COPD patients with chronic hypercapnia, a treatment proven to reduce mortality and re-hospitalisation, is not provided freely in the government sector. Advanced interventions such as Lung Volume Reduction Surgery (LVRS) and lung transplantation are rarely used in Sri Lanka. This leaves patients with end-stage disease with very few options to halt their decline.

Advanced therapies for advanced COPD such as Roflumilast or newer biologic treatments (e.g., Dupilumab), which are designed to break the cycle of chronic inflammation, have not yet been integrated into the local formulary.

For many from low socioeconomic backgrounds, the struggle is purely financial. When essential medications are not provided by the government, they opt for suboptimal management. The follow-up setting is also hindered by low health literacy, and many patients struggle with poor inhaler technique, especially among the poor socio-economic group.

Beyond the physiological mechanisms of decline, it is critical to recognize that this universal deterioration is fueled by a combination of socioeconomic and structural barriers unique to the Sri Lankan healthcare landscape.

5. Conclusion

This study highlights that AECOPD in Sri Lanka predominantly affects a high-risk population of elderly males with advanced disease, significant smoking exposure, poor baseline respiratory function, and considerable socioeconomic vulnerability. Respiratory tract infections were the leading exacerbating factor, while low vaccination coverage, biomass fuel exposure, poor inhaler technique, and suboptimal medication compliance further contributed to disease instability. Standard inpatient management, including nebulization, antibiotics, oxygen therapy, and early use of NIV, achieved excellent short-term outcomes with zero in-hospital mortality. However, higher baseline CAT scores and NIV requirement were associated with prolonged hospital stay, reflecting greater exacerbation severity and symptom burden. Despite successful acute stabilisation, significant deterioration in respiratory function and symptom burden was observed within three months following discharge, with worsening FEV1, CAT, and mMRC scores together with high re-exacerbation rates. These findings emphasise that AECOPD is not merely an acute respiratory event but a marker of ongoing systemic and functional decline. Strengthening preventive strategies, vaccination coverage, inhaler education, pulmonary rehabilitation, and structured post-discharge follow-up may help reduce recurrent exacerbations and progressive respiratory deterioration among COPD patients in Sri Lanka.

6. Recommendations

To break the cycle of "respiratory deterioration" and improve the life trajectory of patients with COPD in Sri Lanka, the following multidisciplinary strategies can be recommended:

Early identification and guideline-based management of AECOPD should be strengthened through specialised respiratory care and structured post-discharge follow-up, particularly during the high-risk first three months after discharge. A multidisciplinary approach addressing respiratory disease, cardiovascular comorbidities, systemic inflammation, and nutritional status is essential for improving outcomes. Optimisation of pharmacotherapy according to GOLD recommendations, including greater access to LAMA/LABA dual bronchodilator therapy, should be prioritised, while primary healthcare services should be strengthened to

facilitate early COPD detection and risk-factor identification. Preventive strategies should focus on improving vaccination coverage against influenza, pneumococcus, COVID-19, RSV, and pertussis among COPD patients. Patients should be educated on minimising exposure to biomass fuel smoke, occupational dust, and air pollution, while broader public health policies targeting reduction of ambient pollutants such as $PM_{2.5}$ and NO_2 are also needed. Comprehensive patient education programmes should emphasise early recognition of exacerbation symptoms, adherence to long-term therapy, and correct inhaler technique through repeated demonstrations during clinic visits. Culturally appropriate health education materials may further improve health literacy and medication compliance. Expansion of supportive services, including free access to essential COPD medications, community-based pulmonary rehabilitation programmes, and selected use of domiciliary non-invasive ventilation (NIV) for stable hypercapnic patients, may help reduce recurrent exacerbations, hospital readmissions, and progressive functional decline.

7. Limitations

While this study provides critical insights into AECOPD in a tertiary care setting and the post-discharge trajectory of COPD patients in Sri Lanka, it is not without limitations.

First, the research was conducted within a resource-limited tertiary care setting, where there is scarcity of ICU beds, the limited availability of Non-Invasive Ventilation (NIV) machines, and the lack of access to specialized medications (such as biologics or LAMA/LABA inhalers) may influence clinical decision making, inward management and discharge timelines in ways that differ from resource-rich settings.

Furthermore, the study's statistical power was constrained by its sample size and the five-month data collection period. (sampling done by consecutive non-probability sampling method as per the inclusion criteria). Specifically, when assessing the determinants of length of stay(LOS), the CAT score and NIV use emerged as significant predictors of the length of stay (LOS); other clinical markers, such as age, comorbidities, and baseline FEV1, did not reach statistical significance. It is highly probable that in a larger, multi-centre population studied over a longer duration, these variables might show a significant correlation with hospital stay and recovery.

The relatively short follow-up window of three months also means that the observed "universal deterioration" may not capture long-term disease fluctuations or the potential for late-phase recovery in some patients.

The study relied on patient-reported data for elements such as medication compliance, smoking history, and biomass fuel exposure, which introduces the possibility of recall bias.

Lastly, as the study was conducted at a single tertiary centre in Kandy, the findings reflect specific regional environmental and occupational patterns such as farming and masonry that may not be fully generalizable to the entire Sri Lankan population.

8. References

1. Lin P, Shen C, Li Q, Huang Y, Zhou J, Lu Y, et al. A systematic review and meta-analysis of chronic obstructive pulmonary disease in asia: risk factors for readmission and readmission rate. BMC Pulm Med [Internet]. 2024 Dec 1 [cited 2025 Jun 27];24(1). Available from: https://pubmed.ncbi.nlm.nih.gov/39129020/
2. Müllerova H, Maselli DJ, Locantore N, Vestbo J, Hurst JR, Wedzicha JA, et al. Hospitalized exacerbations of COPD: Risk factors and outcomes in the ECLIPSE cohort. Chest [Internet]. 2015 Apr 1 [cited 2025 Jun 27];147(4):999–1007. Available from:

https://www.sciencedirect.com/science/article/abs/pii/S0012369215389480

3. Hoogendoorn M, Feenstra TL, Hoogenveen RT, Al M, Mölken MR van. Association between lung function and exacerbation frequency in patients with COPD. Int J Chron Obstruct Pulmon Dis. 2010;5:435–44.

4. De Miguel-Díez J, Hernández-Vázquez J, López-De-Andrés A, Álvaro-Meca A, Hernández-Barrera V, Jiménez-García R. Analysis of environmental risk factors for chronic obstructive pulmonary disease exacerbation: A case-crossover study (2004- 2013). PLoS One [Internet]. 2019 May 1 [cited 2025 Jun 27];14(5). Available from: https://pubmed.ncbi.nlm.nih.gov/31120946/

5. Choi JY, Kim KJ, Rhee CK. Change in exacerbation rate of COPD patients before and after COVID-19 infection. Sci Rep [Internet]. 2025 [cited 2025 Jun 29];15(1):2427. Available from: https://doi.org/10.1038/s41598-025-86426-9

6. Taddei L, Malvisi L, Hui DS, Malvaux L, Samoro RZ, Lee SH, et al. Airway pathogens detected in stable and exacerbated COPD in patients in Asia-Pacific. ERJ Open Res [Internet]. 2022;8(3). Available from: http://dx.doi.org/10.1183/23120541.00057-2022

7. Venkatesan P. GOLD COPD report: 2024 update. Vol. 12, The Lancet. Respiratory medicine. 2024. p. 15–6.

8. Parikh R, Shah TG, Tandon R. COPD exacerbation care bundle improves standard of care, length of stay, and readmission rates. Int J COPD. 2016;11(1):577–83.

9. Gavish R, Levy A, Dekel OK, Karp E, Maimon N. The Association Between Hospital Readmission and Pulmonologist Follow-up Visits in Patients With COPD. Chest [Internet]. 2015 Aug 1 [cited 2025 Jun 29];148(2):375–81. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0012369215503334

10. Agustí A, Edwards LD, Rennard SI, Macnee W, Tal-Singer R, Miller BE, et al. Persistent Systemic Inflammation is Associated with Poor Clinical Outcomes in COPD: A Novel Phenotype. [cited 2025 Jun 29]; Available from: www.plosone.org

11. Gunasekera, K. *et al.* (2025) "Chronic obstructive Pulmonary Disease (COPD) in non-smoking Sri Lankan adults; a cross-sectional study," *BMC Research Notes*, 18(1), p. 84. Available at: https://doi.org/10.1186/s13104-025-07146-x.

12. Sijapati, M. *et al.* (2014) "Study of Factors Determining Outcomes in the Hospitalized Patients with Acute Exacerbation of Chronic Obstructive Pulmonary Disease (COPD)," *Journal of Universal College of Medical Sciences*, 2(2), pp. 28–34. Available at: https://doi.org/10.3126/jucms.v2i2.11171.

13. Dassanayaka, I.M.M., Dayananda, K.K.V.P. and Amarasekara, T.D. (2020) "FACTORS AFFECTING ADHERENCE TO RECOMMENDED MEDICATIONS AMONG PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD) IN A SELECTED TEACHING HOSPITAL, SRI LANKA," *International Journal of Research -GRANTHAALAYAH*, 7(9), pp. 16–29. Available at: https://doi.org/10.29121/granthaalayah.v7.i9.2019.553.

14. Qian, Y. *et al.* (2023) "Analyses of Factors Associated with Acute Exacerbations of Chronic Obstructive Pulmonary Disease: A Review," *International Journal of Chronic Obstructive Pulmonary Disease*, Volume 18, pp. 2707–2723. Available at: https://doi.org/10.2147/COPD.S433183.

15.Montserrat-Capdevila, J. *et al.* (2016) "Risk factors for exacerbation in chronic obstructive pulmonary disease: a prospective study," *The International Journal of Tuberculosis and Lung Disease*, 20(3), pp. 389–395. Available at: https://doi.org/10.5588/ijtld.15.0441.

16.Zhang, H. *et al.* (2022) "Effect of pulmonary rehabilitation in patients with chronic obstructive pulmonary disease: a systematic review and meta-analysis of randomized controlled trials," *Annals of Medicine*, 54(1), pp. 262–273. Available at: https://doi.org/10.1080/07853890.2021.1999494.

17.Andreas, S. *et al.* (2019) "Decline of COPD exacerbations in clinical trials over two decades – a systematic review and meta-regression," *Respiratory Research*, 20(1), p. 186. Available at: https://doi.org/10.1186/s12931-019-1163-2.

18.Kumarihamy, R.M.K. and Tripathi, N.K. (2019) "Geostatistical predictive modeling for asthma and chronic obstructive pulmonary disease using socioeconomic and environmental determinants," *Environmental Monitoring and Assessment*, 191(S2), p. 366. Available at: https://doi.org/10.1007/s10661-019-7417-0.

19.Bahadori, K. and FitzGerald, J.M. (no date) "Risk factors of hospitalization and readmission of patients with COPD exacerbation – systematic review," *International Journal of COPD* [Preprint].

20. Steer, J., Gibson, G.J. and Bourke, S.C. (2010) "Predicting outcomes following hospitalization for acute exacerbations of COPD," *QJM*, 103(11), pp. 817–829. Available at: https://doi.org/10.1093/qjmed/hcq126.

21. Roberts, C.M. *et al.* (2011) "Co-morbidities and 90-day Outcomes in Hospitalized COPD Exacerbations," *COPD: Journal of Chronic Obstructive Pulmonary Disease*, 8(5), pp. 354–361. Available at: https://doi.org/10.3109/15412555.2011.600362.

22. Mahesh, B. *et al.* (2018) "Quality of life and its associated factors among patients with COPD before and after an exacerbation in Sri Lanka," *Journal of the College of Community Physicians of Sri Lanka*, 24(2), p. 66. Available at: https://doi.org/10.4038/jccpsl.v24i2.8146

23.Quintana, J.M. *et al.* (2014) "Predictors of Hospital Admission Two Months after Emergency Department Evaluation of COPD Exacerbation," *Respiration*, 88(4), pp. 298–306. Available at: https://doi.org/10.1159/000365996.

24. Wedzicha, J.A. *et al.* (2017) "Management of COPD exacerbations: a European Respiratory Society/American Thoracic Society guideline," *European Respiratory Journal*, 49(3), p. 1600791. Available at: https://doi.org/10.1183/13993003.00791-2016.

25.Perera, C. *et al.* (2025) "How to culturally adapt the pulmonary rehabilitation programme for people living with COPD in Sri Lanka: a qualitative study," *BMJ Open Respiratory Research*, 12(1), p. e002407. Available at: https://doi.org/10.1136/bmjresp-2024-002407.

26.Gaude, G. *et al.* (2015) "Outcomes associated with acute exacerbations of chronic obstructive pulmonary disorder requiring hospitalization," *Lung India*, 32(5), p. 465. Available at: https://doi.org/10.4103/0970-2113.164150.

27.Hatipoglu, U.S. and Aboussouan, L.S. (2016) "Treating and preventing acute exacerbations of COPD," *Cleveland Clinic Journal of Medicine*, 83(4), pp. 289–300. Available at: https://doi.org/10.3949/ccjm.83a.14188.

28. Wedzicha, J.A. and Seemungal, T.A. (2007) "COPD exacerbations: defining their cause and prevention," *The Lancet*, 370(9589), pp. 786–796. Available at: https://doi.org/10.1016/S0140-6736(07)61382-8.

29. Hurst, J.R. *et al.* (2010) "Susceptibility to Exacerbation in Chronic Obstructive Pulmonary Disease," *New England Journal of Medicine*, 363(12), pp. 1128–1138. Available at: https://doi.org/10.1056/NEJMoa0909883.

30. Hurst, J.R. *et al.* (2022) "Prognostic risk factors for moderate-to-severe exacerbations in patients with chronic obstructive pulmonary disease: a systematic literature review," *Respiratory Research*, 23(1), p. 213. Available at: https://doi.org/10.1186/s12931-022-02123-5.

9. FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

10. CONFLICT OF INTEREST

The authors declare no conflict of interest.