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A retrospective study of association of CT severity with clinical profile and outcomes of patients with COVID-19 in the second wave

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ABSTRACT

Objectives: This study aimed to find out the association of CT severity score with demographic and clinical characteristics as well as mortality in the patients who were confirmed to have COVID-19 disease in the second wave.

Material and Methods: This retrospective study included collection and assessment of the demographic, clinical, laboratory data, and mortality of the patients, suspected with COVID-19 infection who underwent chest HRCT scan during March to April 2021. The findings of the chest HRCT were retrieved manually from the Medical Records section. Determination of the severity was done by the scoring system that involved the visual evaluation of the affected lobes.

Results: CT severity score was mild, moderate, and severe in 21.94%, 41.60%, and 30.48% patients, respectively. Mortality rate was 5.70%. Age of the patients with mild, moderate, and severe CT severity score was significantly more than those with normal severity score (50 vs. 50 vs. 50 vs. 31, $P=0.0009$). When compared to patients with normal score, those with mild, moderate, and severe CT severity score had significantly higher dyspnoea (10.39% vs. 67.81% vs. 97.20% vs. 0%), significantly more cases with diabetes mellitus (16.88% vs. 25.34% vs. 31.78% vs. 9.52%, $P=0.044$), hypertension (27.27% vs. 21.23% vs. 32.71% vs. 4.76%, $P=0.026$), and obesity (6.49% vs. 8.90% vs. 23.36% vs. 0%, $P=0.0005$). Total leucocyte counts, absolute neutrophil counts, creatinine, serum glutamic pyruvic transaminase (SGPT), lactate dehydrogenase (LDH), ferritin, and D-dimer were deranged in significantly more patients of severe score (53.27%, 62.62%, 60.75%, 85.05%, 90.65%, 97.20%, and 95.35%, respectively). Interleukin-6 (IL-6) and C-reactive protein were deranged in significantly more patients with moderate disease (98.18% and 98.63%, respectively). Increasing severity scores were associated with increased mortality (mild vs. moderate vs. severe: 1.30% vs. 1.37 vs. 15.89%, $P<0.0001$). Oxygen saturation (SpO_2) was significantly lowest in severe score followed by moderate, mild and normal scores (87 vs. 90 vs. 96 vs. 97, $P<0.0001$). Duration of non-rebreather mask (NRBM), noninvasive ventilation (NIV), high-flow nasal cannula (HFNC), Venture/face mask, and intubation was also associated with increasing severity scores ($P<0.0001$).

Conclusion: CT scans play an important role in guiding physicians with their management plans and can serve as a predictor of disease severity and outcomes.

Keywords: COVID-19, CT severity score, HRCT, Ground-glass opacities

INTRODUCTION

Coronavirus disease 2019 (COVID-19) was originally identified in a group of 41 patients in Wuhan, China, in December 2019, who all had unexplained cases of pneumonia. COVID-19 was declared to be public health emergency by the World Health Organization on January 30, 2020. COVID-19 is an infection that has spread widely and quickly worldwide, resulting in a pandemic with serious consequences for the economy and healthcare delivery systems.^[1]

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It was a new and unforeseen challenge because the clinical presentations ranged from asymptomatic carriers to patients requiring assisted ventilatory support, and ICU stays with higher mortality. The diagnostic test utilized as the standard of reference for confirmation of the disease has been the nasopharyngeal swab reverse transcription-polymerase chain reaction (RT-PCR) test.^[2] The test has proven to be an effective tool, but it is reported to be associated with a fewer but significant number of false-negative findings.^[3]

There is a significant role of the non-contrast high-resolution CT (HRCT) chest in detecting the disease in the early stage, specifically among patients who have false-negative reports of RT-PCR. It also helps in observing the disease progression.^[4] The typical findings of chest CT in the case of COVID-19 pneumonia include “bilateral, peripheral, and basal predominant ground-glass opacities with or without consolidation and broncho-vascular thickening.”^[5] In addition, atypical findings are “cavitations, central upper lobe predominance, nodules, masses, tree-in-bud sign, lymphadenopathy, and pleural effusion.”

For the diagnosis of COVID-19 pneumonia after a mean duration of 5 days, the HRCT chest is reported to show a sensitivity of 97%.^[6] Chest computed tomography severity score was developed to assist evaluation of the effect of COVID-19 on the scan performed at the time of admission.^[7] This severity scoring system gives an approach for recognizing the requirement of hospital admission in patients. In addition, the severity of the disease can be determined through findings of CT scan, which supports the clinicians in clinical evaluation and taking decisions regarding appropriate management.^[8]

During the acute phase of the disease, a CT severity score system allows patients' outcomes to be recognized. In critically-ill patients, the severity of the disease can also affect the prognosis, allowing for proper early involvement of intensive care.^[9,10]

Many previous researches used visual as well as software quantitative assessments for examining the involvement of lungs on the chest CT images.^[11,12] There is a scarcity of studies that evaluated the association of chest CT severity scores and the outcomes in COVID-19 patients, especially in India.^[13-19] Thus, we conducted this study to find out the association of CT severity score with demographic and clinical characteristics as well as mortality in the patients who were confirmed to have COVID-19 disease in the second wave.

MATERIALS AND METHODS

Patient Selection and Data Collection

A retrospective observational study was done in a tertiary care hospital, Government Institute of Medical Sciences in Greater Noida, India. The institute caters to a population of western Uttar Pradesh and NCR collectively, resulting in a

generous influx of patients. Collection of data of patients admitted over three months, i.e., March, April, and May 2021; of the second wave of COVID-19 in India was done.

A total number of COVID-19 patients that visited the hospital in the duration of the study were 465. Among them, the asymptomatic and mildly symptomatic patients, turning up in OPDs, were sent for home quarantine as per government advisory guidelines while only moderate to severely affected patients were admitted and included in the study.

The demographic (age, gender), clinical symptoms, comorbidities, and laboratory data [total leukocyte count (TLC), absolute neutrophil count, absolute lymphocyte count, creatinine, alanine aminotransferase (ALT), lactate dehydrogenase (LDH), C-reactive protein (CRP), ferritin, IL-6, D-dimer] related to the patients, suspected with COVID-19 infection who underwent chest HRCT scan during March to April 2021, were collected retrospectively from an electronic medical record system. The data relating to mortality was also collected. The findings of the chest HRCT were retrieved manually from the medical records section. Exclusion criteria included patients who had lung malignancy, tuberculosis, or atelectasis and those who underwent lobectomy. Since it was a retrospective study, ethical clearance and informed consent were waived off.

Sample Size Calculation

The study of Saeed GF *et al.*^[19] observed a mortality rate of 3.7% in COVID-19 pneumonia patients. Taking this value as reference, the minimum required sample size with a 2% margin of error and 5% level of significance is 343 patients. To reduce the margin of error, the total sample size taken is 351.

The formula used was:

$$N \geq (p(1-p))/(ME/z_{\alpha})^2$$

Where Z_{α} is the value of Z at two-sided alpha error of 5%, ME is the margin of error and p is the mortality rate.

Calculations:

$$n \geq ((.037*(1-.037))/(.02/1.96)^2 = 342.20 = 343(\text{approx.})$$

CT Images Assessment

When patients presented to the hospital, they underwent an initial chest HRCT scan through the “128 slice GE Revolution EVO CT Scanner.” When laid down in a supine position, patients were asked to be in single breath-hold. The CT scan parameters included: “scan direction (craniocaudally), tube voltage (120 kV), tube current (100–600 mA)—smart mA dose modulation, slice collimation (64 × 0.625 mm), width (0.625 × 0.625 mm), pitch,^[13] rotation time (0.5 seconds), and scan length (60.00–1300.00s).”

CT Images Analysis

For finding out the disease severity score in each patient, the evaluation of the images was done by two radiologists who had >5 years of experience. The evaluation was done according to the “Radiological Society of North America (RSNA) Consensus statement.” The CT scan images were first evaluated whether negative or positive for typical findings of COVID-19 pneumonia, including “bilateral, multilobe, posterior peripheral ground-glass opacities.”^[14] Then, determination of the severity was done by the scoring system that involved the visual evaluation of the affected lobes [Tables 1 and 2].^[15]

The outcome measures were mortality and duration of non-rebreather mask (NRBM), noninvasive ventilation (NIV), a high-flow nasal cannula (HFNC), venture/face mask, and hospital stay. The patients were followed till discharge or death.

Statistical analysis: The presentation of the categorical variables was done in the form of number and percentage (%). The quantitative data with non-normal distribution were represented as median with 25th and 75th percentiles (interquartile range). The data normality was checked by using the Kolmogorov-Smirnov test. The cases in which the data was not normal, nonparametric tests were used.

1. The association of age, oxygen saturation (SpO₂) on admission (room air), duration of NRBM, NIV, HFNC, venture/face mask, intubation with CT severity score was done using Kruskal-Wallis test. Mann-Whitney U test was used for the association of age, SpO₂ on admission (room air), duration of NRBM, NIV, HFNC, venture/face mask, intubation with mortality.
2. The association of gender, dyspnea, diabetes mellitus, hypertension, TLC, Absolute neutrophil count, creatinine, ALT, LDH, ferritin with CT severity score was analyzed using the Chi-square test. The association of gender, cough, diabetes mellitus, hypertension, obesity with mortality was also done using the Chi-square test.
3. The association of fever, cough, diarrhea, headache, obesity, chronic kidney disease (CKD), asthma/chronic obstructive pulmonary disease (COPD), absolute lymphocyte count, CRP, IL-6, D-dimer, mortality with

CT severity score was done using Fisher’s Exact test. The association of fever, dyspnea, diarrhea, headache, CKD, asthma/COPD, TLC, absolute neutrophil count, absolute lymphocyte count, creatinine, CRP, IL-6, D-dimer, ALT, LDH, ferritin with mortality was also analyzed using Fisher’s Exact test.

4. Multivariate logistic regression was used to find out significant risk factors of mortality.

The data entry was done in the Microsoft Excel spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences (SPSS) software, IBM manufacturer, Chicago, USA, ver 21.0.

For statistical significance, P-value of less than 0.05 was considered statistically significant.

RESULTS

The mean age of the patients in the present study was 49.62 ± 15.3 years with 69.52% of the patients being males. The chief symptoms were fever (80.63%), cough (68.95%), and dyspnea (60.11%). Hypertension diabetes mellitus and obesity were present in 25.07%, 24.50%, and 12.25%, respectively [Table 3].

Regarding respiratory support parameters, the mean values of SpO₂ on admission were 90.49 ± 6.07. The median duration of NRBM, NIV, HFNC, venture/face mask, and intubation were 0, 0, 0, 1, and 0 respectively [Table 4].

TLC, absolute neutrophils, absolute lymphocyte, Creatinine, ALT, CRP, LDH, Ferritin, IL-6, and D-dimer were deranged in 39.03%, 38.18%,85.19%,45.87%, 58.69%, 95.16%, 66.38%, 64.96%, 96.40%, and 82.72%, respectively [Table 5].

CT severity score was normal in 5.98% of patients, mild in 21.94%, moderate in 41.60%, and severe in 30.48% of patients [Figure 1]. Mortality rate was 5.70% in the study [Table 6]. The representative case images with varying severity is shown in Figures 2–4.

Age of the patients with mild, moderate, and severe CT severity scores was significantly more than those with normal scores (50 vs. 50 vs. 50 vs. 31, P = 0.0009). Gender was not associated with CT severity score (P = 0.195).

Regarding symptoms, when compared to patients with a normal score, those with mild, moderate, and severe CT severity scores had significantly higher dyspnea (10.39%

Table 1: Individual lobar scores on the basis of % of involvement.^[15]

Lobar involvement	Score
≤5%	1
5–25%	2
26–49%	3
50–75%	4
>75%	5

Table 2: The severity of the five lobes is indicated by sum of the individual lobar scores.^[15]

Total score	Category of severity
≤7	Mild
8–17	Moderate
≥18	Severe

vs. 67.81% vs. 97.20% vs. 0%). Other symptoms were comparable. When compared to patients with normal score, those with mild, moderate, and severe CT severity score had significantly more cases with diabetes mellitus (16.88% vs. 25.34% vs. 31.78% vs. 9.52%, $P = 0.044$), hypertension (27.27% vs. 21.23% vs. 32.71% vs. 4.76%, $P = 0.026$), and obesity (6.49% vs. 8.90% vs. 23.36% vs. 0%, $P = 0.0005$).

Derangement of blood parameters increased with increasing severity of CT score, as TLC, absolute neutrophil counts, creatinine, ALT, LDH, ferritin, and D-dimer were deranged in significantly more patients with severe scores (53.27%, 62.62%, 60.75%, 85.05%, 90.65%, 97.20%, and 95.35%, respectively), IL-6 and CRP were deranged in significantly more patients with moderate disease (98.18% and 98.63%, respectively).

Increasing severity scores were associated with increased mortality (mild vs. moderate vs. severe: 1.30% vs. 1.37 vs.

15.89%, $P < 0.0001$). SpO₂ was significantly lowest in severe scores followed by moderate, mild, and normal scores (87 vs. 90 vs. 96 vs. 97, $P < 0.0001$). Duration of NRBM, NIV, HFNC, Venture/face mask, and intubation was also associated with increasing severity scores ($P < 0.0001$) [Table 7].

On performing multivariate regression, age(years), SpO₂ on admission (room air), intubation, obesity were significant independent risk factors of mortality after adjusting for confounding factors. With the increase in SpO₂ on admission (room air), risk of mortality significantly decreases with an adjusted odds ratio of 0.848 (0.727–0.99). With the increase in age (years) risk of mortality significantly increases with an adjusted odds ratio of 1.075 (1.006–1.148). Patients with intubation, obesity had a higher risk of mortality with an adjusted odds ratio of 4.049 (1.654–9.914), 6.643 (1.052–41.955) respectively [Table 8].

Table 3: Distribution of demographic and clinical characteristics of study subjects.

Demographic and clinical characteristics	Frequency	Percentage
Gender		
Female	107	30.48%
Male	244	69.52%
Symptoms		
Fever	283	80.63%
Cough	242	68.95%
Dyspnoea	211	60.11%
Diarrhea	33	9.40%
Headache	62	17.66%
Diabetes mellitus	86	24.50%
Hypertension	88	25.07%
Obesity	43	12.25%
CKD	5	1.42%
Asthma/COPD	18	5.13%
Age (years)		
Mean ± SD	49.62 ± 15.3	
Median (25th–75th percentile)	50 (38–61)	
Range	14–90	

Table 5: Distribution of investigations of study subjects.

Investigations	Normal	Deranged
TLC (10 ⁶ /L) {Normal {4000–10000}}	214 (60.97%)	137 (39.03%)
Abs Neutrophil count (10 ⁹ /L) {Normal {2–7}}	217 (61.82%)	134 (38.18%)
Abs Lymphocyte count (10 ⁹ /L) {Normal {1–3}}	52 (14.81%)	299 (85.19%)
Creatinine (mg/dL) {Normal {0.2–1.2}}	190 (54.13%)	161 (45.87%)
ALT (U/L) {Normal {<45}}	145 (41.31%)	206 (58.69%)
CRP Day 1 (U/L) {Normal {<5}}	17 (4.84%)	334 (95.16%)
LDH (U/L) {Normal {240–480}}	118 (33.62%)	233 (66.38%)
Ferritin (ng/mL) {Normal {10–290}}	123 (35.04%)	228 (64.96%)
IL-6(pg/mL) {Normal {0–17}}	5 (3.60%)	134 (96.40%)
D-dimer (mcg/mL) {Normal {0–0.5}}	33 (17.28%)	158 (82.72%)

Table 4: Descriptive statistics of respiratory support of study subjects.

Respiratory support	Mean ± SD	Median (25th–75th percentile)	Range
SpO ₂ on admission (room air)	90.49 ± 6.07	90 (87–96)	70–99
NRBM	1.05 ± 2.17	0 (0–1)	0–10
NIV	0.32 ± 1.14	0 (0–0)	0–10
HFNC	1.05 ± 2.51	0 (0–1)	0–18
Venture/face mask	2.75 ± 3.54	1 (0–5)	0–20
Intubation	0.11 ± 0.54	0 (0–0)	0–5

DISCUSSION

COVID-19 is a highly contagious disease that has spread around the world. Disease diagnosis is crucial to disease containment and patient management strategies. However, restricted laboratory facilities and insufficient availability of nucleic acid kits have hampered COVID-19 testing. The WHO suggested that chest imaging is advised for diagnosis of COVID-19 disease on non-availability of the RT-PCR testing, delay in test findings, and in the clinically suspected cases of COVID-19 with negative RT-PCR findings. Clinicians are suggested to work in collaboration with the radiologists for taking appropriate decisions regarding the choice of imaging modality.^[16,17]

We found a significant association of CT severity score with age, dyspnea, diabetes mellitus, hypertension, obesity, TLC, absolute neutrophil count, creatinine, ALT, CRP, LDH, ferritin, IL-6, D-dimer, SpO₂ on admission, and duration of NRBM, NIV, HFNC, venture/face mask, and intubation.

Table 6: Distribution of mortality of study subjects.

Mortality	Frequency	Percentage
Survivors	331	94.30%
Died	20	5.70%
Total	351	100.00%

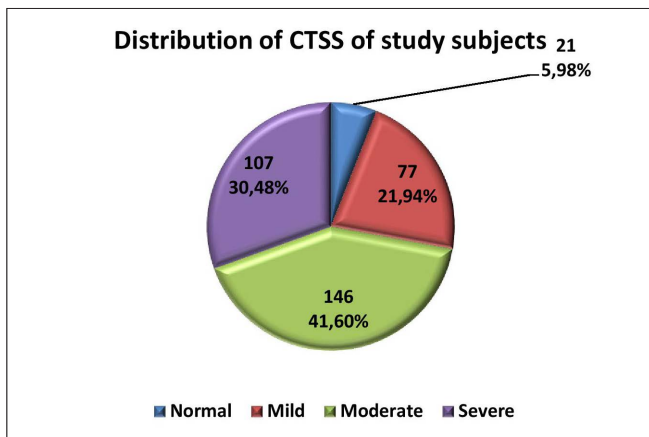


Figure 1: Distribution of CTSS of study subjects.

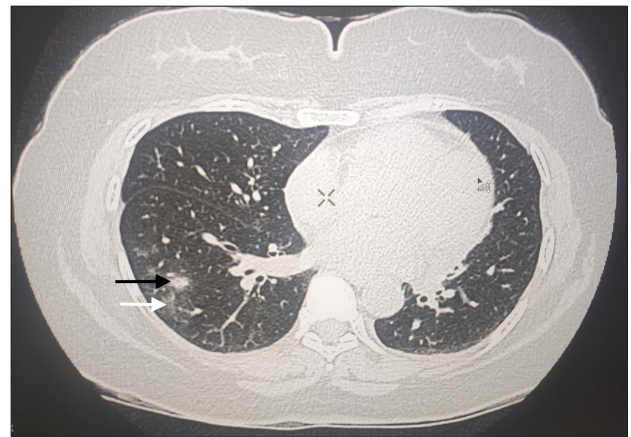


Figure 3: A 50-year-old male who presented with dyspnea and cough. HRCT coronal section revealed patchy areas of consolidation (black arrow) and subpleural ground glass opacities (white arrow) scattered in bilateral lungs. The CT severity score is 13/25 suggestive of moderate lung involvement.

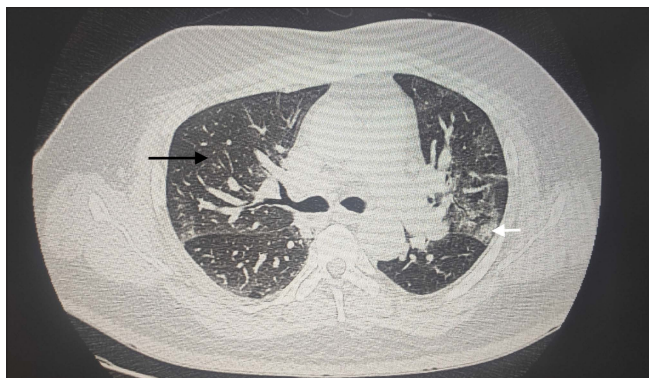


Figure 2: A 54-year-old female admitted with complaints of shortness of breath and fever for 1 week. HRCT coronal section revealed ground glass density opacities (black arrow) diffusely scattered in bilateral lungs, along with subpleural fibrotic bands (white arrow) and traction bronchiectasis. There is more than 75% involvement of all five lobes of both the lungs, with severity score of 25/25, which is severe involvement associated with poor prognosis.

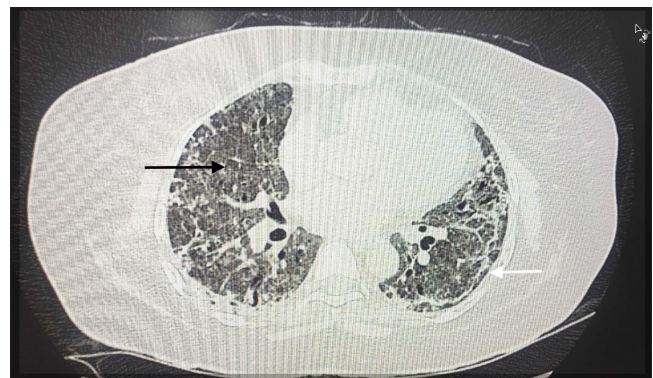


Figure 4: A 69-year-old female who presented with complaints of fever and mild cough. Coronal section of HRCT thorax revealed patchy subpleural ground glass opacities (white arrow) and patchy consolidation (black arrow). The score of involvement is 6/25 which is mild involvement. The occasional subpleural fibrosis is suggestive of concomitant resolution of inflammation and is of prognostic value.

Table 7: Association of parameters with CT severity score.

Parameters	Normal	Mild	Moderate	Severe	Total	P-value
Age (years)	31 (26–45)	50 (36–59)	50 (38–62)	50 (40–61)	50 (38–61)	0.0009 [‡]
Gender						
Female	10 (47.62%)	26 (33.77%)	44 (30.14%)	27 (25.23%)	107 (30.48%)	0.195 [†]
Male	11 (52.38%)	51 (66.23%)	102 (69.86%)	80 (74.77%)	244 (69.52%)	
Symptoms						
Fever	17 (80.95%)	67 (87.01%)	113 (77.40%)	86 (80.37%)	283 (80.63%)	0.393 [*]
Cough	10 (47.62%)	50 (64.94%)	102 (69.86%)	80 (74.77%)	242 (68.95%)	0.079 [†]
Dyspnea	0 (0%)	8 (10.39%)	99 (67.81%)	104 (97.20%)	211 (60.11%)	<0.0001 [†]
Diarrhea	2 (9.52%)	10 (12.99%)	12 (8.22%)	9 (8.41%)	33 (9.40%)	0.664 [*]
Headache	2 (9.52%)	11 (14.29%)	28 (19.18%)	21 (19.63%)	62 (17.66%)	0.619 [*]
Diabetes mellitus	2 (9.52%)	13 (16.88%)	37 (25.34%)	34 (31.78%)	86 (24.50%)	0.044 [†]
Hypertension	1 (4.76%)	21 (27.27%)	31 (21.23%)	35 (32.71%)	88 (25.07%)	0.026 [†]
Obesity	0 (0%)	5 (6.49%)	13 (8.90%)	25 (23.36%)	43 (12.25%)	0.0005 [*]
CKD	0 (0%)	0 (0%)	3 (2.05%)	2 (1.87%)	5 (1.42%)	0.719 [*]
Asthma/COPD	1 (4.76%)	3 (3.90%)	6 (4.11%)	8 (7.48%)	18 (5.13%)	0.595 [*]
Total leucocyte count (106/L)						
Normal {4000–10000}	13 (61.90%)	56 (72.73%)	95 (65.07%)	50 (46.73%)	214 (60.97%)	0.002 [†]
Deranged	8 (38.10%)	21 (27.27%)	51 (34.93%)	57 (53.27%)	137 (39.03%)	
Absolute Neutrophil count (109/L)						
Normal {2–7}	18 (85.71%)	65 (84.42%)	92 (63.01%)	42 (39.25%)	217 (61.82%)	<0.0001 [†]
Deranged	3 (14.29%)	12 (15.58%)	54 (36.99%)	65 (60.75%)	134 (38.18%)	
Absolute Lymphocyte count (109/L)						
Normal {1–3}	4 (19.05%)	6 (7.79%)	29 (19.86%)	13 (12.15%)	52 (14.81%)	0.066 [*]
Deranged	17 (80.95%)	71 (92.21%)	117 (80.14%)	94 (87.85%)	299 (85.19%)	
Creatinine (mg/dL)						
Normal {0.2–1.2}	20 (95.24%)	49 (63.64%)	81 (55.48%)	40 (37.38%)	190 (54.13%)	<0.0001 [†]
Deranged	1 (4.76%)	28 (36.36%)	65 (44.52%)	67 (62.62%)	161 (45.87%)	
ALT (U/L)						
Normal {<45}	20 (95.24%)	55 (71.43%)	54 (36.99%)	16 (14.95%)	145 (41.31%)	<0.0001 [†]
Deranged	1 (4.76%)	22 (28.57%)	92 (63.01%)	91 (85.05%)	206 (58.69%)	
CRP Day 1 (U/L)						
Normal {<5}	6 (28.57%)	9 (11.69%)	2 (1.37%)	0 (0%)	17 (4.84%)	<0.0001 [†]
Deranged	15 (71.43%)	68 (88.31%)	144 (98.63%)	107 (100%)	334 (95.16%)	
LDH (U/L)						
Normal {240–480}	9 (42.86%)	45 (58.44%)	54 (36.99%)	10 (9.35%)	118 (33.62%)	<0.0001 [†]
Deranged	12 (57.14%)	32 (41.56%)	92 (63.01%)	97 (90.65%)	233 (66.38%)	
Ferritin (ng/mL)						
Normal {10–290}	20 (95.24%)	61 (79.22%)	39 (26.71%)	3 (2.80%)	123 (35.04%)	<0.0001 [†]
Deranged	1 (4.76%)	16 (20.78%)	107 (73.29%)	104 (97.20%)	228 (64.96%)	
IL-6 (pg/mL)						
Normal {0–17}	1 (100%)	1 (11.11%)	1 (1.82%)	2 (2.70%)	5 (3.60%)	0.016 [*]
Deranged	0 (0%)	8 (88.89%)	54 (98.18%)	72 (97.30%)	134 (96.40%)	
D-dimer (mcg/mL)						
Normal {0–0.5}	4 (100%)	13 (68.42%)	12 (14.63%)	4 (4.65%)	33 (17.28%)	<0.0001 [†]
Deranged	0 (0%)	6 (31.58%)	70 (85.37%)	82 (95.35%)	158 (82.72%)	
Mortality						
No	21 (100%)	76 (98.70%)	144 (98.63%)	90 (84.11%)	331 (94.30%)	<0.0001 [†]
Yes	0 (0%)	1 (1.30%)	2 (1.37%)	17 (15.89%)	20 (5.70%)	
SpO ₂ on admission (room air)	97 (97–98)	96 (95–98)	90 (88.25–94)	87 (83–88.5)	90 (87–96)	<0.0001 [‡]
Duration of NRBM (days)	0 (0–0)	0 (0–0)	0 (0–1)	1 (0–4)	0 (0–1)	<0.0001 [‡]
Duration of NIV (days)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–1)	0 (0–0)	<0.0001 [‡]
Duration of HFNC (days)	0 (0–0)	0 (0–0)	0 (0–0)	1 (0–3)	0 (0–1)	<0.0001 [‡]
Duration of Venture/face mask (days)	0 (0–0)	0 (0–0)	2 (0–5)	4 (0–6)	1 (0–5)	<0.0001 [‡]
Duration of intubation (days)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)	<0.0001 [‡]

^{*} Fisher's exact test, [†] Chi-square test, [‡] Kruskal-Wallis test

Table 8: Multivariate logistic regression to find out significant risk factors of mortality.

Variable	Beta coefficient	Standard error	P-value	Odds ratio	Odds ratio Lower bound (95%)	Odds ratio Upper bound (95%)
Age (years)	0.072	0.033	0.0316	1.075	1.006	1.148
SpO ₂ on admission (room air)	-0.164	0.079	0.037	0.848	0.727	0.990
NRBM	-0.237	0.209	0.257	0.789	0.524	1.189
NIV	0.001	0.205	0.997	1.001	0.670	1.495
Venture/face mask	-0.320	0.165	0.053	0.726	0.525	1.004
Intubation	1.399	0.457	0.002	4.049	1.654	9.914
Dyspnea	1.440	1.658	0.385	4.222	0.164	108.741
Diabetes mellitus	0.241	0.811	0.766	1.273	0.260	6.237
Hypertension	0.773	0.917	0.399	2.166	0.359	13.056
Obesity	1.894	0.940	0.044	6.643	1.052	41.955
CKD	1.435	1.661	0.388	4.200	0.162	108.917
TLC (10 ⁶ /L)						
Normal {4000–10000}				1.000		
Deranged	1.736	1.154	0.133	5.673	0.591	54.496
Abs Neutrophil count (10 ⁹ /L)						
Normal {2–7}				1.000		
Deranged	-0.569	1.162	0.624	0.566	0.058	5.514
Creatinine (mg/dL)						
Normal {0.2–1.2}				1.000		
Deranged	0.254	0.920	0.782	1.290	0.212	7.832
ALT (U/L)						
Normal {<45}				1.000		
Deranged	0.125	1.030	0.904	1.133	0.151	8.524
LDH (U/L)						
Normal {240–480}				1.000		
Deranged	0.054	1.082	0.960	1.056	0.127	8.802
Ferritin (ng/mL)						
Normal {10–290}				1.000		
Deranged	0.637	1.217	0.601	1.890	0.174	20.553

Since COVID-19 remains a serious disease with adverse outcomes, the prediction holds the key in terms of CT severity score and other indexes like age, gender, symptoms, and investigative findings.

In the present study, increased age was associated with more severity of disease as mild, moderate, and severe scores had more age than those with normal scores (50 vs. 31 years, $P = 0.0009$).

This is in trend with the findings by Yang *et al.*^[18] who found that those with severe scores had significantly more age than patients with mild scores (52.83 vs. 43.70, $P = 0.004$).

Saeed *et al.*^[19] also found that normal scans and mild severity were present mostly in patients of 30–39 years. Moderate severity was present in the majority of patients with 40–49 years of age (31.7%) and severe score in the 50–59 years of age group (34.4%).

The elderly patients are more affected by COVID-19 because of several factors such as the stage of the pandemic during the conduction of the study, presence of comorbidities, and availability of healthcare services.

We found that CT severity scores were not associated with the gender of the patients. Similar findings were reported by Yang *et al.*^[18] who found no significant association between CT severity and gender of the patients. However, Saeed *et al.*^[19] found that males were more affected by the severe disease (93.4%). Factors behind this were the protective effect of estrogen in females.

In the present study, dyspnea increased with increasing severity of CT scores; however, other symptoms such as fever, cough, and diarrhea were not significantly different in patients with mild, moderate, and severe disease.

This is in accordance with the findings by Yang *et al.*^[18] as they also found fever (84.52% vs. 83.33%, $P = 0.817$), cough (67.86% vs. 83.33%, $P = 0.191$), and expectoration (5.95% vs. 16.67%, $P = 0.293$) to be similar in patients with mild and severe disease. Xiao *et al.*^[20] found that chest tightness was the only symptom present in significantly more patients with severe scores than moderate scores (42.5% vs. 23.5, $P = 0.002$). Other symptoms of COVID-19 were similar.

We found that hypertension, diabetes mellitus, and obesity were significantly associated with severity scores.

This is supported by previous studies that reported risk factors, such as hypertension, diabetes, lung diseases, and coronary artery diseases, is associated with poor prognosis, and worse outcome in the presence of multiple risk factors.^[21,22] However, Saeed *et al.*^[19] reported that there was no significant correlation of risk factors such as hypertension and diabetes with CT severity scores.

In the present study, blood investigations such as TLC, absolute neutrophil counts, creatinine, ALT, CRP, LDH, ferritin, IL-6, and D-dimer were more deranged in severe cases followed by moderate, mild, and normal severity scores.

As reported by Saeed *et al.*,^[19] there was a correlation between lymphopenia and increasing CT severity scores. Lymphopenia indicates an inflammatory cytokine storm. Reduced T-cell counts were also found more among patients with severe scores. The serum CRP level was also significantly correlated with CT severity scores.

Yang *et al.*^[18] reported that the severe cases had significantly lower mean lymphocytes ($10^9/L$) (0.68 vs. 1.21) and significantly higher HSCRP (107.91 vs. 11.29) and PCT (0.09 vs. 0.4) ($P < 0.001$).

Treatment of COVID-19 at an early stage can be considered using CRP as a predictive marker for the likelihood of disease progression.^[23] Similarly, serum ferritin is a vital mediator of immune dysregulation, and its level was closely linked to the severity of the disease. D-dimer likewise can be used as a prognostic indicator, where higher levels are seen in more critical conditions. However, there is a lack of evidence regarding the causal effect. It is not yet clear whether this increase is related to the direct effect of the virus or the systemic inflammatory response

The mortality rate in the present study was 5.70%. Increasing severity scores were associated with increased mortality, with the highest mortality seen in patients with severe scores, followed by moderate and mild scores ($P < 0.0001$). Those with severe scores had the lowest SpO₂ followed by moderate, mild, and normal scores (87 vs. 90 vs. 96 vs. 97, $P < 0.0001$). Duration of NRBM, NIV, HFNC, venture/face mask, and intubation was also associated with increasing severity scores ($P < 0.0001$).

In the study by Saeed *et al.*,^[19] mortality rate was 3.7%. The death rate was increased in patients with severe severity scores. Other outcomes were similar to the present study as among severe patients, only two patients were not on oxygen support, the nasal cannula was needed in 13.1% patients, face mask in 13.1%, nonrebreather mask in 8.2%, bi-level positive airway pressure (BiPAP)/HFNC in 6.6%, and intubation

in 55.7% patients. Oxygen requirement was significantly correlated with CT severity scores ($P < 0.0001$, $r = 0.529$). Overall, the need of oxygen increases with the increasing CT severity scores.^[24,25]

The present study found age, SpO₂ on admission (room air), intubation, obesity as the significant independent risk factors of mortality. Among other studies, Iftimie *et al.*^[26] found that in the first wave, the independent risk factors of mortality were old age and the presence of fever, dyspnea, acute respiratory distress syndrome, diabetes, and cancer; whereas, the risk factors associated with second wave were age, gender, and the presence of acute respiratory distress syndrome and chronic neurological diseases.

In another study, Carbonell *et al.*^[27] reported that there was no significant difference in ICU mortality between first and second waves according to age subsets except for the subgroup of 61–75 years of age, as decreased unadjusted ICU mortality was observed in the second/third waves (first vs. second/third: 38.7% vs. 34%, $P = 0.048$).

Limitations

One of the limitations of the study was that as it is a single-center study, its findings cannot be generalized. Thus, further multicenter studies should be conducted for increasing the accuracy of the findings. Also, evaluation of the severity of disease on CT scans can be subjective. We have not considered parameters such as lifestyle factors that might play a role in the outcomes. Also, self-reporting of the comorbidities by the patients' needs to take into account. Lastly, the treatment given for COVID-19 in the study was not compiled and that can have a bearing on mortality and length of hospital stay.

CONCLUSION

To conclude, CT scans can play an important role in guiding physicians with their management plans and can serve as a predictor of disease severity and outcomes. In patients with COVID-19 infection, the CT severity score is linked to age, diabetes, hypertension, obesity, inflammatory laboratory markers, and oxygen consumption. Higher CT scores showed a significant association with increased mortality, oxygen requirement, and duration of intubation.

Declaration of patient consent

Patient's consent is not required as patient's identity is not disclosed or compromised.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Statement of ethics

The research complies with the guidelines for human studies and was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

Data availability statement

The data of all the patients in the excel form is available on request from which the results have been derived.

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