OPEN ACCESS

ORIGINAL ARTICLE

Prevalence of Hypoxemia in Hospitalized Patients with Community-Acquired Pneumonia at Tertiary Care Hospital in Quetta

Abdul Ghaffar[1], Maqbool Ahmed Langove[2], Qudrat Ullah[3], Tahir Khan[4], Muhammad Sharif[5] and Jasim Hussain[6]

[1,2,3,4,6] Department of Pulmonology, Fatima Jinnah Institute of Chest Diseases, Quetta,
[5] Department of Pulmonology, Bolan Medical College / Hospital, Quetta

ABSTRACT

Background: Community-acquired pneumonia (CAP) is a significant cause of hospitalization and disability/mortality especially in the developing world. Hypoxemia is one of the most important signs of the severity of the disease and is linked to adverse clinical outcomes. Despite extensive research on CAP-related hypoxemia globally, limited evidence exists regarding its prevalence and associated factors among hospitalized patients in resource-limited regions of Pakistan, particularly Balochistan. Early identification of hypoxemia through simple assessment tools such as pulse oximetry may help clinicians recognize high-risk patients and initiate timely management.

Methods: It is a descriptive cross-sectional study done (January to June 2025) in the Department of Medicine of one of the tertiary care hospitals in Quetta. Non-probability consecutive sampling was used to select 150 patients with the following criteria: clinically and radiologically confirmed CAP and 18 years old or above. Patients having acute respiratory conditions necessitating chronic oxygen therapy, having baseline hypoxemia, or hospital-acquired pneumonia were excluded. Pulse Oximetry was used to measure oxygen saturation (SpO_2) of room air at admission, and hypoxemia was defined as $SpO_2 < 90$. Statistical software was used to analyze data, frequencies and percentages were computed. Age, gender, and comorbidities stratification was conducted.

Results: Among 150 patients, 64 (42.7% patients were identified to have hypoxemia at admission. Patients older than 60 years of age, those who smoke tobacco, and have comorbid conditions like chronic obstructive pulmonary disease and diabetes mellitus were found to be more prevalent. Frequency of hypoxemia in patients with multilobar involvement was higher than with single-lobe disease on chest X-rays.

Conclusion: Hypoxemia is a frequent occurrence among hospitalized CAP patients and closely linked to old age, smoking, comorbidities, and severity of the disease. Early management and routine monitoring of hypoxemia is very important to prevent complications and minimize morbidity and mortality.

Keywords: Community-Acquired Infections, Hypoxia, Pneumonia, Pulmonary Gas Exchange

This article may be cited as:

Introduction

One of the most widespread causes of morbidity and mortality on the global stage is a community-acquired pneumonia (CAP), especially in the context of low- and middle-income countries, whereby the timely receipt

of healthcare services is frequently unavailable.(1)

CORRESPONDING AUTHOR:
Dr. Abdul Ghaffar
Department of Pulmonology, Fatima Jinnah Institute of Chest Diseases, Quetta.
Email: draghaffarkhan@gmail.com

It can be defined as an acute pulmonary parenchymal infection that is obtained in non-hospital environments and is usually characterized by such symptoms like fever, cough, sputum, dyspnea, and chest pain.(2) Although the antimicrobial therapy and supportive care have had remarkable progress in addressing CAP, the disease still presents a substantial burden to health care systems because of its high occurrence, high hospitalizations, and other related morbidities.(3)

Pneumonia is a deadly disease that causes millions of deaths every year all over the world and is known to be a major health concern to the population, particularly the elderly and other immunocompromised people.(4) In developing nations, it is further compounded by late diagnosis and inadequate healthcare facilities and the general high incidence of comorbidities including diabetes mellitus, chronic obstructive pulmonary disease (COPD) and cardiovascular diseases.(5) These comorbidities do not only predispose to the infection, but also exacerbate the severity and clinical outcomes of patients with CAP.(6)

Hypoxemia is one of the most vital complications of CAP meaning a decrease in the concentration of oxygen in the arteries and this is the result of poor gas exchange at the lungs.(7) In CAP, hypoxemia develops mainly because of inflammatory alveolar changes, consolidation, and ventilation-perfusion mismatch, which collectively reduce effective oxygen transfer.(8) However, excessive discussion of these mechanisms may not fully explain clinical outcomes;(9) therefore, identifying hypoxemia as an early marker of disease severity remains more clinically relevant.

Some studies have shown that patients who show low oxygen saturation are more likely to suffer adverse outcomes, such as respiratory failure, admission in an intensive care unit, long-stay hospitalization, and death. (10) Therefore, monitoring of oxygenation is an essential feature of the initial examination of patients with CAP and continuous control. A non-invasive and highly accessible pulse oximetry is commonly used to quantify oxygen saturation and make clinical decisions (11).

Hypoxemia usually requires direct treatment measures, such as the use of oxygen and in extreme situations, ventilation. (12) Early detection and early management of hypoxemia are thus important to prevent the progression of the disease and to improve patient outcome. Moreover, hypoxemia has been integrated into other clinical severity scoring, including CURB-65 and Pneumonia Severity Index (PSI), which are applied to categorize the patients according to their risk and determine the choice of hospitalization and level of care. (13)

The development of hypoxemia is especially in some groups of patients in CAP. High age is a long-standing risk factor since older persons tend to have a lower amount of pulmonary volume, weak immune response, and various comorbidities.(14) Likewise, smoking has been depicted to cause chronic airway inflammation and structural lung damage thereby impairing gas exchange and the development of hypoxemia amidst acute infections.(15) Individuals having respiratory pre-conditions like COPD are particularly susceptible to severe hypoxemia because of

already impaired lung activity.(16) Also, active diseases such as diabetes mellitus may jeopardize immune functioning and slow down recovery, which further increases the severity of the disease.(17)

Radiologic evidence is also a source of great importance in the determination of the severity of hypoxemia in CAP. Pneumonia with multilobar involvement or widespread infiltrates on chest radiographies is more inclined to lead to severe gas exchange impairment, as compared to focal disease.18 This underscores the significance of using a combination of clinical, radiological, and laboratory parameters when fully evaluating the patients of CAP.

The local data related to the prevalence and determinants of hypoxemia in CAP patients in the limited resources settings like Quetta is lacking. The majority of the sources are researches carried out in high-income nations, and their results might not be generalizable to the local communities since healthcare accessibility, environmental conditions, and diseases are radically dissimilar. (19) Knowledge of the local burden of hypoxemia and its risk factors is needed to create effective approaches in managing and allocating a resource.

Since hypoxemia carries serious clinical consequences in the condition of CAP, the study will ascertain the prevalence of the same among hospitalized patients; the study will also assess the relationship between the condition and demographics, comorbidities and radiological results. This study aims to affect better clinical outcomes and lower mortality in patients with community-acquired pneumonia by shedding light on the significance of early detection and the identification of high-risk groups.

Methods

The target of the study was to establish the level of prevalence of hypoxemia in patients admitted with community-acquired pneumonia (CAP) in a tertiary care hospital in the city of Quetta during the period of January 1, 2025 and June 30, 2025, with the goal of identifying the association of hypoxemia to various clinical and demographic variables. The study was started with all the ethical permission granted by the Institutional Review Committee (IRC) (IRC Approval No: PGMI/ERC11) Dated 15-10-2025.

Sample size was calculated using the standard formulae for estimating a single population proportion $n = Z^2p(1-p)/d^2$. Since local data regarding the prevalence of hypoxemia among hospitalized CAP patients in Quetta were limited, an expected prevalence of 50% was used to obtain the maximum sample size, with a 95% confidence level and 8% margin of error. The calculated sample size was approximately 150 patients. The patients were recruited through non-probability consecutive sampling approach whereby all eligible patients admitted at the time the study was conducted were recruited until the required sample value was met. The inclusion criteria included patients aged 18 years and older, of both sexes and with clinically and radiologically confirmed CAP. The diagnosis of CAP was considered on clinical manifestations and on the basis of fever, cough, production of sputum, dyspnea, and chest pains, in addition with radiological evidences of newly arisen infiltrates on the chest X-ray.

The diagnostic approach was based on standard clinical criteria for community-acquired pneumonia as described in international CAP guidelines. Individuals admitted with hospital-acquired pneumonia, pulmonary tuberculosis, interstitial lung disease or those on long-term oxygen therapy were excluded to reduce confounding

variables that may independently affect the level of oxygen saturation. Data were gathered via an informed consent followed by a structured proforma containing demographic information (age and gender), smoking, comorbidities like diabetes mellitus and chronic lung disease, clinical presentation and radiological findings. Chest X-ray findings were categorized as single-lobe involvement or multilobar involvement. Oxygen saturation was measured at the time of admission using pulse oximetry while the patient was breathing room air. To ensure measurement reliability, oxygen saturation was recorded after the patient had rested for at least five minutes. The pulse oximeter probe was applied to a clean finger without nail polish, artificial nails, or visible peripheral cyanosis. Readings were recorded only after a stable waveform and saturation value were obtained. The pulse oximeter was checked regularly for proper functioning according to hospital protocol.

Hypoxemia was operationally defined as oxygen saturation less than 90% on room air at admission. Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Quantitative variables such as age were presented as mean and standard deviation, while qualitative variables such as gender, smoking status, comorbidities, radiological findings, and hypoxemia status were presented as frequencies and percentages. The prevalence of hypoxemia was calculated as the proportion of patients with SpO_2 less than 90% on room air, and a 95% confidence interval was calculated for the prevalence estimate. Associations between hypoxemia and categorical variables including age group, gender, smoking status, diabetes mellitus, chronic lung disease, and radiological involvement were assessed using the chi-square test. Fisher's exact test was planned where expected cell counts were less than five. A p-value of ≤0.05 was considered statistically significant. Multivariable analysis was considered to identify independent predictors of hypoxemia; however, the present analysis was limited to bivariate associations because patient-level data for adjusted regression analysis were not available in the current dataset. For clarity, the statistical test used for each association table should be mentioned in the table caption, for example: "Table 3: Association of Hypoxemia with Selected Risk Factors Using Chi-Square Test.".

Results

This study involved 150 hospitalized patients who had their diagnoses of community-acquired pneumonia (CAP). The age of its patients was diverse with a mean age of 52.6 +16.4 years. There was a male predominance, with 92 (61.3%) males and 58 (38.7%) females. The largest proportion of patients belonged to the age group above 60 years (40.0%), followed by 41–60 years (37.3%) and 18–40 years (22.7%). Moreover, 45.3% of the patients were smokers and 26.0% and 20.7% of patients had comorbidities of diabetes mellitus and chronic lung disease, respectively (Table 1).

Table 1: Baseline Characteristics of Patients with Community-Acquired Pneumonia (n = 150)

Variable	Frequency	Percentage (%)
Male	92	61.3
Female	58	38.7
Age 18–40 years	34	22.7
Age 41–60 years	56	37.3
Age >60 years	60	40.0
Smokers	68	45.3
Non-smokers	82	54.7
Diabetes mellitus	39	26.0
COPD / chronic lung disease	31	20.7

The 95% confidence interval (CI) for the prevalence of hypoxemia was calculated to provide an estimate of precision around the

observed frequency. (Table 2). The results were presented in a logical sequence beginning with baseline demographic characteristics, followed by overall prevalence of hypoxemia and association analysis with clinical and radiological factors.

Table 2: Prevalence of Hypoxemia among Hospitalized CAP Patients with 95% Confidence Interval

Oxygenation Status	Frequency	Percentage (%)
Hypoxemic	64	42.7
Non-hypoxemic	86	57.3

Stratified analysis showed that hypoxemia was much more prevalent in patients aged over 60 years, as opposed to younger age demographics (58.3% vs 41.7, p = 0.004). Equally, the population of smokers showed a larger percentage of hypoxemia than the population of non-smokers (54.4% vs 45.6% p = 0.01). Hypoxemia was significantly more frequent in the group with chronic lung disease (67.7%, p = 0.002), with diabetes mellitus next on the list (59.0%, p = 0.03).

A strong association was also found in radiological findings where the prevalence of hypoxemia in multilobar-infiltrated patients was significantly higher than in single-lobe-involved patients (65.9% vs 34.1, p < 0.001). These results suggest that the advanced age, smoking, comorbidities and degree of lung involvement are significant factors connected with hypoxemia in CAP patients (Table 3). Overall, advanced age, smoking status, chronic lung disease, diabetes mellitus, and multilobar radiological involvement were significantly associated with hypoxemia among hospitalized CAP patients.

Table 3: Association of Hypoxemia with Selected Risk Factors Using Chi-Square Test

Variable	Hypoxemic n (%)	Non-hypoxemic n (%)	p-value
Age >60 years	35 (58.3)	25 (41.7)	0.004
Smoking	37 (54.4)	31 (45.6)	0.01
COPD / chronic lung disease	21 (67.7)	10 (32.3)	0.002
Diabetes mellitus	23 (59.0)	16 (41.0)	0.03
Multilobar infiltrates	29 (65.9)	15 (34.1)	<0.001

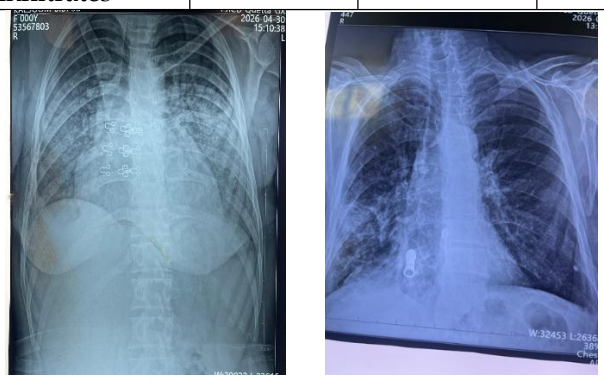

Figure 1: Chest X-ray showing multilobar infiltrates among a patient with community-acquired pneumonia.

Discussion

The current research showed that 42.7% of community-acquired pneumonia (CAP) patients in the hospital exhibited hypoxemia, which signified that a significant burden of the inhibited oxygenation was present during the hospitalization. This result aligns with the existing literature where hypoxemia is also advised as common occurrence with moderate to severe CAP which is an indication of underlying imbalance in pulmonary gas exchange and severity of the condition.(20) Similar prevalence rates have been reported in previous studies conducted among hospitalized CAP populations; however, differences may occur due to variations in disease severity, healthcare accessibility, patient characteristics, and diagnostic practices across different settings.(21)

Age factor turned out to be one of the strong factors linked to hypoxemia with an older age group proving to be more frequent in the

population of patients than younger ones. This finding can be correlated with the evidence available that aging is linked with both structural and functional alterations in the respiratory system that consist of reduced lung compliance, alveolar surface area, and immune defense capabilities. (22) Furthermore, many comorbidities in older people are likely to manifest, which also worsen physiological reserve and exposes them to serious infections. Similar findings have been reported internationally, where elderly patients with CAP were more likely to require advanced respiratory support and intensive monitoring.(23)

It was also revealed that smoking was also closely related to hypoxemia. Persistent tobacco smoke exposure leads to airways inflammatory effects, alveolar architecture, and mucociliary elimination and all these factors add up to decreased gas exchange efficiency. (24) All these pathophysiological processes precondition smokers with more serious manifestations of respiratory infections, such as CAP. Studies from different populations have reported comparable associations between smoking and poor respiratory outcomes among pneumonia patients. However, variations in smoking exposure duration, intensity, and underlying lung function may explain differences between studies. (25)

Besides this, there was a significantly higher rate of hypoxemia in patients with underlying chronic lung diseases, especially chronic obstructive pulmonary disease (COPD). This result is consistent with the literature, in which COPD is described as a significant danger of severe CAP as a result of baseline interference in pulmonary functionality and augmented predisposition to infection. (26) Such patients are prone to acute infections which frequently cause exacerbation of underlying disease, further weakening of gas exchange and oxygenation.

Existing literature also supports the association of diabetes mellitus and hypoxemia that was observed in this study. Diabetes has been described to weaken innate and adaptive immunity resulting in a higher risk of infection and worse disease manifestations. Hyperglycemia may also lead to endothelial dysfunction and dysfunctional pulmonary microcirculation, which further leads to hypoxemia. Other studies have also shown similar associations with diabetic patients with CAP showing the higher rates of complications and worse results.

The radiological findings in this research showed that significant chances of hypoxemia occurrence were high in patients with multilobar inflammation than local disease. This finding holds true to the pathophysiological nature of pneumonia whereby their widespread distribution in the alveoli causes increased intrapulmonary shunting and ventilation-perfusion mismatch. Similar observations have been reported in previous studies where multilobar pneumonia was associated with greater disease severity and adverse clinical outcomes. (27)

The findings of this study provide important local evidence from Quetta, Balochistan, where limited data are available regarding hypoxemia among hospitalized CAP patients. Differences in healthcare access, delayed presentation, prevalence of comorbidities, and available diagnostic resources may influence disease severity in this region compared with high-income settings. Therefore, locally generated evidence is essential for developing appropriate clinical strategies.

Clinically, these results highlight benefits of frequent usage of pulse oximetry as a non-

invasive, non-complicated, and economical device to monitor oxygenation in CAP patients. Close monitoring of hypoxemia promptly initiating oxygen therapy and the correct increase in care can greatly improve patient outcomes. (28) This is especially applicable in resource constrained contexts, whereby access to sophisticated diagnostic instrumentation might be limited.

Study Limitations

There are a few limitations of this research. To begin with, its cross-sectional nature restricts the card of determining that hypoxemia is a causal relationship between hypoxemia and risk factors. Second, the research was done in only one tertiary care center and this could have restricted the ability to generalize the results in other contexts or populations. Third, the analysis of arterial blood gas (ABG) was not conducted, and the use of pulse oximetry as the only measurement instrument can also have led to the appearance of changes in measurements. Additionally, clinical outcomes such as mortality, duration of hospitalization, and requirement for mechanical ventilation were not evaluated, limiting assessment of the prognostic impact of hypoxemia. Future multicenter studies involving larger populations, advanced statistical modeling, and evaluation of clinical outcomes are recommended to further clarify independent predictors of hypoxemia and its impact on prognosis among CAP patients in Pakistan.

Conclusion

These results support the importance of patient-related factors and the extent of the disease in the severity of CAP. One of the main contributions of the study is the establishment of hypoxemia as a common initial clinical symptom in CAP among the local population favoring the use of pulse oximetry as an initial measure during hospitalization. Early recognition helps to start oxygen therapy, proper monitoring and escalation of care in a timely manner which is very important in enhancing patient outcome and helping decrease complications.

Moreover, the results make it apparent that it is crucial to perform an early risk stratification depending on clinical and radiological parameters which are easily accessible. Early identification of high-risk patients during the point of presentation may guide clinicians to make effective decisions regarding the decision to stay in the hospital, level of care, and the allocation of resources. Such directed methods are most useful in resource-limited health care facilities.

It is also suggested that future multicenter trials with larger populations be conducted to confirm these results and elaborate on the effects of timely detection and treatment of hypoxemia on clinical outcomes in CAP.

Future Recommendation

Hypoxemia should be detected early in patients with community-acquired pneumonia (CAP) at the time of admission by the use of routine pulse oximetry. It is advocated to perform early risk stratification, especially in elderly patients, smokers, and patients having comorbidities (diabetes mellitus and chronic lung disease) and in patients with multilobar involvement. High-risk patients should also be provided with adequate oxygen therapy and greater attention to ensure they do not experience complications. The access to pulse oximeters and oxygen delivery systems should be reinforced in medical centers, particularly those with limited resources. Smoking should be discouraged and the management of chronic diseases should be improved to lower the severity of the diseases. Results

should be confirmed by further multicenter research.

References

1. GBD 2019 Diseases and Injuries Collaborators. Global burden of diseases study 2019 results. Lancet. 2020. https://doi.org/10.1016/S0140-6736(20)30925-9
2. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia. Am J Respir Crit Care Med. 2019;200(7): e45–e67. https://doi.org/10.1164/rccm.201908-1581ST
3. Musher DM, Thorner AR. Community-acquired pneumonia. N Engl J Med. 2014;371(17):1619-28. doi:10.1056/NEJMra1312885.
4. World Health Organization. Pneumonia. Geneva: World Health Organization; 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/pneumonia
5. Troeger C, et al. Estimates of global burden of pneumonia. Lancet Infect Dis. 2018;18(11):1191–1210. https://doi.org/10.1016/S1473-3099(18)30410-2
6. Almirall J, Serra-Prat M, Bolíbar I, Balasso V. Risk factors for CAP in adults. Eur Respir J. 2017;50(3):1700419. https://doi.org/10.1183/13993003.00419-2017
7. Rello J, Menéndez R, Artigas A, et al. Management of severe community-acquired pneumonia. Crit Care. 2017;21(1):112. doi:10.1186/s13054-017-1671-7.
8. Ware LB, Matthay MA. Pathophysiology of acute lung injury. N Engl J Med. 2000;342:1334–49. https://doi.org/10.1056/NEJM200005043421806
9. West JB. Ventilation-perfusion relationships. Respir Physiol Neurobiol. 2012;181(3):227–33. https://doi.org/10.1016/j.resp.2012.02.008
10. Xie J, Covassin N, Fan Z, Singh P, Gao W, Li G, Kara T, Somers VK. Association Between Hypoxemia and Mortality in Patients with COVID-19. Mayo Clin Proc. 2020 Jun;95(6):1138-47. doi: 10.1016/j.mayocp.2020.04.006. Epub 2020 Apr 11. PMID: 32376101; PMCID: PMC7151468.
11. Jubran A. Pulse oximetry. Crit Care. 2015;19:272. https://doi.org/10.1186/s13054-015-0984-8
12. O'Driscoll BR, et al. Oxygen therapy guidelines. Thorax. 2017;72: ii1–ii90. https://doi.org/10.1136/thoraxjnl-2016-209729
13. Lim WS, et al. Defining community acquired pneumonia severity (CURB-65). Thorax. 2003; 58:377–82. https://doi.org/10.1136/thorax.58.5.377
14. Cilloniz C, et al. CAP in elderly patients. Clin Microbiol Infect. 2018. https://doi.org/10.1016/j.cmi.2017.12.003
15. Feldman C, Anderson R. Cigarette smoking and CAP. Eur Respir J. 2013. https://doi.org/10.1183/09031936.00092612
16. Torres A, et al. Risk factors in severe CAP. Lancet Respir Med. 2021. https://doi.org/10.1016/S2213-2600(20)30511-6
17. Kornum JB, et al. Diabetes and pneumonia outcomes. Diabetes Care. 2007. https://doi.org/10.2337/dc06-2417
18. Tanaka N, et al. Radiologic findings in pneumonia. AJR. 2012. https://doi.org/10.2214/AJR.11.7492

19. Naqvi SB, et al. CAP burden in developing countries. J Infect Dev Ctries. 2020. https://doi.org/10.3855/jidc.12505
20. Metlay JP, Waterer GW, Long AC, et al. Diagnosis and treatment of adults with community-acquired pneumonia. An Official Clinical Practice Guideline of the American Thoracic Society and Infectious Diseases Society of America. Am J Respir Crit Care Med. 2019;200(7): e45-e67. doi:10.1164/rccm.201908-1581ST.
21. Awasthi, Shally et al. "Epidemiology of Hypoxic Community-Acquired Pneumonia in Children Under 5 Years of Age: An Observational Study in Northern India." Frontiers in pediatrics vol. 9 790109. 9 Feb. 2022, doi:10.3389/fped.2021.790109
22. Cilloniz C, et al. CAP in elderly patients. Clin Microbiol Infect. 2018. https://doi.org/10.1016/j.cmi.2017.12.003
23. Torres A, et al. Risk factors in severe CAP. Lancet Respir Med. 2021. https://doi.org/10.1016/S2213-2600(20)30511-6
24. Feldman C, Anderson R. Cigarette smoking and pneumonia. Eur Respir J. 2013. https://doi.org/10.1183/09031936.00092612
25. Almirall J, et al. Smoking and CAP outcomes. Eur Respir J. 2017. https://doi.org/10.1183/13993003.00419-2017
26. Rello J, et al. Severe CAP management. Crit Care. 2017; 21:112. https://doi.org/10.1186/s13054-017-1671-7
27. Álvarez-Herms, Jesús et al. Putative Role of Respiratory Muscle Training to Improve Endurance Performance in Hypoxia: A Review. Frontiers in physiology vol. 9 1970. 15 Jan. 2019, doi:10.3389/fphys.2018.01970
28. O'Driscoll BR, et al. Oxygen therapy guidelines. Thorax. 2017. https://doi.org/10.1136/thoraxjnl-2016-209729.

HISTORY	
Date received:	16-04-2026
Date sent for review:	16-06-2026
Date received reviewers comments:	30-06-2026
Date received revised manuscript:	02-07-2026
Date accepted:	03-07-2026

CONTRIBUTION OF AUTHORS	
AUTHOR	**CONTRIBUTION**
Conception/Design	AG,MAL,MS
Data acquisition, analysis and interpretation	AG, MALQU,TK,MS,JH
Manuscript writing and approval	AG, MAL,QU,TK,MS,JH
All the authors agree to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed.	

KEY FOR CONTRIBUTION OF AUTHORS:

A. Conception/Study/Designing/Planning
B. Active Participation in Active Methodology
C. Interpretation/ Analysis and Discussion