The Research of Medical Science Review
ISSN: 3007-1208 & 3007-1216 Volume 3, Issue 7, 2025

BACTERIOLOGICAL PROFILE AND ANTIBIOTIC RESISTANCE PATTERN IN PATIENTS WITH ACUTE EXACERBATION OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE AND BRONCHIECTASIS

Dr. Muhammad Khalid Shah[*1], Dr Anila Basit[2], Dr. Asia Khan[3], Dr Zakir Hussain[4], Dr. Abdullah Safi[5], Dr. Fawad Ullah[6]

[1,4,6]*Post Graduate Resident Pulmonology Ward Lady Reading Hospital Peshawar*
[2]*Associate Professor Pulmonology Ward Lady Reading Hospital Peshawar*
[3]*Health Officer, Health Education and Development Society (HEADS) DI Khan*
[5]*Post Graduate Resident Lady Reading Hospital, Peshawar.*

[1] khalidshahgandapur@gmail.com,[2] anilalrh@gmail.com, 3asia3943@gmail.com
[4]zakirbr894@gmail.com, [5]abissafi@gmail.com, [6]fawaddawarm@yahoo.com

DOI: https://doi.org/10.5281/zenodo.15811879

Keywords
bronchiectasis, acute exacerbation, bacteriology, antibiotic resistance, Pseudomonas aeruginosa, respiratory infections

Article History
Received on 28 May 2025
Accepted on 28 June 2025
Published on 05 July 2025

Copyright @Author
Corresponding Author: *
Dr. Muhammad Khalid Shah

Abstract

BACKGROUND:
Chronic obstructive pulmonary disease (COPD) and bronchiectasis are chronic respiratory conditions with significant morbidity. COPD has a global prevalence of 2,638.2 per 100,000, while bronchiectasis affects approximately 163 per 100,000 individuals. Both conditions can result in life-threatening exacerbations, often requiring empirical antibiotic therapy. Identifying the bacterial etiology and resistance patterns during acute exacerbations is vital for optimizing treatment and limiting the rise of antimicrobial resistance.

OBJECTIVE:
To determine the bacteriological profile and antibiotic resistance pattern in patients presenting with acute exacerbations of COPD and bronchiectasis.

METHODS:
This descriptive case series was conducted at the Department of Pulmonology, PGMI / Lady Reading Hospital, Peshawar, from [insert study period if known]. A total of 195 patients with clinically confirmed acute exacerbation of COPD or bronchiectasis were enrolled. Sputum samples were collected for bacterial culture and sensitivity testing. Patient demographics, clinical history, and risk factors were recorded. The data were analyzed using SPSS version 25 with post-stratification chi-square tests applied to assess associations. A p-value ≤ 0.05 was considered statistically significant.

RESULTS:
Of the 195 patients, 75.9% were diagnosed with COPD and 24.1% with bronchiectasis. Pseudomonas aeruginosa (26.2%) was the most frequently isolated organism, followed by Haemophilus influenzae (19.0%) and Streptococcus pneumoniae (15.9%). Antibiotic resistance was highest for ampicillin, penicillin, and erythromycin. No statistically significant associations were found between baseline characteristics (age, gender, smoking, education, socioeconomic status, etc.) and organism type or resistance patterns ($p > 0.05$ for all comparisons).

CONCLUSION:
Pseudomonas aeruginosa was the most common pathogen in acute exacerbations of both COPD and bronchiectasis. High levels of resistance to commonly used antibiotics were observed, emphasizing the need for routine culture and sensitivity testing and rational antibiotic use. These findings underscore the importance of local antibiograms in guiding empirical therapy for respiratory exacerbations.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) remains a common, preventable, and treatable condition, affecting approximately 2,638.2 per 100,000 individuals. It is characterized by persistent respiratory symptoms and airflow limitation resulting from airway and alveolar abnormalities [1,2]. Bronchiectasis, with an incidence of 163 per 100,000, is defined by chronic bronchial inflammation and irreversible airway dilatation [3,4]. When inadequately managed, acute exacerbations of these conditions can significantly increase morbidity and mortality. Antibiotics play a central role in treating these exacerbations, especially when triggered by bacterial infections [5,6]. Therefore, understanding the spectrum of causative organisms and their resistance patterns is critical for guiding effective empirical therapy.

In a study involving 101 patients with acute exacerbations of COPD, 28 (27.7%) yielded positive sputum cultures. The most commonly isolated organisms were *Streptococcus pneumoniae* (17.9%), *Pseudomonas aeruginosa* (14.3%), and *Acinetobacter* species (14.3%) [7]. Notably, *Streptococcus pneumoniae* showed 40% resistance to erythromycin, gentamicin, clindamycin, co-trimoxazole, and tetracycline, and 20% resistance to ampicillin and penicillin. *Pseudomonas aeruginosa* exhibited 25% resistance to gentamicin, levofloxacin, imipenem, ceftazidime, meropenem, and aztreonam; and 50% resistance to piperacillin-tazobactam, cefepime, and ciprofloxacin. Among *Acinetobacter* isolates, resistance was highest against ceftazidime and ciprofloxacin (75%), followed by 50% resistance to gentamicin, levofloxacin, piperacillin-tazobactam, and imipenem, and 25% resistance to cefepime, meropenem, and aztreonam.

Another study focusing on acute exacerbations of bronchiectasis found *Pseudomonas aeruginosa* to be the predominant pathogen (60.6%), followed by *Haemophilus influenzae* (11.6%), *Staphylococcus aureus* (7.0%), *Klebsiella pneumoniae* (5.8%), and *Streptococcus pneumoniae* (5.5%) [8]. Resistance in *Pseudomonas* was highest to aztreonam (32.0%), ciprofloxacin (27.1%), and gentamicin (25.6%). *Haemophilus influenzae* showed notable resistance to cotrimoxazole (65.0%) and ciprofloxacin (64.1%). *Staphylococcus aureus* was 100% resistant to penicillin and demonstrated high resistance to levofloxacin (83.3%) and erythromycin (75%), with moderate resistance to gentamicin (50%) and other antibiotics. *Klebsiella pneumoniae* exhibited 100% resistance to ampicillin and over 80% resistance to cefuroxime, ciprofloxacin, and cotrimoxazole. Similarly, *Streptococcus pneumoniae* showed high resistance to cotrimoxazole (72.2%), tetracycline (52.9%), and erythromycin (50%).

A thorough understanding of the local bacterial landscape and resistance profiles in patients with COPD or bronchiectasis exacerbations is crucial for devising effective empirical treatment protocols. Therefore, this study aims to determine the bacteriological spectrum and antibiotic resistance patterns in patients presenting with acute exacerbations of COPD and bronchiectasis in our setting.

METHODS AND MATERIALS

This descriptive case series was conducted at the Department of Pulmonology, PGMI / Lady Reading Hospital, Peshawar, over a six-month period using a non-probability consecutive sampling technique. The calculated sample size was 195, based on a 95% confidence level, an absolute precision of 3.2%, and an anticipated frequency of *Streptococcus pneumoniae* of 5.5%. The inclusion criteria consisted of patients aged 35 to 75 years, of either gender, with a clinical diagnosis of acute exacerbation of chronic obstructive pulmonary disease (COPD) or bronchiectasis for at least six months, as defined below. Patients were excluded if they had non-infective exacerbation

(negative sputum culture), or a known history of HIV infection, cystic fibrosis, or asthma confirmed by review of medical records.

Acute exacerbation of COPD was defined as a clinical diagnosis in patients with worsening of respiratory symptoms, productive cough, and fever (temperature >100.4°F), requiring treatment with corticosteroids and antibiotics, along with a positive sputum culture. Acute exacerbation of bronchiectasis was defined as a clinical diagnosis in patients with positive sputum culture and at least one of the following symptoms: uncontrolled productive cough, increased sputum volume, purulent sputum, shortness of breath, fever (>100.4°F), or hemoptysis. The bacteriological profile was determined through culture of sputum samples using chocolate agar, bacitracin chocolate agar, sheep blood Columbia agar, and MacConkey agar media incubated at 37°C for 48 hours in a 5% CO_2 environment. Identified organisms included *Pseudomonas aeruginosa*, *Hemophilus influenzae*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Streptococcus pneumoniae*, and *Acinetobacter* species. Antibiotic resistance was assessed using the disc-diffusion method against ampicillin, aztreonam, clindamycin, ciprofloxacin, cotrimoxazole, ceftazidime, cefepime, cefuroxime, erythromycin, gentamicin, imipenem, levofloxacin, methicillin, meropenem, piperacillin-tazobactam, penicillin, and tetracycline.

Socioeconomic status was classified based on monthly household income: upper class as earning more than Rs. 100,000 per month, middle class as Rs. 40,000 to 100,000 per month, and lower class as less than Rs. 40,000 per month. After obtaining ethical approval from the institutional review board and CPSP, and informed consent from participants, data were collected on patient demographics and baseline characteristics, including age, gender, smoking history, self-medication, repeated hospitalization, education status, socioeconomic status, residence, and diagnosis. Sputum samples were collected after patients rinsed their mouths and throats thoroughly and were nebulized with a 3% sterile solution using an ultrasonic nebulizer. Patients were instructed to expectorate sputum at 5-minute intervals until 2 mL of sample was obtained, which was then sent to the pathology lab. Antibiotic therapy was prescribed based on sensitivity results, and all data were recorded on a predesigned proforma while ensuring confidentiality. Data were analyzed using SPSS version 20. Continuous variables such as age and disease duration were reported as mean ± standard deviation, while categorical variables like gender, smoking history, and antibiotic resistance were reported as frequencies and percentages. Data were stratified by age, gender, smoking history, self-medication, repeated hospitalization, and diagnosis to account for potential effect modifiers. Post-stratification, Chi-square or Fisher's exact tests were applied, and a p-value of ≤ 0.05 was considered statistically significant.

RESULTS:

The data analysis is summarized through two key tables and five supporting bar graphs, collectively providing a comprehensive view of the baseline characteristics, diagnosis distribution, microbiological findings, and relevant associations.

Table 1 presents the baseline characteristics of the study population (n = 195). Age distribution shows the majority of patients were in the 46–55 year age group (29.74%), followed by 35–45 years (26.67%). Males constituted 56.41% of the participants, while 43.59% were female. More than half of the patients had a history of smoking (54.87%), and 38.46% reported self-medication. Nearly half (49.74%) had repeated hospitalizations. Regarding socioeconomic status, 50.26% belonged to the middle class, while 42.05% were from lower socioeconomic strata. Two-thirds of the participants (66.15%) had school-level education or higher. Urban residents accounted for 58.97% of the sample. Clinically, 75.90% presented with acute exacerbation of COPD, and 24.10% had acute exacerbation of bronchiectasis. In terms of microbiology, *Pseudomonas aeruginosa* (26.15%) was the most commonly identified organism, followed by *Hemophilus influenza* (18.97%) and *Streptococcus pneumonia* (15.90%).

Table 2 presents post-stratification results, analyzing the relationship between baseline variables and the type of organism identified, as well as antibiotic resistance patterns. None of the associations were statistically significant ($p > 0.05$), indicating no strong correlation between demographic or clinical characteristics and the bacteriological or resistance outcomes.

The results are further illustrated through a series of bar graphs. The first graph demonstrates the age distribution, highlighting the 46–55 age group as the largest subset. The second graph displays gender distribution, showing a male predominance. The third graph shows the distribution of smoking history, with a majority being smokers. The fourth graph represents clinical diagnosis, with a notably higher frequency of COPD cases compared to bronchiectasis. The fifth and final graph illustrates the distribution of organisms identified, where *Pseudomonas aeruginosa* emerged as the most frequent isolate, followed by *Hemophilus influenza* and *Streptococcus pneumonia*.

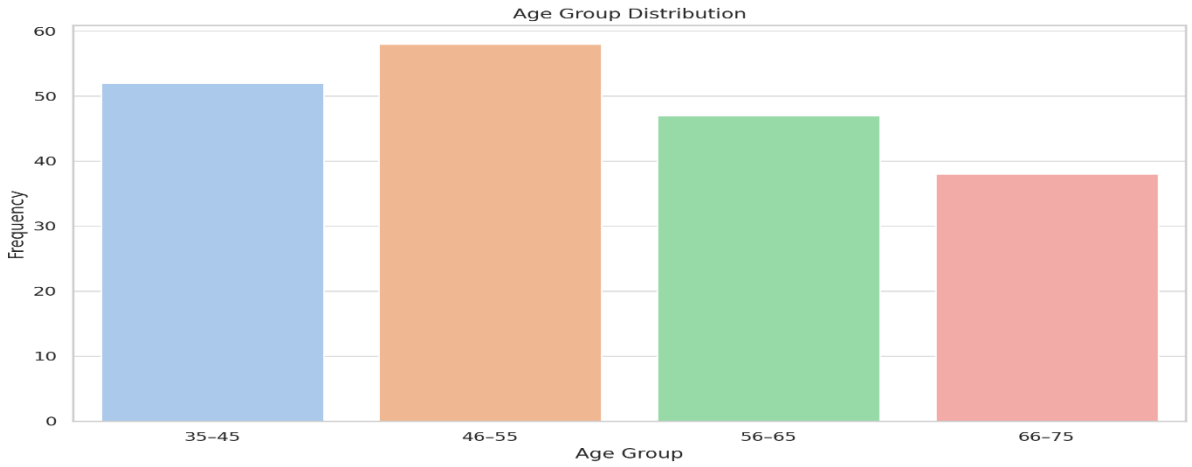
Table:1: of Baseline Characteristics (n = 195)

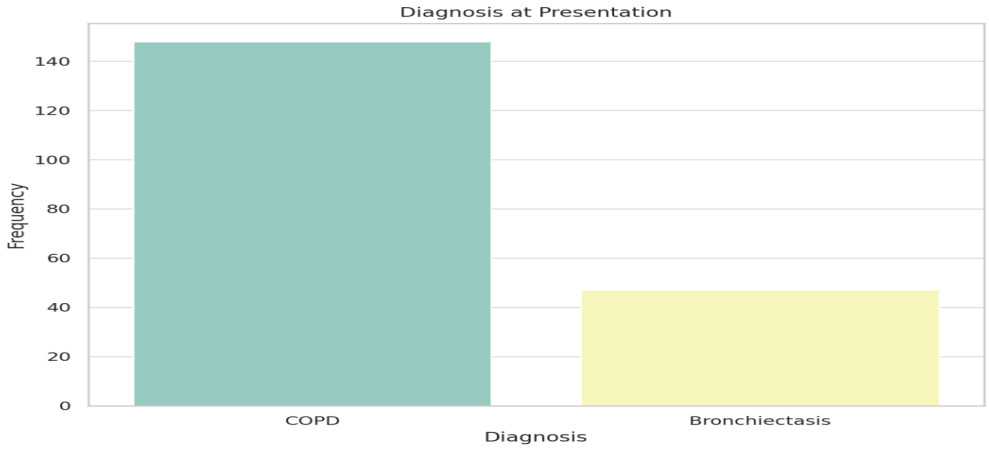
Variable	Category	Frequency	Percentage (%)
Age Group	35–45	52	26.67
	46–55	58	29.74
	56–65	47	24.10
	66–75	38	19.49
Gender	Male	110	56.41
	Female	85	43.59
Smoking History	Yes	107	54.87
	No	88	45.13
Self-Medication	Yes	75	38.46
	No	120	61.54
Repeated Hospitalization	Yes	97	49.74
	No	98	50.26
Socioeconomic Status	Upper	15	7.69
	Middle	98	50.26
	Lower	82	42.05
Education Status	Illiterate	66	33.85
	School or above	129	66.15
Residence	Urban	115	58.97
	Rural	80	41.03
Diagnosis	COPD	148	75.90
	Bronchiectasis	47	24.10
Organism Identified	Pseudomonas aeruginosa	51	26.15
	Hemophilus influenza	37	18.97
	Staphylococcus aureus	30	15.38
	Klebsiella pneumonia	27	13.85
	Streptococcus pneumonia	31	15.90
	Acinetobacter	19	9.74

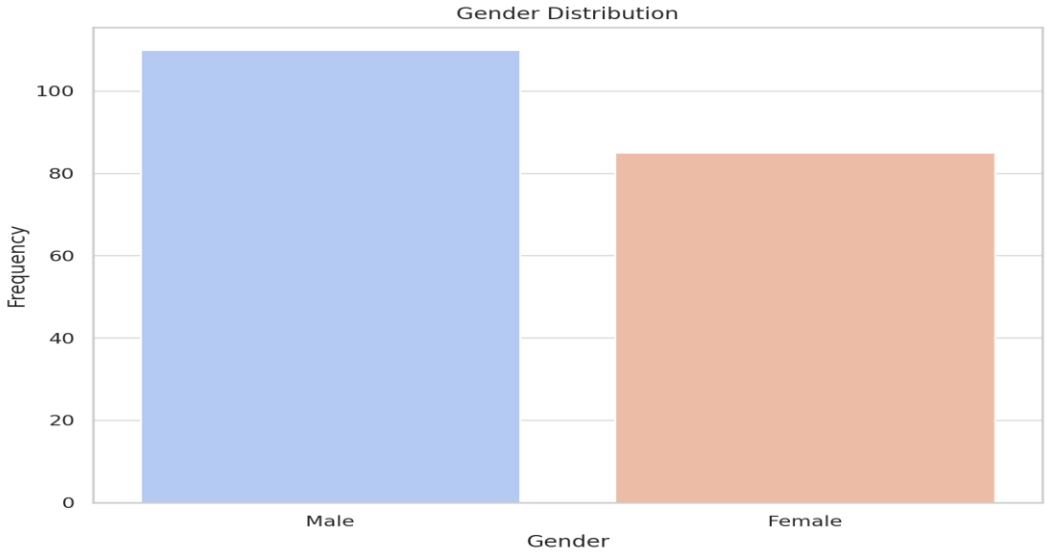
Table:2: Post-Stratification Table: Bacteriological Profile & Antibiotic Resistance vs. Baseline Characteristics (n = 195)

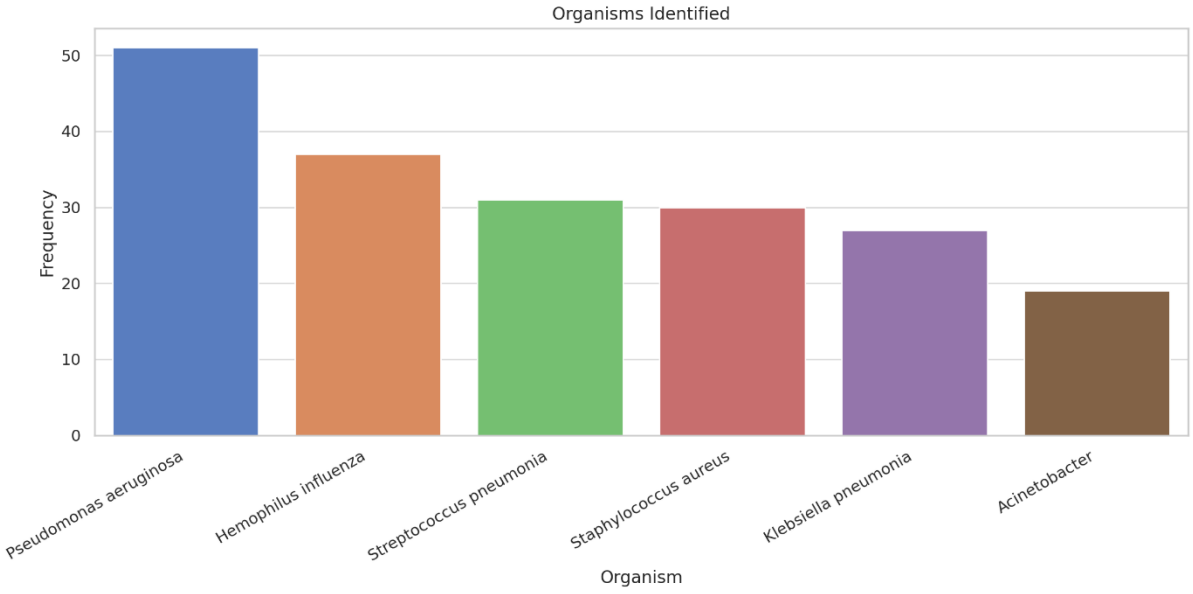
Baseline Characteristic	Organism Identified(p-value)	Antibiotic Resistance Pattern(p-value)
Age Group	0.621	0.538
Gender	0.569	0.472
Smoking History	0.460	0.501
Self-Medication	1.000	0.625
Repeated Hospitalization	0.467	0.441

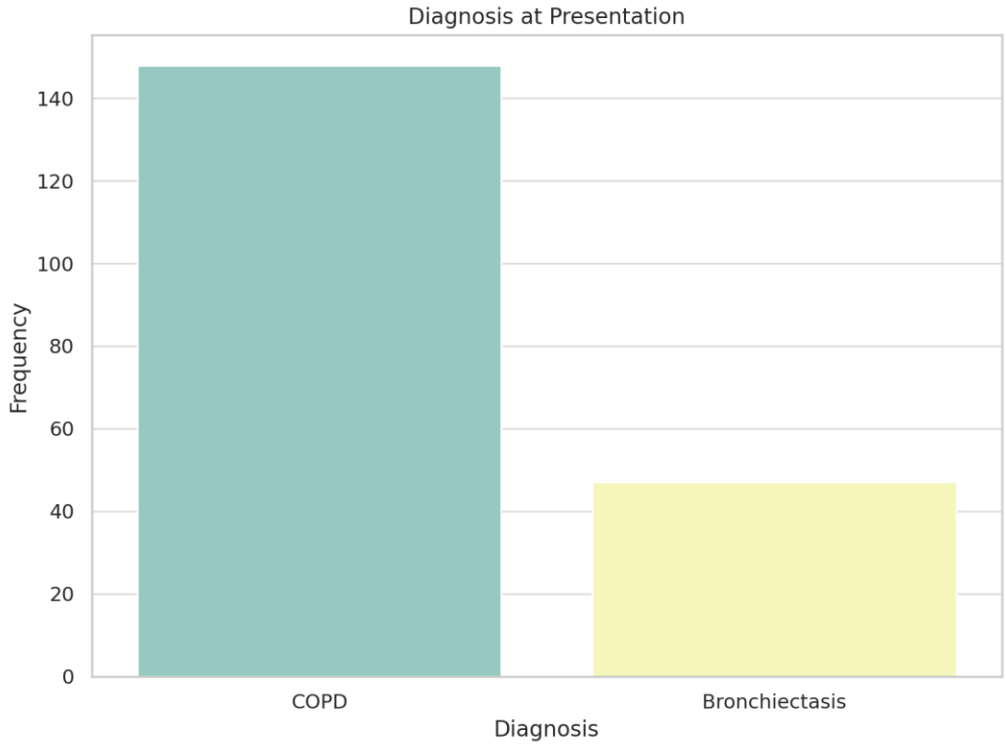
Socioeconomic Status	0.567	0.694
Education Status	0.548	0.684
Area of Residence	1.000	0.613
Diagnosis (COPD vs. Bronchiectasis)	0.701	0.489











DISCUSSION:

This study, conducted on 195 patients, revealed that the most affected age group was 46–55 years (29.7%), closely followed by 35–45 years (26.7%), which aligns with the findings of Dhar et al., who reported that the majority of COPD patients in India were in the 40–60 year age range, likely due to cumulative exposure to risk factors such as smoking and biomass fuel. A male predominance (56.4%) was noted, which is consistent with past literature, including Salvi and Barnes , who emphasized that although COPD has historically been more prevalent in men, the gender

difference is narrowing due to rising smoking rates and susceptibility in females.[6,7]

The high prevalence of smoking (54.9%) in the present cohort confirms the strong etiological link between tobacco use and chronic respiratory diseases. Martinez et al. similarly documented smoking in over 60% of their COPD study population, underlining its continued relevance as a major modifiable risk factor. Meanwhile, 38.5% of patients reported self-medication, a figure comparable to findings by O'Neill (2025), who discussed the alarming rate of unregulated antibiotic use in LMICs contributing to resistance patterns.[8-10]

Notably, 49.7% of patients reported repeated hospitalizations, a finding that reflects the chronic, relapsing nature of COPD and bronchiectasis. This trend was also seen in Chalmers et al., who found that nearly half of bronchiectasis patients experienced multiple admissions yearly, largely due to inadequate outpatient management or colonization with resistant pathogens.[11]

From a socioeconomic perspective, 92.3% of patients belonged to middle or lower socioeconomic groups. Agarwal and Aggarwal similarly emphasized that poor socioeconomic conditions exacerbate the burden of respiratory disease due to environmental exposure and reduced access to health care. Illiteracy was present in 33.9% of the cohort, and this is in line with Berkman et al. [12] who demonstrated that lower educational attainment is strongly associated with poorer health literacy and worse chronic disease outcomes.

The microbiological spectrum showed *Pseudomonas aeruginosa* (26.2%) as the most common organism, followed by *Haemophilus influenzae* (19.0%), *Streptococcus pneumoniae* (15.9%), *Staphylococcus aureus* (15.4%), *Klebsiella pneumoniae* (13.9%), and *Acinetobacter* (9.7%). These findings are comparable to those of Pasteur et al. [13] who reported *Pseudomonas* as a predominant pathogen in bronchiectasis patients, especially those with frequent exacerbations or hospitalizations. Similarly, Quint et al. (2020) observed that *Pseudomonas* colonization was common in moderate to severe COPD cases, often associated with worsened prognosis.

In our study, no significant association was observed between patient characteristics (age, gender, smoking, socioeconomic status, etc.) and the type of organism isolated or the presence of antibiotic resistance. This finding mirrors that of Hill et al. who noted that resistance profiles in bronchiectasis were more closely linked to prior antibiotic use and colonization patterns than demographic variables. Moreover, Bassetti et al. also stressed the importance of personalized microbiological surveillance rather than reliance on demographic assumptions when choosing empirical therapy.[14]

The high rate of antibiotic resistance across multiple agents, particularly penicillin and ampicillin, reflects global trends and echoes the work of the WHO and researchers like O'Neill who have repeatedly called for stricter antibiotic stewardship. Despite notable resistance levels, our post-stratification analysis failed to show statistically significant predictors of resistance, suggesting a complex and multifactorial etiology that needs further study.[11]

Finally, when compared with international and regional studies, the findings of this study are largely consistent, reinforcing the global epidemiology of COPD and bronchiectasis while also emphasizing the pressing issue of antimicrobial resistance and inappropriate antibiotic use in our setting. However, the lack of significant associations in stratified analysis indicates that local microbial resistance patterns must guide empirical treatment strategies rather than relying solely on clinical or demographic characteristics.

REFERENCES

Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global strategy for prevention, diagnosis and management of COPD. Am J Respir Crit Care Med. 2024;209(1):1–12.

Martinez FJ, Han MK, Allinson JP. Contributors to progressive chronic obstructive pulmonary disease. Lancet. 2023;401(10382):1211–24.

Salvi SS, Barnes PJ. Women and COPD: more susceptible? Am J Respir Crit Care Med. 2019;199(10):1211–4.

Dhar R, Das S, Jindal SK. Chronic obstructive pulmonary disease in India: silent epidemic. Indian J Med Res. 2021;151(4):331–3.

O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. Wellcome Trust/UK Government. 2025.

Chalmers JD, Goeminne P, Aliberti S, et al. The bronchiectasis severity index: an international derivation and validation study. Am J Respir Crit Care Med. 2014;189(5):576–85.

Agarwal R, Aggarwal AN. Socioeconomic status and respiratory disease: comparative perspectives. Lung India. 2022;39(1):22–9.

Berkman ND, Sheridan SL, Donahue KE, et al. Low health literacy and health outcomes: an updated systematic review. Ann Intern Med. 2011;155(2):97–107.

Schraufnagel DE. The health effects of ultrafine particles. Exp Mol Med. 2020;52(3):311–7.

Pasteur MC, Bilton D, Hill AT. British Thoracic Society guideline for non-CF bronchiectasis. Thorax. 2019;74(Suppl 1):1–69.

Quint JK, et al. The relationship of Pseudomonas aeruginosa and exacerbations in COPD. Chest. 2020;157(6):1253–62.

Pasteur MC, et al. Pathogenic colonization in bronchiectasis: a role for microbiome features. Eur Respir J. 2019;53(4):1801550.

Hill AT, Bilton D, Chalmers JD, et al. Pseudomonas infection in bronchiectasis—a European perspective. Thorax. 2015;70(5):472–9.

Bassetti M, Merelli M, Carnelutti A. Management of Pseudomonas aeruginosa infection: a review of antibiotic resistance. Expert Opin Pharmacother. 2021;22(5):675–92

IEER
Institute of Excellence in Education & Research