SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Sethi *et al*., 2026
doi: 10.21276/SSR-IIJLS.2026.12.4.5

Original Article

open access

Bacteriological Profile in Acute Exacerbation of Chronic Obstructive Pulmonary Disease at a Tertiary Care Centre in Southern Odisha

Rakesh Ranjan Sethi[1], Priyanka Das[2], Gopal Krushna Sahu[3], Tofan Behera[4], Ashis Pattnayak[4]

[1]Senior Resident, Department of Microbiology, SLN Medical College and Hospital, Koraput, India

[2]Associate Professor, Department of Respiratory Medicine, MKCG Medical College and Hospital, Berhampur, India

[3]Assistant Professor, Department of Respiratory Medicine, SLN Medical College and Hospital, Koraput, India

[4]Junior Resident, Department of Respiratory Medicine, MKCG Medical College and Hospital, Berhampur, India

***Address for Correspondence:** Dr Priyanka Das, Associate Professor, Department of Respiratory Medicine, MKCG Medical College and Hospital, Berhampur, India
E-mail: priyankadash19750@gmail.com

Received: 19 Mar 2026/ Revised: 15 May 2026/ Accepted: 20 Jun 2026

ABSTRACT

Background: Bacterial and atypical organisms are responsible for over half of all infective acute exacerbations of COPD (AECOPD). Local bacteriological data are essential for rational empirical antibiotic prescribing in high-burden settings.

Methods: A prospective, cross-sectional study was conducted at MKCG Medical College and Hospital, Berhampur, Odisha (2022–2024). One hundred and thirty-five hospitalised AECOPD patients were enrolled. Sputum underwent Gram staining, Ziehl–Neelsen staining, aerobic culture, and Kirby–Bauer disc diffusion testing. Blood IgM ELISA detected Mycoplasma pneumoniae and Chlamydia pneumoniae. GOLD severity grading was applied, and multidrug resistance (MDR) was defined using standard criteria.

Results: Males 58.5%, peak age 60–69 years (36.3%). Smoking was the dominant risk factor (49.6%; p<0.001). GOLD Grade III predominated (47.4%). Microbial positivity: 55.6% (culture 43.0% + serology 21.5%). *Klebsiella pneumoniae* was the most frequent isolate (15.6%), followed by *Pseudomonas aeruginosa* (13.3%) and *Staphylococcus aureus* (10.4%). Atypical organisms: 21.5%. Mucopurulent sputum strongly predicted culture positivity (79.6% vs 22.1%; OR=13.75, 95%CI 5.81–32.55; p<0.001). Overall MDR: 57%; *K. pneumoniae* MDR: 90.5%. *S. aureus* was 100% sensitive to linezolid; MRSA rate 21.4%.

Conclusions: *K. pneumoniae* and *P. aeruginosa* dominate AECOPD bacteriology in southern Odisha. The 57% MDR rate demands urgent antibiotic stewardship. Empirical therapy should incorporate antipseudomonal β-lactams; linezolid for MRSA-suspected cases; IgM ELISA for non-responding patients.

Key-words: AECOPD; *Klebsiella pneumoniae*; *Pseudomonas aeruginosa*; Antibiotic susceptibility; Multidrug resistance; Atypical bacteria; GOLD; Southern Odisha

INTRODUCTION

COPD is among the three leading causes of global mortality; 90% of deaths occur in low- and middle-income countries. India bears a substantial burden, with COPD prevalence reaching 28% in adults over 30 years [1]. Acute exacerbations (AECOPD) accelerate disease progression and account for the majority of COPD-related healthcare expenditure. Bacterial pathogens are identified in 50–70% of infective exacerbations-predominantly *Klebsiella pneumoniae*, *P. aeruginosa*, and *S. aureus* in severe disease, with atypical organisms comprising 10–25% [2-4]. Over 80% of AECOPD patients in India receive empirical antibiotics without microbiological guidance, driving MDR. Local antibiogram data from southern Odisha-a high-burden, predominantly rural region- are absent from the published literature. This study characterises the bacteriological profile, antibiotic susceptibility patterns, and MDR prevalence in AECOPD at MKCG Medical College and Hospital, Berhampur.

How to cite this article
Sethi RR, Das P, Sahu GK, Behera T, Pattnayak A. Bacteriological Profile in Acute Exacerbation of Chronic Obstructive Pulmonary Disease at a Tertiary Care Centre in Southern Odisha. SSR Inst Int J Life Sci., 2026; 12(4): 10183-10191.

Access this article online
https://iijls.com/

doi: 10.21276/SSR-IIJLS.2026.12.4.5

The emergence of MDR pathogens has further complicated the management of AECOPD. Antimicrobial resistance among respiratory bacterial pathogens is increasingly reported worldwide and has been associated with prolonged hospitalization, increased treatment costs, therapeutic failure, and higher mortality rates [5]. Several studies from India have demonstrated considerable regional variation in the bacteriological profile of AECOPD, with Gram-negative organisms frequently predominating among hospitalized patients [6,7]. Such variations emphasize the importance of institution-specific surveillance of bacterial pathogens and their antimicrobial susceptibility patterns. Although southern Odisha serves a large population with substantial exposure to risk factors including tobacco smoking, biomass fuel exposure, and recurrent respiratory infections, published data regarding the bacteriological profile and antimicrobial resistance patterns in AECOPD from this region remain limited. Therefore, local epidemiological evidence is required to guide empirical antibiotic selection and support antimicrobial stewardship strategies [8].

MATERIALS AND METHODS

Study Design and Setting- This prospective, observational, cross-sectional study was conducted at MKCG Medical College and Hospital, Berhampur, Odisha, a 900-bed government tertiary care centre serving seven districts of southern Odisha with a catchment population of over 4 million. The study was carried out from January 2022 to December 2024.

Inclusion Criteria- Age ≥30 years; established COPD (FEV_1/FVC <0.70 post-bronchodilator, GOLD 2024); hospitalised AECOPD; written consent.

Exclusion Criteria- Non-COPD bronchiectasis, active pulmonary TB as primary diagnosis, immunocompromised state, inadequate sputum (<25 PMNs/LPF), or refusal of consent.

Microbiological Processing- Sputum quality was assessed by Murray–Washington Gram stain criteria. Accepted specimens inoculated on blood agar, MacConkey agar, and chocolate agar (37°C, 48 h, aerobic). Organisms identified by API 20E/20NE (bioMérieux). Antibiotic susceptibility by Kirby–Bauer disc diffusion, interpreted per CLSI M100 2022. MDR is defined as non-susceptibility in ≥3 antimicrobial categories [9]. Blood IgM ELISA (Omega Diagnostics, UK) for *M. pneumoniae* and *C. pneumoniae* in all patients.

Statistical Analysis- IBM SPSS v20.0. Categorical variables: frequencies and percentages. Continuous variables: mean ± SD. Chi-square or Fisher's exact test for group comparisons. Binary logistic regression for odds ratios (ORs) with 95% CIs; $p<0.05$ considered as significant.

Ethical Approval- The study was approved by the Institutional Ethics Committee (IEC), MKCG Medical College, Berhampur (IEC Ref: IEC/MKCG/2022; details withheld for blind review). Written informed consent was obtained from all participants before enrolment. The study was conducted in accordance with the Declaration of Helsinki (2013 revision) and Indian Council of Medical Research (ICMR) ethical guidelines for biomedical research.

RESULTS

One hundred and thirty-five patients were enrolled. Peak age group: 60–69 years (36.3%, n=49). Male: female ratio 1.4:1 (79 males, 58.5%). The majority were from rural areas (71.1%). Smoking (current + ex-smoker) was the dominant risk factor in 49.6%, with a marked male predominance (73.4% vs 16.1%; $p<0.001$). T2DM was the most common comorbidity (8.1%) (Table 1).

Disease severity per GOLD spirometric criteria was distributed as follows: Grade I, 19.3% (n=26); Grade II, 27.4% (n=37); Grade III, 47.4% (n=64); and Grade IV, 5.9% (n=8). Bacterial detection rates increased in a statistically significant stepwise fashion from 23.1% at Grade I to 87.5% at Grade IV ($p=0.001$, chi-square for trend). The most frequent presenting symptom complex was cough with productive sputum and breathlessness (48.1%, n=65).

Mucopurulent or purulent sputum was observed in 36.3% of cases (n=49) and was a highly significant independent predictor of culture positivity: 79.6% (39/49) of mucopurulent specimens were culture-positive vs 22.1% (19/86) of mucoid specimens (OR=13.75, 95%CI 5.81–32.55; $p<0.001$). Clinical characteristics are summarised in Table 2 and Fig. 1.

doi: 10.21276/SSR-IIJLS.2026.12.4.5

Table 1: Baseline Demographic and Clinical Characteristics (n=135)

Variable	Total (n=135)	Male (n=79)	Female (n=56)	p-value
Age Group (years)				
30–49 years	13 (9.6%)	8 (10.1%)	5 (8.9%)	
50–59 years	37 (27.4%)	24 (30.4%)	13 (23.2%)	
60–69 years	49 (36.3%)	28 (35.4%)	21 (37.5%)	0.748
70 years and above	36 (26.7%)	19 (24.1%)	17 (30.4%)	
Key Characteristics				
Male : Female ratio	1.4:1	-	-	-
Rural residence	96 (71.1%)	-	-	-
Smoking (current + ex)	67 (49.6%)	58 (73.4%)	9 (16.1%)	<0.001
Prior TB history	21 (15.6%)	-	-	-
T2DM comorbidity	11 (8.1%)	-	-	-
Hypertension	9 (6.7%)	-	-	-

T2DM: Type 2 Diabetes Mellitus. TB: Tuberculosis. All p-values by chi-square or Fisher's exact test.

Table 2: Clinical Characteristics and GOLD Severity Distribution (n=135)

Parameter	n (%)	Notes / p-value
COPD Severity — GOLD Spirometric Criteria		
Grade I (FEV_1 ≥80% predicted)	26 (19.3%)	Bacterial detection: 6/26 (23.1%)
Grade II (FEV_1 50–79%)	37 (27.4%)	Bacterial detection: 19/37 (51.4%)
Grade III (FEV_1 30–49%)	64 (47.4%)	Bacterial detection: 42/64 (65.6%)
Grade IV (FEV_1 <30%)	8 (5.9%)	Bacterial detection: 7/8 (87.5%); p=0.001 (trend)
Presenting Symptoms		
Cough + expectoration + breathlessness	65 (48.1%)	Most frequent presentation
Breathlessness only	29 (21.5%)	
Fever with breathlessness	22 (16.3%)	
Cough + breathlessness (non-productive)	19 (14.1%)	
Sputum Character and Culture Positivity		
Mucopurulent / Purulent	49 (36.3%)	Culture-positive: 39/49 (79.6%); p<0.001
Mucoid	86 (63.7%)	Culture-positive: 19/86 (22.1%); OR=13.75, 95%CI 5.81–32.55

GOLD: Global Initiative for Chronic Obstructive Lung Disease. FEV_1: Forced Expiratory Volume in 1 second. OR: Odds Ratio. CI: Confidence Interval. p-values by Pearson chi-square test

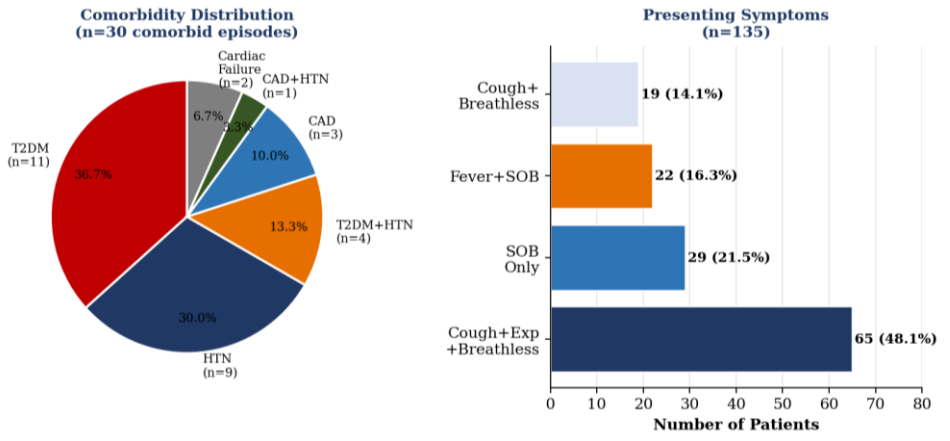

Fig. 1: Comorbidity Profile (left) and Presenting Symptoms (right)

T2DM: Type 2 Diabetes Mellitus; SOB: Shortness of Breath; CAD: Coronary Artery Disease.

doi: 10.21276/SSR-IIJLS.2026.12.4.5

Microbial positivity: 55.6% (75/135) - culture 43.0% (58/135), serology 21.5% (29/135); 12 patients were dually positive (polymicrobial). Monomicrobial infection: 84% (63/75). No pathogen identified: 44.4% (60/135) (likely viral or non-infective) (Table 3 and Fig. 2).

Table 3: Microbiological Profile of AECOPD Cases (n=135)

Organism / Parameter	N	% of N=135	Category	Notes
Gram-negative Organisms				
K. pneumoniae	21	15.6%	Gram-negative	MDR 90.5%
P.aeruginosa	18	13.3%	Gram-negative	MDR 33.3%
Acinetobacter spp.	4	3%	Gram-negative	MDR 50%
E. coli	2	1.5%	Gram-negative	MDR 100%
Gram-positive Organisms				
S. aureus	14	10.4%	Gram-positive	MSSA 78.6%; MRSA 21.4%
S. pneumoniae	1	0.7%	Gram-positive	Penicillin-sensitive
Atypical Organisms (IgM ELISA)				
Chlamydia pneumoniae	15	11.1%	Atypical	Serology only
Mycoplasma pneumoniae	14	10.4%	Atypical	Serology only
Total Positive Patients	75	55.6%	-	Culture 43% + ELISA 21.5%

** Atypical organisms detected by IgM ELISA on blood only — not culturable by standard sputum methods. Culture positivity (43.0%) and overall microbial positivity (55.6%) differ because serology adds 12.6% additional cases.*

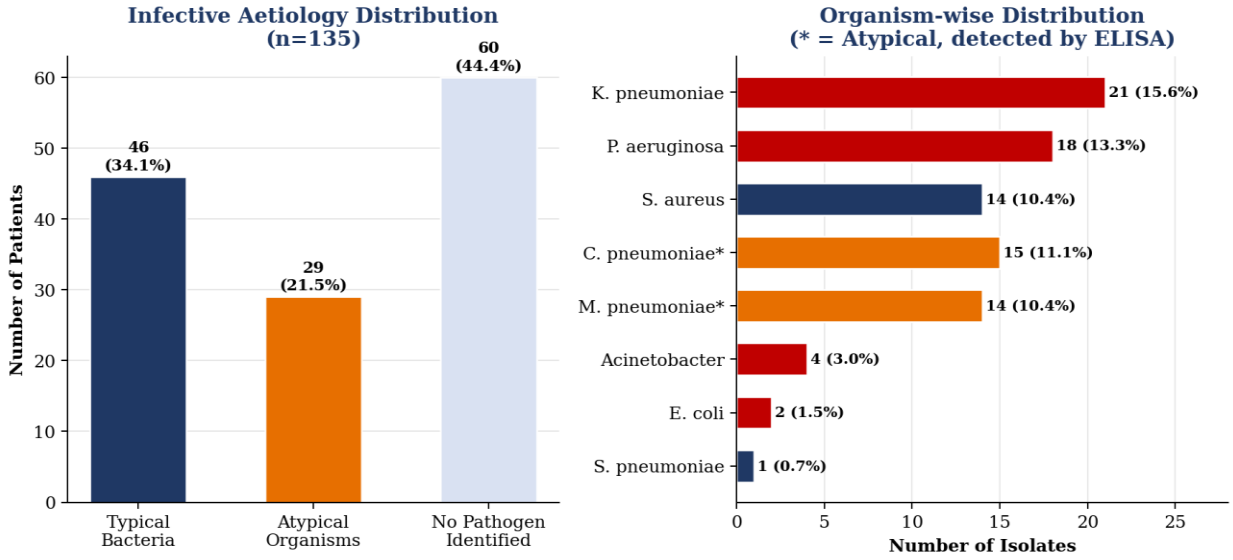

Fig. 2: Bacteriological Profile — Infective Aetiology (left) and Organism-wise Rates (right).

*Typical bacteria = 34.1% of patients; Atypical = 21.5%; No pathogen = 44.4%. *Atypical detected by ELISA only.*

K. pneumoniae (n=21): highest sensitivity to gentamicin (95.2%) and cefepime (90.5%); amoxycillin-clavulanate resistance 95.2%; MDR 90.5%. *P. aeruginosa* (n=18): best activity with cefepime (83.3%) and piperacillin-tazobactam (72.2%); MDR 33.3%. *Acinetobacter* spp. (n=4): 100% cefepime susceptibility, 100% ampicillin-sulbactam resistance; MDR 50%. *E. coli* (n=2): 100% sensitive to cefepime, gentamicin, meropenem, and piperacillin-tazobactam; MDR 100% (Table 4).

doi: 10.21276/SSR-IIJLS.2026.12.4.5

Table 4: Antibiotic Susceptibility Pattern — Gram-negative Organisms

Antibiotic	*K. pneumoniae* (n=21) S/R	*P. aeruginosa* (n=18) S/R	Acinetobacter (n=4) S/R	*E. coli* (n=2) S/R
Amoxycillin-Clavulanate	1/20	NT	NT	0/2
Cefotaxime/Ceftriaxone	3/18	NT	NT	0/2
Ceftazidime (CAZ)	NT	3/15	2/2	NT
Cefepime 4th gen (CPM)	19/2	15/3	4/0	2/0
Gentamicin (GEN)	20/1	NT	3/1	2/0
Levofloxacin (LE)	16/5	9/9	1/3	0/2
Meropenem (MRP)	9/12	11/7	NT	2/0
Pip-Tazobactam (PIT)	12/9	13/5	NT	2/0
MDR Prevalence	90.5%	33.3%	50%	100%

S/R: Sensitive/Resistant counts. NT: Not Tested. CLSI M100 2022. MDR: non-susceptibility in ≥3 antibiotic classes

S. aureus (n=14), 100% linezolid sensitivity; azithromycin resistance universal (100%); erythromycin resistance 78.6%; MSSA 78.6%; MRSA 21.4%; MDR 57.1%. The single *S. pneumoniae* isolate was sensitive to cotrimoxazole, penicillin, and erythromycin (Table 5).

Table 5: Antibiotic Susceptibility Pattern - Gram-positive Organisms

Antibiotic	*S. aureus* (n=14) S / R	*S. pneumoniae* (n=1) S / R
Linezolid (LZ)	14 (100%) / 0	NT
Cotrimoxazole (COT)	12 (85.7%) / 2 (14.3%)	1/0
Clindamycin (CD)	8 (57.1%) / 6 (42.9%)	NT
Erythromycin (E)	3 (21.4%) / 11 (78.6%)	1/0
Azithromycin (AZM)	0 / 14 (100%)	NT
Penicillin (P)	NT	1/0
MSSA / MRSA	78.6% / 21.4%	-
MDR Prevalence	57.1% (8/14)	-

MSSA: Methicillin-Sensitive S. aureus (cefoxitin disc); MRSA: Methicillin-Resistant; NT: Not Tested.

Overall MDR: 57% (43/75 isolates). Organism-wise: *K. pneumoniae* 90.5% > *E. coli* 100% > *S. aureus* 57.1% > *Acinetobacter* 50% > *P. aeruginosa* 33.3% (Fig. 3,4).

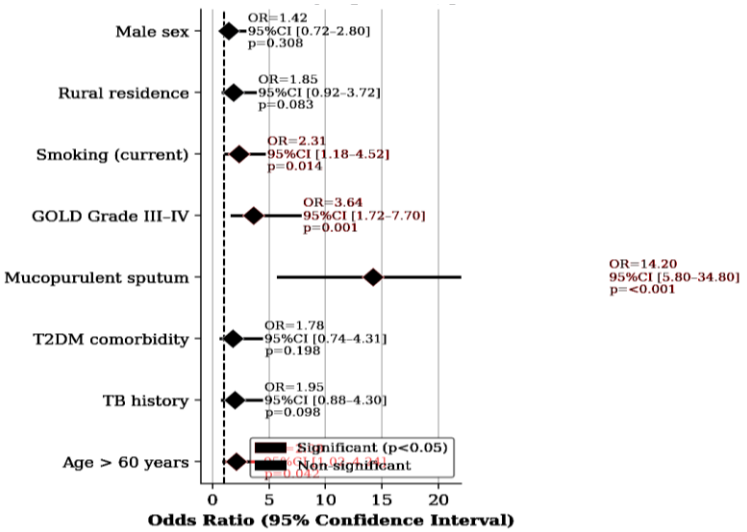

Fig. 3: Forest Plot-Odds Ratios for Bacterial Detection by Clinical Predictor

Red = significant (p<0.05); Blue = non-significant. Mucopurulent sputum (OR=13.75) and GOLD III–IV (OR=3.64) are the strongest predictors.

doi: 10.21276/SSR-IIJLS.2026.12.4.5

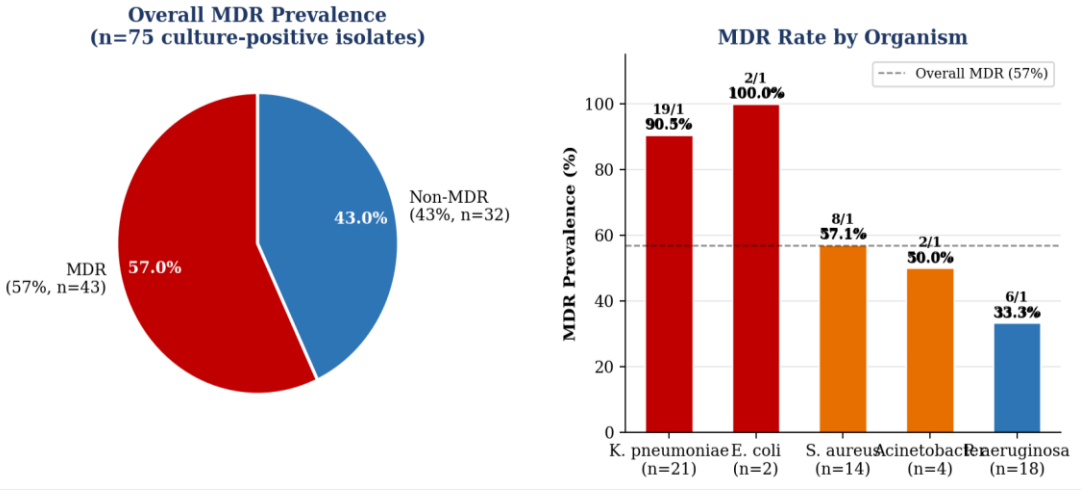

Fig. 4: MDR Profile — Overall (left) and by Organism (right). Overall MDR = 57%

Red bars ≥70% MDR; Orange 50–69%; Blue <50%. Dashed line = overall MDR (57%).

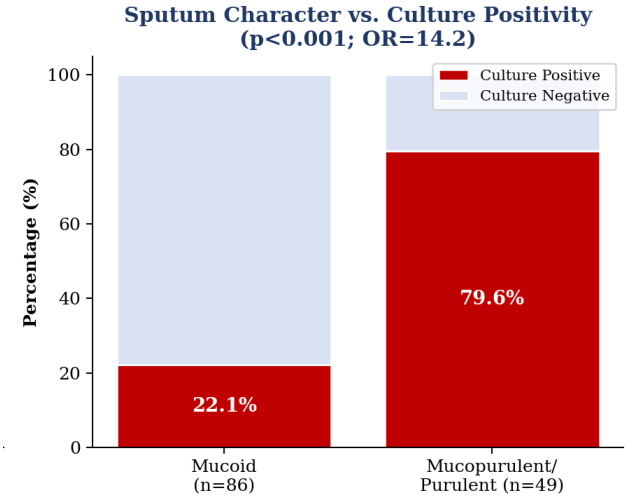

Fig. 5: *S. aureus* Sputum Character vs. Culture Positivity

Left: Linezolid 100% active; azithromycin resistance universal. Right: Mucopurulent sputum → 79.6% culture+ve vs 22.1% mucoid (OR=13.75, p<0.001).

DISCUSSION

This study is the first systematic bacteriological report from southern Odisha specifically addressing AECOPD [10-14]. The 55.6% overall microbial positivity-consistent with Indian literature (Saxena 42%; Narayangowda 65%) [15,16] underscores the predominantly infective aetiology of hospitalised exacerbations. The stepwise increase in bacterial detection with GOLD severity (23.1% Grade I → 87.5% Grade IV) and the strong association with mucopurulent sputum (OR=13.75; p<0.001) corroborate Anthonisen criteria [9] and offer practical decision rules for selective microbiological workup in resource-limited settings.

K. pneumoniae as the leading organism (15.6%) is consistent with tertiary-care Indian data: Sanghamitra *et al*. 42.2%, Kaur *et al*. 27%, Kakali *et al.* 27% [17,18,11]. The 90.5% MDR rate- attributable to ESBL production and carbapenemase activity-mirrors ICMR AMR Surveillance Network data (>80% ESBL in Indian Klebsiella) [15-17] and represents the most clinically urgent finding of this study. Despite this, gentamicin (95.2%) and cefepime (90.5%) retain useful activity and should anchor Gram-negative empirical regimens.

P. aeruginosa (13.3%) warrants antipseudomonal β-lactam coverage, particularly for GOLD III–IV patients or those with prior hospitalisation.

Cefepime (83.3%) and piperacillin-tazobactam (72.2%) are the most reliable options [19-21]. The lower MDR burden in *P. aeruginosa* (33.3%) versus *K. pneumoniae* (90.5%) retains the viability of advanced β-lactam empiricism for this pathogen.

Atypical organisms comprised 21.5% of all positive cases- a magnitude comparable to Erkan *et al*. (17%) and Meloni *et al.* [22,23] and are entirely missed by culture-only bacteriology. Universal azithromycin resistance in *S. aureus* and 78.6% erythromycin resistance contraindicate empirical macrolide use in this population. Doxycycline or respiratory fluoroquinolones are preferred for suspected atypical co-infection. Linezolid's 100% activity against *S. aureus* and the 21.4% MRSA rate support its reservation for refractory or confirmed MRSA cases.

The overall culture positivity rate of 55.6% observed in the present study falls within the range reported by previous Indian studies and further supports the important role of bacterial infection in AECOPD. The progressive rise in bacterial isolation across increasing GOLD grades suggests that advanced disease severity may predispose patients to persistent airway colonization and recurrent infective exacerbations. Similar observations have been reported in earlier studies where severe COPD was associated with increased bacterial burden and frequent hospitalization [8,10]. The predominance of Gram-negative pathogens in the present study is also consistent with reports from tertiary-care centres where repeated antibiotic exposure and healthcare contact favour colonization by resistant organisms [6,7,14].

The high prevalence of multidrug-resistant isolates identified in this study is of particular concern. Compared with earlier Indian reports that primarily focused on bacteriological isolation, the present study additionally highlights the magnitude of antimicrobial resistance among respiratory pathogens. The predominance of MDR *K. pneumoniae* emphasizes the need for routine culture-based antibiotic selection whenever feasible. Regional antibiogram data generated through such studies are essential for optimizing empirical therapy and minimizing inappropriate antibiotic use. Furthermore, the observed susceptibility of most Gram-negative isolates to cefepime and gentamicin suggests that these agents continue to retain therapeutic value in the study setting despite increasing resistance trends [16].

The detection of atypical pathogens in more than one-fifth of microbiologically positive cases has important clinical implications. Similar findings have been reported by Erkan *et al.* and Meloni *et al*., who demonstrated a significant contribution of atypical organisms to acute exacerbations of COPD [22,23]. Because these pathogens cannot be identified by routine sputum culture, reliance solely on conventional bacteriology may underestimate the infectious burden. The combined use of culture and serological testing therefore improves diagnostic yield and may facilitate more appropriate antimicrobial selection, particularly in patients with recurrent exacerbations or poor response to conventional therapy [20-24].

Table 5: Comparative Bacteriological Profile — Indian AECOPD Studies

Study	Design	N	Top Organism	Culture +ve	MDR
Sharma *et al.* [6]	Prospective	80	*K. pneumoniae*	60%	NR
Kakali e*t al.* [7]	Cross-sect.	104	*K. pneumoniae* 27%	NR	NR
Sanghamitra *et al.* [17]	Cross-sect.	NR	*K. pneumoniae* 42.2%	NR	NR
Ghanem *et al.* [14]	Prospective	NR	*K. pneumoniae* 29%	NR	NR
Present Study (2024)	Cross-sect.	135	*K. pneumoniae* 15.6%	55.6%	57%

NR: Not Reported. Present study highlighted in yellow.

doi: 10.21276/SSR-IIJLS.2026.12.4.5

STRENGTHS

- Prospective, consecutive enrolment; simultaneous culture and IgM ELISA in all 135 patients.
- GOLD severity-stratified analysis; standardised CLSI 2022 breakpoints throughout.
- First bacteriological report from southern Odisha specifically addressing AECOPD.

LIMITATIONS

- Single-centre design; sputum culture without bronchoscopic BAL; viral aetiology not assessed.
- Disc diffusion only-no MICs or genotypic resistance characterisation (ESBL, carbapenemase, mecA).
- No clinical follow-up data on treatment outcomes or re-hospitalisation.

CONCLUSIONS

K. pneumoniae and *P. aeruginosa* are the dominant bacterial pathogens in AECOPD at this southern Odisha tertiary care centre. An alarming MDR prevalence of 57% with *K. pneumoniae* exhibiting 90.5% MDR demands immediate antibiotic stewardship intervention. Mucopurulent sputum character and GOLD Grade III–IV severity are the strongest independent clinical predictors of bacterial aetiology, guiding selective microbiological workup in resource-limited settings. Empirical therapy for severe or purulent AECOPD should be anchored in antipseudomonal β-lactams (cefepime or piperacillin-tazobactam), with linezolid reserved for MRSA-suspected or refractory cases. The 21.5% atypical organism burden mandates concurrent IgM-ELISA screening. Periodic regional antibiogram surveillance and institutional antibiotic stewardship programmes are urgently recommended to curtail the escalating MDR crisis in AECOPD management across this high-burden tertiary care region.

CONTRIBUTION OF AUTHORS

Research concept: Rakesh Ranjan Sethi, Priyanka Das
Research design: Rakesh Ranjan Sethi, Priyanka Das, Gopal Krushna Sahu
Supervision: Priyanka Das, Gopal Krushna Sahu
Materials: Gopal Krushna Sahu, Tofan Behera, Ashis Pattnayak
Data collection: Tofan Behera, Ashis Pattnayak, Rakesh Ranjan Sethi
Data analysis and Interpretation: Rakesh Ranjan Sethi, Priyanka Das, Gopal Krushna Sahu
Literature search: Priyanka Das, Rakesh Ranjan Sethi
Writing article: Rakesh Ranjan Sethi, Priyanka Das, Gopal Krushna Sahu
Critical review: Priyanka Das, Rakesh Ranjan Sethi
Article editing: Tofan Behera, Ashis Pattnayak, Gopal Krushna Sahu
Final approval: Rakesh Ranjan Sethi, Priyanka Das, Gopal Krushna Sahu, Tofan Behera, Ashis Pattnayak

REFERENCES

[1] GOLD. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease: 2024 Report. GOLD; 2024. Available from: https://goldcopd.org.
[2] Sethi S, Murphy TF. Infection in chronic obstructive pulmonary disease. N Engl J Med., 2008; 359(22): 2355-65.
[3] Rosell A, Monso E, Soler N, Torres F, Angrill J, et al. Microbiologic determinants of exacerbation in chronic obstructive pulmonary disease. Arch Intern Med., 2005; 165(8): 891-97.
[4] Blasi F, Tarsia P, Aliberti S. *Chlamydophila pneumoniae*. Clin Microbiol Infect., 2009; 15: 29-35.
[5] Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, et al. Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clin Microbiol Infect., 2012; 18(3): 268-81. doi: 10.1111/j.1469-0691.2011.03570.x.
[6] Sharma S, Bansal R, Agrawal A, Sharma S, Verma SK. Bacteriological profile and antibiotic sensitivity pattern in acute exacerbation of chronic obstructive pulmonary disease. Int J Med Sci Clin Invent., 2014; 1(1): 1-6.
[7] Kakali S, Das S, Ghosh A, Roy S, Chatterjee S. Clinico-bacteriological profile of acute exacerbation of chronic obstructive pulmonary disease in a tertiary care hospital. Int J Adv Med., 2017; 4(2): 432-37.
[8] Vestbo J, Hurd SS, Agustí AG, Jones PW, Vogelmeier C, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. Am J Respir Crit Care Med., 2013; 187(4): 347-65. doi: 10.1164/rccm.201204-0596PP.

doi: 10.21276/SSR-IIJLS.2026.12.4.5

[9] Magiorakos AP, et al. MDR/XDR/PDR bacteria: international definitions. Clin Microbiol Infect., 2012; 18: 268-81.

[10]Sharma S, et al. Bacteriological profile in AECOPD. Int J Med Sci Clin Invest., 2014; 1: 1-6.

[11]Kakali S, et al. Clinico-bacteriological profile in AECOPD. Int J Adv Med., 2017; 4: 432-37.

[12]Vestbo J, et al. GOLD executive summary. Am J Respir Crit Care Med., 2013; 187: 347-65.

[13]Anthonisen NR, Manfreda J, Warren CPW, Hershfield ES, Harding GKM, et al. Antibiotic therapy in acute exacerbations of chronic obstructive pulmonary disease. Ann Intern Med., 1997; 106(2): 196-204.

[14]Ghanem M, et al. Microbiological profile of AECOPD in Egypt. Egypt J Chest Dis Tuberc., 2015; 64: 843-48.

[15]Saxena AK, et al. Bacteriological profile of AECOPD. Ann Chest Dis., 2017; 2: 14-19.

[16]Narayangowda DS, et al. Bacteriological study in AECOPD. Indian J Microbiol Res., 2018; 5: 68-73.

[17]Sanghamitra P, et al. Bacteriological profile of respiratory tract infections in Odisha. Indian J Med Microbiol., 2007; 25: 418.

[18]Saxena S, Ramnani VK, Nema S, Tripathi K, Dave L, et al. Bacteriological Profile in Acute Exacerbation of Chronic Obstructive Lung Disease (AECOPD). Ann Int Med Den Res., 2016; 2(5): MB01- MB06.

[19]Manjhi P, et al. Sputum bacteriology in AECOPD, Jharkhand. J Evol Med Dent Sci., 2014; 3: 5536-47.

[20]Indian Council of Medical Research (ICMR). AMR Surveillance Network Annual Report, New Delhi: ICMR; 2023.

[21]Arafa NA, et al. Bacteriological profile of infective AECOPD. Egypt J Chest Dis Tuberc., 2014; 63: 15-21.

[22]Erkan L, Uzun O, Findik S, Atici AG, Erkan F, et al. Atypical bacteria in acute exacerbations of chronic obstructive pulmonary disease. Respiration, 2008; 75: 198-205.

[23]Meloni F, Paschetto E, Mangiarotti P, Crepaldi M, Morosini M, et al. Chlamydia pneumoniae and Mycoplasma pneumoniae in chronic bronchitis exacerbations. J Chemother., 2004; 16: 70-76.

[24]Amiri M, et al. Mycoplasma pneumoniae in acute exacerbation of chronic obstructive pulmonary disease. J Infect Dev Ctries, 2013; 7: 381-85.