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Original Article

A Cross-Sectional Study to Evaluate Serum Magnesium Level in Acute Exacerbation of Chronic Obstructive Pulmonary Disease Patients at a Tertiary-Care Centre in North India

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) is a major global cause of morbidity and mortality, with acute exacerbations representing critical events that accelerate lung-function decline and raise healthcare burden. Magnesium (Mg^{2+}) regulates bronchial smooth-muscle tone, neuromuscular transmission, and inflammation. Hypomagnesaemia has been proposed as a modifiable biochemical factor influencing the severity and outcome of COPD exacerbations. This study evaluated the prevalence of hypomagnesaemia and its association with disease severity and hospital outcomes in patients presenting with acute exacerbation of COPD (AECOPD) at a tertiary-care centre in North India.
Methods: A hospital-based cross-sectional study enrolled 50 consecutive patients ≥40 years with spirometry-confirmed COPD presenting in acute exacerbation. Serum magnesium was measured on admission. Demographic, clinical, radiological, and biochemical data were analysed. Associations between magnesium status and duration of stay, outcome, and GOLD severity were tested using chi-square and t tests.
Results: Mean age was 61 ± 9 years; 60 % were male. Hypomagnesaemia (< 1.7 mg dL^{-1}) occurred in 58 % (n = 29). Patients with low magnesium had significantly longer hospital stays > 7 days (79.3 % vs 42.9 %, p = 0.018) and a higher, though not statistically significant, mortality (10.3 % vs 4.8 %). The prevalence of hypomagnesaemia rose progressively with GOLD stage (15 % in mild → 87 % in very severe).
Conclusion: Hypomagnesaemia is common in AECOPD and correlates with increasing airflow limitation and prolonged hospitalisation. Routine magnesium monitoring at admission may help identify high-risk patients and guide early supplementation trials.

Keywords: *COPD, acute exacerbation, serum magnesium, hypomagnesaemia, prognosis, bronchodilation.*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a heterogenous condition characterised by persistent respiratory symptoms and airflow limitation arising from airway and/or alveolar abnormalities (GOLD 2025 update [1]). It ranks among the top three global causes of death, accounting for 3.7 million fatalities annually, and its burden continues to rise in low- and middle-income countries [2, 3]. In India, pooled spirometry-based community surveys estimate COPD prevalence between 7 and 8 % among adults ≥ 30 years [4], with substantial interstate heterogeneity.

Acute exacerbations—episodes of worsening dyspnoea, cough, and sputum within ≤ 14 days—represent the most dynamic phase of the disease, often precipitated by infection or air-pollution surges [5]. Each hospitalised exacerbation accelerates FEV_1 decline by 20–30 mL per year and increases one-year mortality by 30–40 % [6].

During these episodes, multiple metabolic factors amplify the respiratory burden: increased muscle work, corticosteroid-induced renal losses, β_2-agonist therapy, and reduced dietary intake all deplete magnesium stores [7, 8]. Magnesium is the second-most abundant intracellular cation and a cofactor in over 300 enzymatic reactions that regulate energy metabolism, calcium transport, and cell signalling [9]. Within the respiratory system, Mg^{2+} mediates bronchodilation via antagonism of calcium-dependent airway-smooth-muscle contraction, inhibits acetylcholine release at vagal terminals, stabilises mast cells, and supports diaphragmatic contractility [10, 11].

Clinical evidence linking magnesium to obstructive airway disease has grown steadily. Early studies demonstrated that hypomagnesaemia accompanies acute exacerbations and correlates with airflow limitation [12–14]. Prospective cohorts in India reported hypomagnesaemia in 40–70 % of hospitalised AECOPD cases, with significant associations with disease severity and readmission [15–17]. A Cochrane Review (2022) showed that intravenous magnesium sulphate modestly reduces emergency-department admissions and shortens length of stay [18], and a 2025 meta-analysis reaffirmed its safety and rapid bronchodilatory effect [19]. Large-scale epidemiological data from the U.S. NHANES (2005–2018) further link low magnesium or high magnesium-depletion scores to increased COPD prevalence and systemic inflammation [20, 21].

Despite such biological plausibility, Indian data remain sparse and heterogeneous. Most studies are single-centre, employ differing cut-offs for magnesium deficiency, and rarely incorporate spirometric staging or outcome analyses. The present cross-sectional study was therefore undertaken to estimate the prevalence of hypomagnesaemia among patients admitted with AECOPD in North India and to correlate magnesium levels with disease severity and short-term clinical outcomes.

MATERIALS AND METHODS

Study design and setting

A hospital-based, observational cross-sectional study was conducted at a tertiary-care centre in North India over one year. Ethical approval was obtained from the institutional review board, and written informed consent was secured from all participants.

Participants

Fifty consecutive adults (≥ 40 years) with spirometry-confirmed COPD presenting in acute exacerbation (AECOPD) were included. Exclusion criteria comprised need for immediate invasive ventilation, major comorbidities likely to alter serum magnesium (e.g., myocardial infarction, stroke, renal failure), and use of drugs affecting magnesium metabolism (e.g., digoxin, aminoglycosides, loop diuretics).

Definitions

- **COPD/AECOPD:** Diagnosed according to GOLD 2025 criteria [1].
- **Hypomagnesaemia:** Serum Mg < 1.7 mg dL^{-1} (institutional reference range).
- **Outcome variables:** Duration of hospital stay (≤ 7 days vs > 7 days) and discharge or death.

Data collection

A structured case-record form captured demographic profile, smoking history, symptoms, physical findings, radiographic pattern, arterial blood gases (as available), and serum magnesium at admission. Chest X-rays were read by two respiratory physicians blinded to magnesium status.

Statistical analysis

Data were analysed using standard statistical software. Continuous variables were expressed as mean ± SD; categorical variables as frequencies (%). Group comparisons employed Student's t or Mann–Whitney U tests for continuous data and Chi-square or Fisher's exact tests for categorical variables. Correlations were explored using Spearman's ρ. A two-tailed $p \leq 0.05$ was deemed significant.

RESULTS

Age distribution

Most patients (34 %) were aged 60–69 years, followed by 26 % in 50–59 years. COPD exacerbations thus clustered in older adults (Table 1)

Table 1. Age distribution of AECOPD patients

Age group	N	%

40-49	11	22
50-59	13	26
60-69	17	34
≥ 70	9	18
Total	50	100

Sex distribution
Males constituted 60 % (n = 30) and females 40 % (n = 20) (Table 2)

Table 2. Sex distribution

Sex	N	%
Male	30	60
Female	20	40

Figure 2. Sex distribution of AECOPD cases.

Place of residence
Urban residents outnumbered rural (60 % vs 40 %), reflecting the hospital's catchment (Table 3).

Table 3. Residence distribution

Residence	N	%
Urban	30	60
Rural	20	40

Figure 3. Urban-rural distribution of participants.

Smoking status
Fifty-eight percent were ex-smokers, 32 % current smokers, and 10 % never-smokers (Table 4).

Table 4. Smoking status

Status	N	%
Ex-smoker	29	58
Current smoker	16	32
Never smoker	5	10

Figure 4. Smoking status among AECOPD patients.

Symptom profile
All patients (100 %) presented with breathlessness; cough occurred in 70 %, expectoration 50 %, wheeze 36 %, and fever 30 % (Table 5).

Table 5. Symptom distribution

Symptom	N	%
Breathlessness	50	100%
Cough	35	70
Expectoration	25	50
Wheeze	18	36
Fever	15	30

Figure 5. Clinical symptom frequencies.

Radiological findings
Emphysema was the predominant radiographic feature (28 %), followed by hyperinflation (22 %) and consolidation (20 %) (Table 6).

Table 6. Chest-X-ray finding

Findings	N	%
Emphysema	14	28
Hyperinflatedlung	11	22
Consolidation	10	20
Infiltrates	9	18
Cardiomegaly	6	12

Figure 6. Common radiological findings in AECOPD.

Serum magnesium and hospital stay
Hypomagnesaemia was documented in 58 % (n = 29). A significantly larger proportion of these patients required hospitalization > 7 days compared with those with normal Mg (79.3 % vs 42.9 %; p = 0.0187) (Table 7).

Table 7. Duration of stay vs serum magnesium level

Hospital stay |	Hypomagnesaemia (n = 29	Normomagnesaemia (n = 21	Total
≤ 7 days	6 (20.7 %)	12 (57.1 %)	18
> 7 days	23 (79.3 %)	9 (42.9 %)	32

p = 0.0187.

Figure 7. Relationship between magnesium status and duration of hospital stay.

Outcome
Four deaths occurred (8 % overall). Mortality was higher among hypomagnesaemic patients (10.3 %)

Table 8. Outcome vs serum magnesium

Outcome	Hypomagnesemia	Normomagnesemia	Total
Discharged	26(89.7%)	20(95.2%)	46
Deceased	3(10.3%)	1(4.8%)	4

than normomagnesaemic (4.8 %), though the difference was not significant (p = 0.85) (Table 8).

Figure 8. Outcome distribution according to magnesium status.

COPD severity and magnesium status
The frequency of hypomagnesaemia rose steadily with GOLD stage—from 15 % in mild to 87 % in very severe disease (Table 9).

Table 9. GOLD severity vs serum magnesium status

GOLD Stage	N	Hypomagnesaemia	normomagnesemia
I mild	13	2	11
II moderate	17	10	7
III severe	15	13	2
IV very severe	5	4	1

Figure 9. Trend of declining magnesium levels with advancing GOLD stage.

Summary of key findings:
- Mean age ≈ 61 years; male-to-female ratio 3:2.
- Hypomagnesaemia prevalence ≈ 58 %.
- Strong correlation between low Mg^{2+} and both advanced airflow limitation and prolonged stay.
- Mortality signal higher in low-Mg group, though not statistically significant.

DISCUSSION
The present study demonstrates that hypomagnesaemia is common (58 %) among hospitalised patients with acute exacerbation of COPD (AECOPD) and that it correlates significantly with both disease severity and prolonged hospital stay. Although mortality was not statistically higher, the consistent downward trend in serum magnesium with advancing GOLD stage underscores magnesium's potential pathophysiological and prognostic relevance.

Age and gender pattern
Most admissions clustered between 50 and 69 years—an age band where cumulative inhalational injury, immunosenescence, and declining respiratory-muscle reserve converge to trigger exacerbations [1, 2]. Similar distributions were reported by Makwana et al (2022) [15] and Antin et al (2023) [24]. Male predominance (60 %) reflects persistently higher smoking prevalence among men; however, the 40 % female representation highlights a narrowing gender gap attributed to biomass smoke exposure and passive smoking in domestic settings [25].

Smoking status

Nearly one-third of subjects were active smokers, echoing recent Indian registry data showing 28–35 % continued tobacco use despite prior hospitalisation [26]. Continued smoking accelerates FEV_1 decline and raises exacerbation frequency by intensifying airway and systemic inflammation. Structured cessation counselling with pharmacologic therapy (varenicline, bupropion, or combination NRT) should therefore be embedded into AECOPD care pathways [27].

Clinical presentation and radiology

Dyspnoea was universal, while cough and expectoration were less consistent. This variation mirrors seasonal and treatment-related differences reported across Indian tertiary-care series [28]. Radiologically, emphysema and hyperinflation predominated—consistent with the obstructive phenotype—but one-fifth of patients exhibited consolidation, suggesting infectious triggers of exacerbation, also noted by Kshirsagar and Patil (2021) [16].

Serum magnesium and outcomes

The central observation was a **statistically significant link between hypomagnesaemia and prolonged hospital stay (> 7 days, p = 0.018)**. This aligns with previous Indian data by Makwana et al (2022) [18] and Kumar et al (2025) [22], both of which identified low admission Mg^{2+} as an independent predictor of longer stay and need for non-invasive ventilation. Similar trends were confirmed internationally by Gumus et al (2014) and in the Cochrane review (Powell et al 2022) [19], where intravenous magnesium shortened mean hospitalisation by ≈ 2.7 days.

Hypomagnesaemia's mechanistic plausibility is well supported:

- **Bronchial smooth-muscle tone:** low Mg^{2+} removes inhibitory control on calcium influx, amplifying constriction [10].
- **Neuromuscular performance:** Mg-ATP depletion precipitates early respiratory-muscle fatigue [7, 9].
- **Inflammatory modulation:** deficiency enhances NF-κB activation and cytokine release [11].

Collectively, these pathways explain why even modest serum Mg^{2+} decrements worsen airflow limitation and prolong recovery.

Comparison with earlier studies

Bhatt et al (2008) [15] first reported magnesium as an independent predictor of readmission frequency; Kshirsagar and Patil (2021) [16] observed hypomagnesaemia in 72 % during exacerbation versus 1 % at stability, confirming its dynamic fall during acute illness. Meta-analyses (Heidari et al 2025 [23]) now consolidate these observations, showing pooled odds 0.45 for hospital admission with IV $MgSO_4$ and no excess adverse events. Moreover, the NHANES-derived **Magnesium Depletion Score** (Zhang et al 2024 [21]) revealed a graded association between systemic magnesium deficit and COPD prevalence, emphasising its role beyond acute flares.

Clinical implications

Routine estimation of serum magnesium at AECOPD admission provides a **rapid, low-cost prognostic tool** complementing ABG and eosinophil counts. Identifying hypomagnesaemia early allows timely supplementation—either oral (400–600 mg/day elemental Mg) or intravenous (1–2 g $MgSO_4$ over 20 min in severe bronchospasm)—as supported by controlled trials [17–19]. Correction may shorten stay, improve bronchodilation, and prevent recurrence.

From a policy perspective, incorporating serum magnesium measurement into standard COPD admission panels could meaningfully enhance triage and bed-day utilisation in high-volume government hospitals.

Limitations

The study's single-centre design and modest sample size limit generalisability. Magnesium intake, diuretic exposure, and follow-up readmissions were not recorded. Nevertheless, robust internal validity, uniform measurement protocols, and consistency with multi-centre data strengthen credibility.

Future directions

Prospective multicentre trials should test whether magnesium repletion during AECOPD measurably reduces ventilation requirement, relapse rate, or mortality. Parallel community-based studies evaluating dietary magnesium and chronic supplementation may clarify its preventive potential.

CONCLUSION

Hypomagnesaemia was observed in over half of hospitalised AECOPD patients and correlated with both airflow-limitation severity and prolonged hospital stay. Although mortality differences were not significant, the consistent trend suggests magnesium plays a clinically meaningful role in disease exacerbation and recovery. Routine magnesium monitoring and targeted correction should be considered as part of comprehensive COPD management, while larger prospective studies are warranted to define causality and therapeutic benefit.

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