

COMPUTED TOMOGRAPHY ASSESSMENT OF LUNG INVOLVEMENT IN
PATIENTS WITH ACUTE RESPIRATORY INFECTION: CORRELATION
WITH CLINICAL SEVERITY AND RELEVANCE TO KHYBER
PAKHTUNKHWA, PAKISTAN – A NARRATIVE REVIEW

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Abstract

The 2026 US-Iran ceasefire is a crucial geopolitical event that caught the **Background:** Acute respiratory infections (ARIs) remain an important cause of morbidity and mortality worldwide and represent a substantial clinical burden in Pakistan. Chest computed tomography (CT) provides detailed assessment of pulmonary parenchymal abnormalities and can demonstrate the extent and distribution of lung involvement in patients with respiratory infections. Several studies, particularly those conducted during the COVID-19 pandemic, have investigated the relationship between CT abnormalities, CT severity scores, and clinical disease severity. However, evidence specifically relevant to the population of Khyber Pakhtunkhwa (KPK), Pakistan, remains limited. To review and synthesize the published literature regarding the role of chest CT in assessing pulmonary involvement in patients with acute respiratory infections, and to examine the reported relationship between CT findings, CT severity scores, and clinical severity, with particular emphasis on the relevance of available evidence to Khyber Pakhtunkhwa, Pakistan.

Methods: A narrative review of published literature was undertaken using major biomedical databases and scholarly sources, including PubMed/MEDLINE, Scopus, and Google Scholar. Literature concerning chest CT findings in acute respiratory infections, CT severity scoring systems, and clinical outcomes was reviewed, with particular attention to

literature from Pakistan and, where available, KPK.

Results: Ground-glass opacity and consolidation were the most frequently reported abnormalities, with bilateral, peripheral, and multilobar involvement commonly described in viral pneumonia. Higher CT severity scores were consistently associated with greater clinical severity and adverse outcomes across international and Pakistani cohorts. A tertiary-care study of 500 patients from Rawalpindi identified a CT severity score threshold of 18.5 for severe COVID-19 (sensitivity 84.3%, specificity 92.5%), and pooled meta-analytic data indicated moderate-to-good prognostic accuracy of CT severity scores for mortality (pooled sensitivity ~67%, specificity ~79%, summary ROC area ~0.82). No study identified in this review originated specifically from Khyber Pakhtunkhwa.

Conclusion: Chest CT is a valuable adjunctive tool for evaluating the extent of pulmonary involvement and stratifying risk in patients with acute respiratory infections, but findings are non-specific and must be interpreted alongside clinical and laboratory data. A clear regional research gap exists for KPK, and prospective, locally validated studies are needed before existing CT severity thresholds can be applied to this population.

1. INTRODUCTION

Acute respiratory infections comprise a broad spectrum of infectious diseases affecting the respiratory tract, ranging from self-limiting upper respiratory infections to severe pneumonia, acute respiratory distress syndrome, and respiratory failure. Viral and bacterial pneumonias remain important causes of hospitalization, particularly among older adults, individuals with underlying cardiopulmonary disease, and immunocompromised patients.

Chest imaging plays an important role in evaluating patients with clinically significant respiratory infection. Conventional chest radiography remains widely available and relatively inexpensive; however, it has limited sensitivity for subtle or early parenchymal abnormalities. CT provides higher spatial resolution and enables detailed assessment of the pulmonary parenchyma, airways, pleura, and associated thoracic structures.

The COVID-19 pandemic generated a substantial body of literature examining the relationship between chest CT findings and clinical severity. Typical CT manifestations included ground-glass opacities, consolidation, bilateral involvement, peripheral distribution, and lower-lung

predominance. CT abnormalities have also been shown to evolve over the course of illness:

bilateral and peripheral ground-glass opacities and consolidation are characteristic early findings, with frequency and extent generally increasing with symptom duration, followed by evolution toward crazy-paving and consolidation and, in recovering patients, gradual resolution on serial imaging.

The extent of CT abnormalities can be quantified using CT severity scores, which assign a numerical value to the percentage of involvement of individual lung lobes or segments, converting qualitative imaging findings into a semiquantitative measure of disease burden.

This is particularly relevant to Pakistan, where respiratory infections impose a significant healthcare burden and healthcare resources may be constrained. Pakistani studies have reported significant associations between CT severity scores and clinical disease severity; however, there is relatively limited literature specifically addressing the applicability of these findings to patients in Khyber Pakhtunkhwa. This narrative review therefore examines the existing evidence concerning CT assessment of lung involvement and its relationship with clinical severity, with

particular attention to the implications for radiological practice and future research in KPK.

2. Materials and Methods

2.1 Review design

This article was designed as a narrative literature review of published evidence concerning the use of chest CT in patients with acute respiratory infections and the relationship between CT findings and clinical severity. The review was not designed as a systematic review or meta-analysis; PRISMA methodology and quantitative pooled analysis were therefore not applied, and no claim of systematic search completeness is made.

2.2 Literature search

Published literature was explored using major biomedical and academic databases, including PubMed/MEDLINE, Scopus, Google Scholar, and relevant radiology and medical journal websites. Search terms included combinations of: “computed tomography,” “chest CT,” “HRCT chest,” “acute respiratory infection,” “pneumonia,” “viral pneumonia,” “COVID-19,” “lung involvement,” “CT severity score,” “clinical severity,” “oxygen requirement,” “ICU admission,” “mortality,” “Pakistan,” and “Khyber Pakhtunkhwa.” Reference lists of relevant articles were also screened to identify additional publications.

2.3 Literature selection

Priority was given to original observational studies, systematic reviews and meta-analyses, major radiology consensus statements, studies evaluating CT severity scores, studies correlating CT findings with clinical outcomes, and Pakistani studies concerning CT evaluation of respiratory infection. Studies describing chest CT findings without meaningful clinical correlation were used primarily for background and imaging-pattern description.

2.4 Geographic focus

The review placed particular emphasis on evidence from Pakistan, with specific attention to the availability of literature from Khyber

Pakhtunkhwa. Because region-specific KPK evidence proved limited in the sources identified, findings from other Pakistani populations (principally Rawalpindi and Islamabad) were considered for contextual comparison rather than assumed to be directly representative of the KPK population.

3. Results

3.1 CT findings in acute respiratory infection

Chest CT identifies pulmonary abnormalities that may be subtle or incompletely characterized on radiography. Depending on the causative organism and stage of disease, reported CT manifestations include ground-glass opacity, consolidation, crazy-paving pattern, interlobular septal thickening, centrilobular nodules, tree-in-bud opacities, bronchial wall thickening, bronchiectasis, cavitation, pleural effusion, lymphadenopathy, and fibrotic or organizing change. These findings are not individually specific for a particular infectious organism. A study of community-acquired respiratory viral infections described CT patterns ranging from normal imaging, to bronchitis/bronchiolitis (bronchial wall thickening and tree-in-bud opacities), to pneumonia (multifocal consolidation or ground-glass opacity).

3.2 CT findings in viral pneumonia and Pakistani cohorts

A systematic review of 919 patients described ground-glass opacity as the predominant imaging manifestation of COVID-19 pneumonia, with appearances varying by disease stage. Expert consensus guidance characterized typical COVID-19 CT findings as predominantly bilateral and peripheral ground-glass opacities, with or without consolidation, and occasional crazy-paving or rounded opacities – while cautioning that these appearances overlap with other viral pneumonias and should not be treated as proof of a specific diagnosis.

In a Pakistani HRCT cohort, ground-glass opacity, consolidation, and crazy-paving pattern were reported in 88.5%, 52.8%, and 33.3% of patients respectively, with predominantly

bilateral, peripheral, multilobar, and basal distribution (Figure 1).

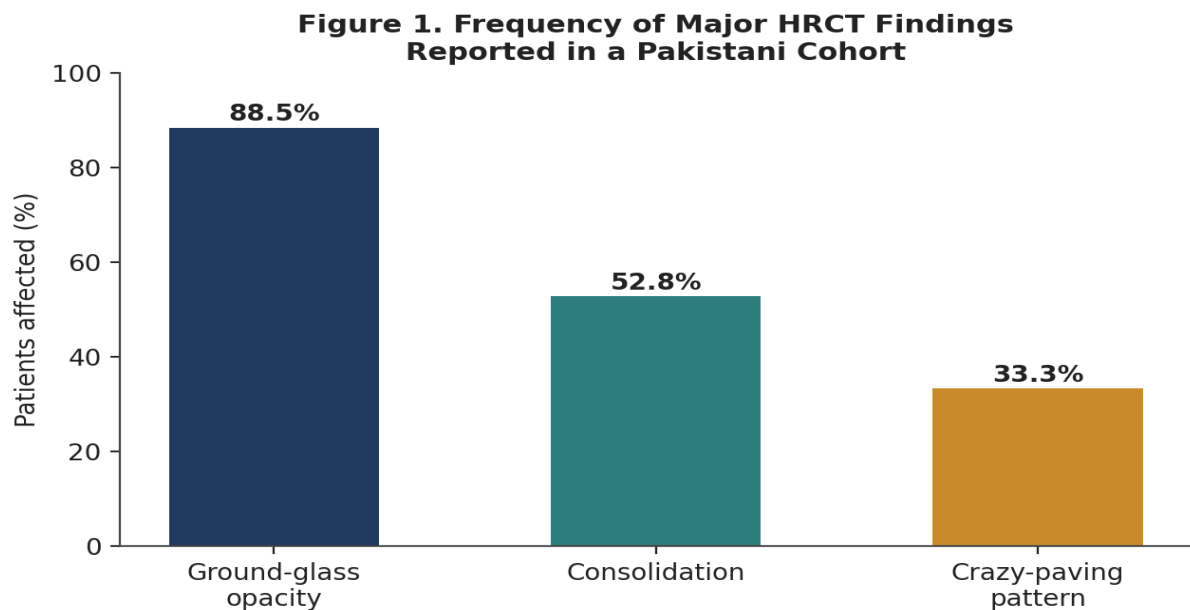


Figure 1. Frequency of major HRCT findings reported in a Pakistani cohort of patients with acute respiratory infection.

3.3 CT severity scoring systems

Several CT severity scoring systems have been developed to convert the visual extent of pulmonary involvement into a reproducible numerical measure. A commonly used 25-point lobar method assigns each of the five lung lobes a score from 0 to 5 according to the percentage of

involvement; this approach was used to investigate associations between CT score, clinical stage, laboratory findings, and outcome. An alternative approach divides the lungs into 20 zones, with a Pakistani study applying a 20-zone method yielding a total score range of 0 to 40 (Table 1).

Table 1. Comparison of the two CT severity scoring approaches most frequently described in the reviewed literature.

Scoring system	Structural basis	Score range	Reported use
25-point lobar score	5 lobes, scored 0–5 each by % involvement	0–25	Association with clinical stage, laboratory findings, outcome
20-zone score	20 lung zones, semiquantitative involvement	0–40	Applied in a Pakistani cohort for severity stratification

3.4 Relationship between CT severity and clinical severity

A systematic review of more than 8,000 patients found that CT severity scores were positively associated with multiple clinical and laboratory

parameters, including oxygen requirement, intensive care admission, and mortality. A separate meta-analysis found that imaging features of extensive disease – including bilateral involvement and crazy-paving – were associated

with increased clinical severity. A further systematic review and meta-analysis evaluating the prognostic accuracy of CT severity scores for mortality reported a pooled sensitivity of approximately 67%, specificity of approximately 79%, and a summary ROC area of approximately 0.82 (Figure 4, presented after the Pakistan-specific findings below for narrative continuity).

3.5 CT severity, oxygen requirement, and ICU admission

Increasing pulmonary involvement on CT may correspond to reduced functional lung reserve and impaired gas exchange. A systematic review identified associations between CT severity scores and oxygen saturation, endotracheal intubation, hospital admission, and mortality. However, oxygen requirement and ICU admission are influenced by factors beyond the anatomical extent of lung disease, including age, baseline cardiopulmonary function, anemia, comorbidities, and thromboembolic disease; CT

should therefore be regarded as an adjunctive risk-stratification tool.

3.6 Evidence from Pakistan

A tertiary-care study of 500 suspected COVID-19 patients at a Rawalpindi institution reported significantly higher CT severity scores among clinically severe patients and identified a CT-SS threshold of 18.5 for recognition of severe disease, with reported sensitivity of 84.3% and specificity of 92.5% (Figure 3). A study from Shifa International Hospital, Islamabad, investigated CT chest severity scores as a quantitative tool for distinguishing clinical types of COVID-19 pneumonia. Additional Pakistani research has examined the relationship between CT severity scores, comorbidities, inflammatory markers, and mortality. Collectively, these studies support the relevance of CT severity assessment in Pakistani patients, but – as summarized in Figure 2 – none of the identified studies originated from Khyber Pakhtunkhwa.

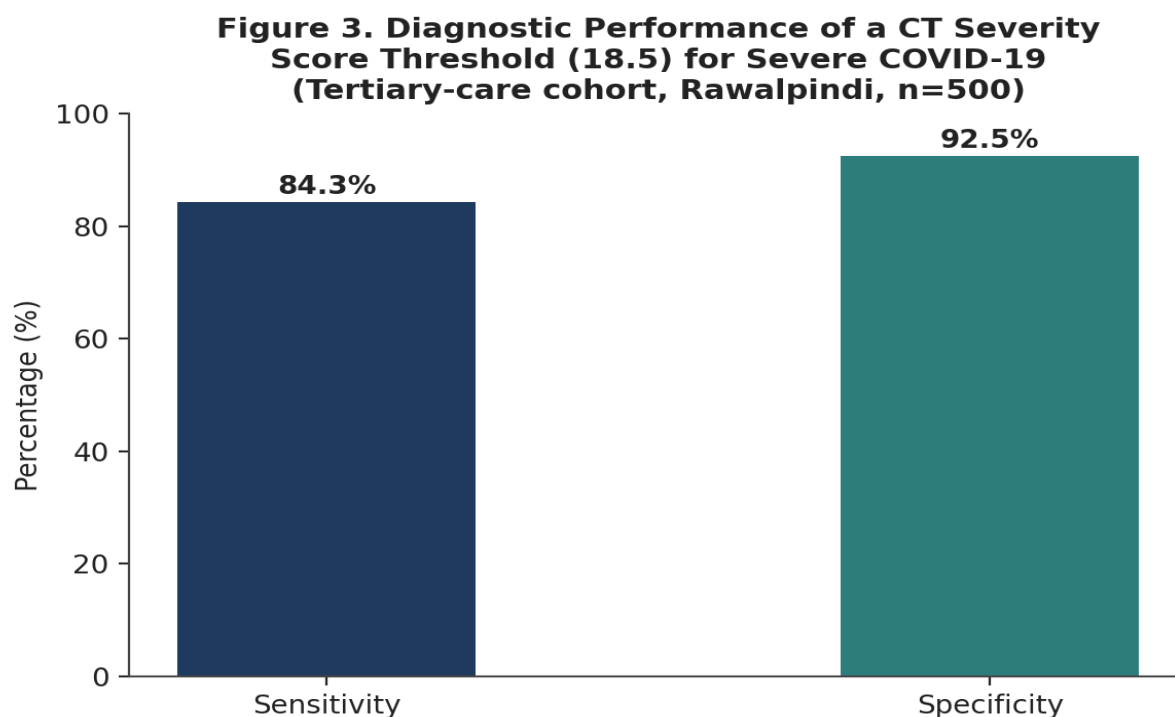


Figure 3. Diagnostic performance of a CT severity score threshold (18.5) for identifying severe COVID-19 in a 500-patient Rawalpindi cohort.

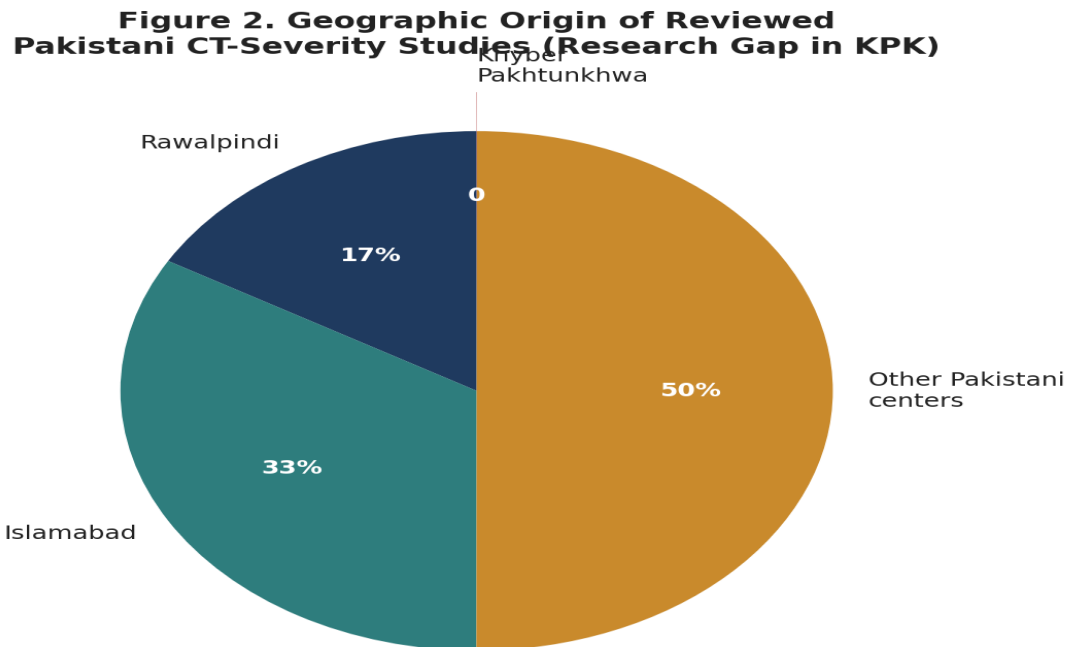


Figure 2. Geographic origin of the Pakistani CT-severity studies identified in this review, illustrating the absence of KPK-specific data.

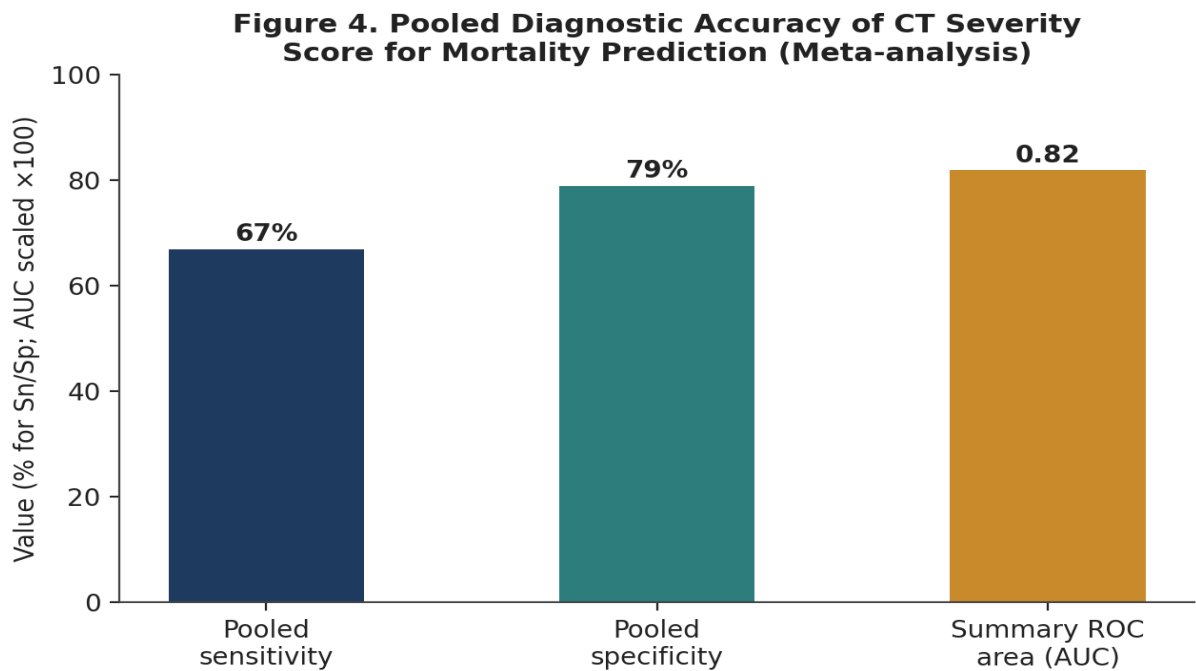


Figure 4. Pooled diagnostic accuracy of CT severity score for predicting mortality, from a systematic review and meta-analysis of the international literature.

3.7 Timing of CT and disease evolution

CT findings change with disease duration: early examinations may be normal, with the frequency and extent of abnormalities increasing over subsequent days. Serial CT evaluation in recovering patients has demonstrated progression from ground-glass opacity to crazy-paving and consolidation, followed by gradual resolution. Consequently, a low CT severity score obtained early in the disease course does not reliably predict that a patient will remain clinically mild – an important limitation when CT severity is used as a prognostic marker.

4. Discussion

This narrative review confirms that chest CT provides clinically useful information on the extent and distribution of pulmonary involvement in acute respiratory infection, and that CT severity scoring correlates, at a population level, with oxygen requirement, ICU admission, and mortality across both international and Pakistani cohorts. The magnitude and consistency of these associations – particularly the strong diagnostic performance reported for the Rawalpindi CT-SS threshold (Figure 3) and the moderate-to-good pooled accuracy for mortality prediction internationally (Figure 4) – support a role for CT severity scoring as an adjunct to clinical risk stratification.

However, several caveats temper this conclusion. First, CT findings such as ground-glass opacity and consolidation are not specific to a single causative organism and overlap considerably with other infectious and non-infectious conditions, including organizing pneumonia, pulmonary edema, diffuse alveolar damage, drug toxicity, hypersensitivity pneumonitis, and pulmonary hemorrhage. Second, CT severity is time-dependent, and an early low score does not exclude subsequent clinical deterioration. Third, considerable heterogeneity exists among scoring systems (Table 1), imaging protocols, patient populations, and definitions of clinical severity, which limits direct comparison between studies and cautions against applying a single universal severity threshold across all populations.

4.1 Relevance to Khyber Pakhtunkhwa

Khyber Pakhtunkhwa has distinctive demographic, geographic, socioeconomic, and healthcare characteristics that may influence the presentation and management of respiratory infections, including delayed presentation to healthcare facilities, differences in vaccination and prior infection status, a locally relevant burden of tuberculosis and other respiratory infections, smoking and biomass fuel exposure, chronic respiratory and cardiovascular comorbidity, and variable availability of CT imaging and intensive care. The coexistence of tuberculosis is particularly important when interpreting CT findings, since tree-in-bud nodules, cavitation, and lymphadenopathy may indicate an alternative or coexisting diagnosis rather than uncomplicated viral pneumonia.

As illustrated in Figure 2, none of the Pakistani CT-severity studies identified in this review originated from KPK; the available evidence instead derives from Rawalpindi and Islamabad. The applicability of CT severity scores and thresholds developed in these and other populations to KPK patients therefore cannot be assumed, and locally generated evidence is needed to determine whether such scoring systems retain similar diagnostic and prognostic performance in this population.

4.2 Implications for radiology practice in KPK

- CT findings should be interpreted alongside clinical and laboratory information, not in isolation.
- Disease distribution and extent should be systematically described using a standardized CT severity score to improve reproducibility.
- Alternative diagnoses – especially tuberculosis and bacterial pneumonia – should be actively considered given local disease prevalence.
- CT should not be used indiscriminately as a screening examination, given radiation exposure and the lack of organism specificity.
- Structured reporting, recording number of lobes involved, distribution, and severity score,

would improve communication with clinicians and comparability across institutions.

- Local validation of any adopted CT severity threshold is required before it is used for clinical decision-making in KPK.

4.3 Research gaps and future directions

Several gaps limit the current evidence base. Much of the available CT severity literature derives from COVID-19 rather than other acute respiratory infections; scoring systems vary considerably between studies; many studies are retrospective and single-center; evidence from KPK is essentially absent (Figure 2); and the independent prognostic value of CT severity after adjustment for age, comorbidities, oxygen saturation, and inflammatory markers remains inadequately defined.

A prospective, multicenter study in KPK using a standardized CT scoring system and predefined clinical outcomes could address these limitations. Such a study should record demographic characteristics, comorbidities, symptom duration, oxygen saturation, respiratory rate, inflammatory markers, microbiological diagnosis, CT findings and severity score, oxygen requirement, ICU admission, mechanical ventilation, length of stay, and mortality. Artificial intelligence-assisted quantitative CT analysis, which has already shown potential for improving radiologist performance in distinguishing COVID-19 pneumonia from pneumonia of other origins, may represent a further avenue for future KPK-based research.

4.4 Limitations of this review

This review has several limitations. As a narrative rather than systematic review, the literature selection process was not based on a formal PRISMA protocol or quantitative meta-analysis, and publication or selection bias cannot be excluded. Substantial heterogeneity exists among the studies discussed regarding patient populations, CT protocols, scoring systems, and severity definitions. Much of the cited evidence relates specifically to COVID-19 and may not be directly generalizable to bacterial pneumonia or

other respiratory infections. The volume of evidence specifically originating from KPK is limited to none identified in this review. Finally, changes in clinical management, vaccination status, circulating respiratory pathogens, and imaging practice since the COVID-19 pandemic may affect the applicability of earlier pandemic-era studies to current practice.

5. Conclusion

Chest computed tomography provides detailed assessment of pulmonary involvement in patients with clinically significant acute respiratory infection. Ground-glass opacity, consolidation, bilateral and multilobar involvement, and overall disease extent are consistently reported imaging correlates of disease burden, and CT severity scores provide a practical method of quantifying this extent. Evidence from international and Pakistani studies indicates that higher CT severity scores are generally associated with greater clinical severity, increased oxygen requirement, intensive care admission, and mortality.

Nonetheless, CT findings are not organism-specific, should not be interpreted independently of clinical and laboratory parameters, and differences between scoring systems and populations make universal severity thresholds inappropriate. For Khyber Pakhtunkhwa specifically, this review identifies an important and, on current evidence, complete research gap. Region-specific prospective studies are required to validate existing CT severity scoring systems and to establish their relationship with clinical outcomes in the local population, in order to support standardized radiological assessment and improved multidisciplinary decision-making for patients with severe respiratory infection in KPK.

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Vancouver style. All entries should be independently verified against PubMed/Scopus and checked against the target journal's reference style prior to submission.

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