The Egyptian Journal of Hospital Medicine (July 2022) Vol. 88, Page 3567-3575

# CT Characterization of COVID-19 Infection: Analysis of 1000 PCR Positive Cases in First and Second Waves

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## ABSTRACT

**Background:** There is a wide variety of CT radiological findings of COVID-19 infection, this study aimed to analyze retrospectively the similarities and differences of CT radiological findings between first and second waves in the confirmed coronavirus patients.

**Materials and methods:** comparative retrospective study between two COVID-19 pandemic waves was conducted on 1000 patients who were diagnosed as COVID-19 patients, at Assiut University hospital, 500 patients in the period from May 2020 to August 2020, while the other 500 patients were in the period from October 2020 to January 2021, all underwent MSCT chest and a comparison between similarities and differences of CT radiological findings was done.

**Results**: Both waves showed nearly the same mean and percentage of total CT severity score with no significant difference between them as p-value > 0.05. There is also a positive moderate correlation between age and total MSCT severity score of the lung in the first wave (r=0.51, p-value<0.001), while a significant positive mild correlation in the second wave (r=0.31 and p-value <0.001), atypical findings were encountered in the second wave more than in the first wave with the most common one was pulmonary fibrosis by (7.2%).

**Conclusion:** Great similarity in CT radiological findings between the two COVID-19 pandemic waves was detected. However, the main difference between them was in the severity of lung involvement in different age groups and demonstration of atypical findings which was more common in the second wave.

**Keywords:** Coronavirus disease; Computed tomography; Computed tomography severity score; and Coronavirus disease imaging reporting system.

## INTRODUCTION

A constant breakdown of pneumonia was recorded in Wuhan, China in December 2019, then after several weeks, Coronavirus disease (COVID-19) infection extended around the world [(1)], and the World Health Organization (WHO) declared it a global pandemic serious health problem on March 2020 [(2)].

RT-PCR has considered the gold standard for the diagnosis of COVID-19. However, due to its long time, sensitivity issues [(3)], and multiple negative RT-PCR test results which may be detected in patients with a high clinical suspicion of COVID-19 [(4)], there is an increased need for a complementary diagnostic approach [(5)]. CT is known as a sensitive and rapid tool for the diagnosis of COVID-19 but with low specificity [(6,7)], as several typical, fairly typical, and atypical CT findings for COVID-19 were detected [(8)].

COVID-19 infection starts as areas of interstitial pneumonitis and then progresses to involve whole lung parenchyma. Bilateral lung involvement is more common than unilateral affection, and although there is a wide variety of CT radiological findings have been reported in different studies, however, the most common findings are peripheral or sub-pleural ground-glass opacities (GGO), focal or diffuse areas of consolidation, and septal thickening [(9,10)].

There was an increase in the number of cases in the second wave in comparison to the first wave and also many countries have experienced the second wave of COVID-19 disease and found many factors that could affect the severity and spread of the disease [(11)].

In this study, we aimed to analyze retrospectively the similarities and differences of CT radiological findings between first and second waves in the confirmed coronavirus patients.

## PATIENTS AND METHODS

Data were collected to perform a comparative retrospective study between two COVID-19 pandemic waves, and this study was conducted on 1000 patients who were diagnosed with COVID-19 and confirmed by real-time polymerase chain reaction (RT-PCR), 500 patients in the period from May 2020 to August 2020, while the other 500 patients were in the period from October 2020 to January 2021.

The patients in each wave were classified according to their age into six groups: (Group A) patients less than 30 years, (B) from 31-39 years, (C) from 40-49 years, (D) 50-59 years, (E) from 60-69 years and (F) 70 years and more.

### CT protocol:

All patients underwent non-contrast high-resolution chest CT examination in a supine position during end-inspiration after restricted sterilization of the CT machine before the examination, CT images were acquired in the



Received: 17/03/2022
Accepted: 15/05/2022

caudo-cranial direction from the level of diaphragm to lung apices, using 64-channel Multi-detector CT scanner (Toshiba, Japan) Aquilion machine with 120-140 kV, 16x1.2 mm collimation, tube current 150-280 mA, all transverse images were reconstructed to 0.625 mm-slice images.

**CT chest image interpretation:**

CT images were reviewed by three radiologists with more than 10 years of experience in imaging. Then multi-planar reconstruction (MPR) was performed for CT analysis, and also MIP (maximum intensity projection) was used for the evaluation of lung nodules.

The following MSCT findings were reported and a comparison between the first and second COVID-19 waves was done:

---Typical, atypical, and fairly typical CT findings.

---Categorization of the 1000 patients into COVID-CORADS categories (Coronavirus disease imaging reporting and data system) based on CT findings [12]. As each category corresponds to the level of suspicion of chest involvement either low (0 and 1), moderate (2A, 2B), or high (grade 3).

---CT severity scoring for each lung lobe involvement for all patients was done, as score 0 means 0% involvement, score 1: less than 5% involvement, score 2: 5% to less than 25% involvement, score 3: 25% to less than 50% involvement, score 4: 50% to less than 75% involvement, and score 5: 75% or greater involvement. Then provides a semi-quantitative evaluation of the total severity score by summation of both lung scores.

---A grade of severity of COVID disease was calculated based on the percentage of whole lung involvement and was classified into:

None: 0%.
Minimal: 1-25%.
Mild: 26-50%.
Moderate: 51-75%.
Sever 76-100%.

--- And finally, an analysis of all collected data and a comparison between the similarities and differences in CT radiological findings between the two pandemic waves were done.

**Ethical consideration:**

**The study was approved by the Ethics Board of Assiut University and informed written consent was taken from each participant in the study. This work was performed in full accordance with the code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.**

***Statistical analysis***

Data analysis was performed using a statistical package for the social science (IBM-SPSS) version 26.0 software. Qualitative data were expressed as frequency and percent and numerical variables were expressed as mean ± SD. The normality test for continuous variables was performed by the Shapiro test.

The Chi-square test and Fisher exact test were used to compare the proportion between categorical variables to determine the significance between the first and second waves. Two continuous data were compared by Mann–Whitney U. Spearman rank correlation was used to determine the correlation between age and total lung and a scatter diagram was used to plot the correlation in the first and second wave. The level of confidence was kept at 95% and hence, the P-value was considered significant if < 0.05.

**RESULTS**

This comparative retrospective study was done on 1000 patients who were confirmed to be COVID-19 positive with a mean age was (46.04 ±15.89 and 54.91 ±15.65 years) and ages ranging from (1-90 years and 7-85 years) in first and second waves respectively. Group C (40-49 years) and Group E (60-69 years) were the most commonly affected age groups at 23% and 28.2%, while Group F (≥ 70 years) and Group B (31-39 years) were the least affected age groups by 6.6% and 6.8 % in first and second waves respectively. Males were more affected than females in both waves (56.8% and 51.8%) respectively with no significant difference as the p-value was <0.05. **(Table 1).**

Regarding grade of lung affection in CT, 127 patients (25.4%) showed moderate affection, followed by minimal affection in 124 patients (24.8%) in the first wave, compared to mild affection was found in 194 patients (38.8%), followed by moderate affection in 142 patients (28.4%) in the second wave. Both waves showed nearly the same mean and percentage of total CT severity score with no significant difference between them as the p-value was > 0.05 **(Table 2).**

Most young patients in age group A (≤ 30 years) and group B (31-39 years) showed minimal affection by (55.3%, 39.2%) and (30.2%, 38.2%) in both waves respectively. While regarding mid-age groups, age group C (40-49 years) showed mild affection in both waves by 33% and 38.5% respectively, however, age group D (50-59 years) showed moderate affection in the first wave by 33.3% and showed mild affection in the second wave by 40.9%. But regarding old age groups, most patients in group E (60-69 years) and age group F (≥ 70 years) showed severe affection in

the first wave by 39% and 42.4% respectively, while showed mild affection by 43.3% and 42.4% respectively in the second wave **(Table 3).**

Regarding total CT-severity score of lung affection in different age groups, there was a positive moderate correlation between age and total severity score of the lung in the first wave ( r=0.51, p-value<0.001), while there was a significant positive mild correlation in the second wave ( r=0.31 and p-value <0.001), as we found that old age groups E (60-69 years) and F (≥ 70 years) showed the highest mean of total CT severity score (16.17±5.67, 13.08±4.62) and (15.45±7.15, 13.11±5.23) in both waves respectively. **(Fig.1 and Table 4).**

According to CORADS classification, CORADS 3 with typical findings of (43.8%, and 49.4%), followed by CORADS 2B with combined findings of (36%, and 44.4%) were the most common in all patients in both first and second waves respectively. **(Table 5).**

But regarding its comparison between the two waves in different age groups, we found that in the first wave, CORADS 2B was common in age group C (40-49 years), group E (60-69 years), and group F (≥ 70 years) by 38.3%, 54.9%, and 66.7% respectively, followed by CORADS 3 in age group B (31-39 year) by 50% and group D (50-59 year) by 1%. While in the second wave, CORADS 2B was most common in age group A (≤ 30 years), group B (31-39 years), and group F (≥ 70 years) by 35.8%, 44.1%, and 52.2% respectively, followed by CORADS 3 which was most common in group C (40-49year), group D (50-59 year), and group E (60-69 year) by 53.8%, 59.1%, and 51.1% respectively. However, most normal patients with CORADS 0 were in young age group A (≤ 30 years) by 12.8% and 22.6% in both first and second waves respectively.

**(Table 6),** However, the most common typical finding was multifocal bilateral ground-glass opacities by (73% and 84.2% respectively) **(Fig.2),** followed by linear opacities and crazy paving pattern **(Fig.3)** by (41.2%, 50.6%) and (20.8%, 22%) in both waves respectively. While, the most common fairly typical findings were bronchial wall thickening, followed by vascular enlargement and focal pleural thickening by (28.2%, 18.4%, and 11.8%) in the first wave, and by (13%%, 11.2%, and 11%) in the second wave respectively. However, the most common atypical findings in the first wave were lymphadenopathy (5.8%), followed by bronchiectasis (4.8%), and the halo sign (4.4%). While in the second wave, pulmonary fibrosis was the most common atypical finding (7.2%) **(Fig.4),** followed by halo sign (7%), then pleural effusion and pulmonary nodules (5.8% and 5.2%) respectively. **(Table 7)**

# TABLES

**Table 1: Age and Gender of the patients in the first and second wave of COVID-19 infection**

| Variables | First wave (n=500) | Second wave (n=500) | P-value |
|---|---|---|---|
| **Age (years)** | | | |
| ▪ ≤ 30 | 94 (18.8%) | 53 (10.6%) | **<0.001*** |
| ▪ 31-39 | 74 (14.8%) | 34 (6.8%) | |
| ▪ 40-49 | 115 (23.0%) | 65 (13.0%) | |
| ▪ 50-59 | 102 (20.4%) | 115 (23.0%) | |
| ▪ 60-69 | 82 (16.4%) | 141 (28.2%) | |
| ▪ ≥ 70 | 33 (6.6%) | 92 (18.4%) | |
| ***Mean ± SD (range)*** | 46.04 ±15.89 (1-90) | 54.91 ±15.65 (7-85) | **<0.001**** |
| **Gender** | | | |
| ▪ Male | 284 (56.8%) | 259 (51.8%) | 0.113* |
| ▪ Female | 216 (43.2%) | 241 (48.2%) | |

Data were expressed as mean ± SD, or frequency (%)

***** Chi-square test

** Mann Whitney U test

**Table 2: Comparison of the grade of lung affection and mean and percentage of total CT-severity score between first and second wave for COVID-19 infection patients**

| | | | |
|---|---|---|---|
| **Grade of lung affection** | | | |
| ▪ None | 42 (8.4%) | 15 (3.0%) | **<0.001*** |
| ▪ Minimal | 124 (24.8%) | 82 (16.4%) | |
| ▪ Mild | 107 (21.4%) | 194 (38.8%) | |
| ▪ Moderate | 127 (25.4%) | 142 (28.4%) | |
| ▪ Sever | 100 (20.0%) | 67 (13.4%) | |
| **Total severity score of lungs** | | | |
| Mean ± SD | 11.07±7.50 | 11.47±5.70 | 0.323** |
| **Percentage (%)** | | | |
| Mean ± SD | 44.35±29.93 | 45.99±22.93 | 0.298** |

Data were expressed as mean ± SD, or frequency (%). ***** Chi-square test, ** Mann Whitney U test

**Table (3): Comparison of the grade of Lung affection in CT between the first and second wave of COVID-19 infection in different age groups: -**

| Lung affection according to age | First wave (n=500) | Second wave (n=500) | P-value* |
|---|---|---|---|
| **≤ 30 years** | ***N=94*** | ***N=53*** | |
| ▪ None | 24 (25.5%) | 12 (22.6%) | **0.001** |
| ▪ Minimal | 52 (55.3%) | 16 (30.2%) | |
| ▪ Mild | 5 (5.3%) | 14 (26.4%) | |
| ▪ Moderate | 10 (10.6%) | 10 (18.9%) | |
| ▪ Sever | 3 (3.2%) | 1 (1.9%) | |
| **31-39 year** | ***N=74*** | ***N=34*** | |
| ▪ None | 5 (6.8%) | 3 (8.8%) | 0.830 |
| ▪ Minimal | 29 (39.2%) | 13 (38.2%) | |
| ▪ Mild | 15 (20.3%) | 8 (23.5%) | |
| ▪ Moderate | 15 (20.3%) | 4 (11.8%) | |
| ▪ Sever | 10 (13.5%) | 6 (17.6%) | |
| **40-49 year** | ***N=115*** | ***N=65*** | |
| ▪ None | 6 (5.2%) | 0 (0.0%) | 0.150 |
| ▪ Minimal | 22 (19.1%) | 17 (26.2%) | |
| ▪ Mild | 38 (33.0%) | 25 (38.5%) | |
| ▪ Moderate | 31 (27.0%) | 18 (27.7%) | |
| ▪ Sever | 18 (15.7%) | 5 (7.7%) | |
| **50-59 year** | ***N=102*** | ***N=115*** | |
| ▪ None | 5 (4.9%) | 0 (0.0%) | **0.006** |
| ▪ Minimal | 15 (14.7%) | 20 (17.4%) | |
| ▪ Mild | 25 (24.5%) | 47 (40.9%) | |
| ▪ Moderate | 34 (33.3%) | 35 (30.4%) | |
| ▪ Sever | 23 (22.5%) | 13 (11.3%) | |
| **60-69 year** | ***N=82*** | ***N=141*** | |
| ▪ None | 1 (1.2%) | 0 (0.0%) | **<0.001** |
| ▪ Minimal | 3 (3.7%) | 10 (7.1%) | |
| ▪ Mild | 17 (20.7%) | 61 (43.3%) | |
| ▪ Moderate | 29 (35.4%) | 48 (34.0%) | |
| ▪ Sever | 32 (39.0%) | 22 (15.6%) | |
| **≥ 70 year** | ***N=33*** | ***N=92*** | |
| ▪ None | 1 (3.0%) | 0 (0.0%) | **0.040** |
| ▪ Minimal | 3 (9.1%) | 6 (6.5%) | |
| ▪ Mild | 7 (21.2%) | 39 (42.4%) | |
| ▪ Moderate | 8 (24.2%) | 27 (29.3%) | |
| ▪ Sever | 14 (42.4%) | 20 (21.7%) | |

**Table (4): Comparison of Total CT-severity score of lung affection between the first and second wave of COVID-19 infection in different age groups.**

| Total severity score of lungs | First wave (n=500) | Second wave (n=500) | P-value* |
|---|---|---|---|
| **Age** | | | |
| ▪ ≤ 30 | 4.48±5.53 | 6.81±6.18 | **0.030** |
| ▪ 31-39 | 9.11±7.03 | 8.65±6.84 | 0.654 |
| ▪ 40-49 | 11.30±6.41 | 10.91±5.48 | 0.720 |
| ▪ 50-59 | 12.80±7.18 | 11.48±5.34 | 0.085 |
| ▪ 60-69 | 16.17±5.67 | 13.08±4.62 | **<0.001** |
| ▪ ≥ 70 | 15.45±7.15 | 13.11±5.23 | **0.050** |
| ***P-Value**** | **<0.001** | **<0.001** | |

Data were expressed as mean ± SD. *Mann Whitney U test

**Table (5): Comparison of CORADS classification between the first and second wave of COVID-19 infection**

| | | | |
|---|---|---|---|
| **CO-RADS** | | | |
| ▪ 0 | 16 (3.2%) | 15 (3.0%) | **<0.001*** |
| ▪ 1 | 4 (0.8%) | 1 (0.2%) | |
| ▪ 2A | 81 (16.2%) | 15 (3.0%) | |
| ▪ 2B | 180 (36.0%) | 222 (44.4%) | |
| ▪ 3 | 219 (43.8%) | 247 (49.4%) | |

**Table (6): Comparison of CORADS classification between the first and second wave of COVID-19 infection in different age groups**

| CO-RADS according to age | First wave (n=500) | Second wave (n=500) | P-value* |
|---|---|---|---|
| **≤ 30 years** | ***N=94*** | ***N=53*** | |
| ▪ 0 | 12 (12.8%) | 12 (22.6%) | **<0.001** |
| ▪ 1 | 0 (0.0%) | 1 (1.9%) | |
| ▪ 2A | 46 (48.9%) | 6 (11.3%) | |
| ▪ 2B | 11 (11.7%) | 19 (35.8%) | |
| ▪ 3 | 25 (26.6%) | 15 (28.3%) | |
| **31-39 year** | ***N=74*** | ***N=34*** | |
| ▪ 0 | 1 (1.4%) | 3 (8.8%) | **0.049** |
| ▪ 1 | 1 (1.4%) | 0 (0.0%) | |
| ▪ 2A | 15 (20.3%) | 2 (5.9%) | |
| ▪ 2B | 20 (27.0%) | 15 (44.1%) | |
| ▪ 3 | 37 (50.0%) | 14 (41.2%) | |
| **40-49 year** | ***N=115*** | ***N=65*** | |
| ▪ 0 | 2 (1.7%) | 0 (0.0%) | 0.166 |
| ▪ 2A | 10 (8.7%) | 1 (1.5%) | |
| ▪ 2B | 44 (38.3%) | 29 (44.6%) | |
| ▪ 3 | 59 (51.3%) | 35 (53.8%) | |
| **50-59 year** | ***N=102*** | ***N=115*** | |
| ▪ 0 | 1 (1.0%) | 0 (0.0%) | 0.048 |
| ▪ 1 | 3 (2.9%) | 0 (0.0%) | |
| ▪ 2A | 8 (7.8%) | 2 (1.7%) | |
| ▪ 2B | 38 (37.3%) | 45 (39.1%) | |
| ▪ 3 | 52 (51.0%) | 68 (59.1%) | |
| **60-69 year** | ***N=82*** | ***N=141*** | |
| ▪ 2A | 1 (1.2%) | 3 (2.1%) | 0.481 |
| ▪ 2B | 45 (54.9%) | 66 (46.8%) | |
| ▪ 3 | 36 (43.9%) | 72 (51.1%) | |
| **≥ 70 year** | ***N=33*** | ***N=92*** | |
| ▪ 2A | 1 (3.0%) | 1 (1.1%) | 0.220 |
| ▪ 2B | 22 (66.7%) | 48 (52.2%) | |
| ▪ 3 | 10 (30.3%) | 43 (46.7%) | |

Data were expressed as frequency (%), ***** Chi-square test

**Table (7): Comparison of typical, fairly typical, and atypical CT findings between first and second wave.**

| Variables | First wave (n=500) | Second wave (n=500) | P-value* |
|---|---|---|---|
| **Typical finding** | | | |
| ▪ Multifocal bilateral GGO | 365 (73.0%) | 421 (84.2%) | **<0.001** |
| ▪ Multifocal unilateral GGO | 22 (4.4%) | 20 (4.0%) | 0.753 |
| ▪ GGO with superimposed consolidation | 79 (15.8%) | 140 (28.0%) | **<0.001** |
| ▪ Consolidation predominant pattern | 1 (0.2%) | 17 (3.4%) | **<0.001** |
| ▪ Linear opacities | 206 (41.2%) | 253 (50.6%) | **0.003** |
| ▪ Crazy paving pattern | 104 (20.8%) | 110 (22.0%) | 0.644 |
| **Fairly typical finding** | | | |
| ▪ Single GGO | 28 (5.6%) | 17 (3.4%) | 0.093 |
| ▪ Consolidation without GGO | 3 (0.6%) | 0 (0.0%) | 0.249 |
| ▪ Focal pleural thickening | 59 (11.8%) | 55 (11.0%) | 0.691 |
| ▪ Vascular enlargement | 92 (18.4%) | 56 (11.2%) | **0.001** |
| ▪ Bronchial wall thickening | 141 (28.2% | 65 (13.0%) | **<0.001** |
| ▪ Air bronchogram | 46 (9.2%) | 40 (8.0%) | 0.499 |
| ▪ White lung stage | 26 (5.2%) | 20 (4.0%) | 0.365 |
| **Atypical finding** | | | |
| ▪ Pleural effusion | 10 (2.0%) | 29 (5.8%) | **0.002** |
| ▪ Cavity | 1 (0.2%) | 3 (0.6%) | 0.624 |
| ▪ Pulmonary nodules | 16 (3.2%) | 26 (5.2%) | 0.115 |
| ▪ Lymphadenopathy | 29 (5.8%) | 15 (3.0%) | **0.031** |
| ▪ Halo sign | 22 (4.4%) | 35 (7.0%) | 0.076 |
| ▪ Tree-in-bud sign | 9 (1.8%) | 25 (5.0%) | **0.005** |
| ▪ Bronchiectasis | 24 (4.8%) | 14 (2.8%) | 0.098 |
| ▪ Pulmonary emphysema | 18 (3.6%) | 23 (4.6%) | 0.425 |
| ▪ Isolated pleural thickening | 2 (0.4%) | 7 (1.4%) | 0.178 |
| ▪ Pulmonary fibrosis | 19 (3.8%) | 36 (7.2%) | **0.018** |
| ▪ Pneumothorax | 0 (0.0%) | 1 (0.2%) | 1.000 |
| ▪ Pericardial effusion | 0 (0.0%) | 2 (0.4%) | 0.499 |

Data were expressed as frequency (%),***** Chi-square, and Fisher Exact test.

# Figures

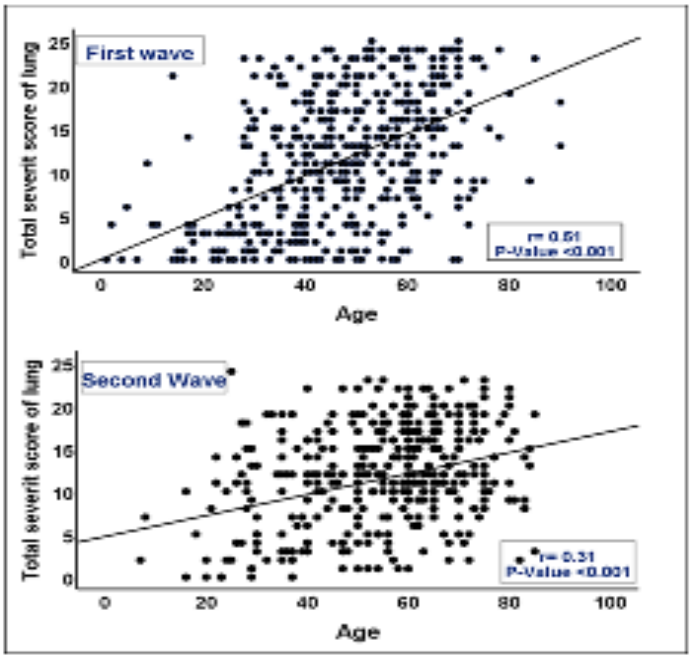


**Figure (1): Correlation between Total severity score of lung and age in the first and second wave of COVID-19 infection, Scatter diagram shows a significant positive moderate correlation between age and total severity score of the lung in the first wave (r=0.51, p-value <0.001) and significant positive mild correlation in the second wave (r=0.31, p-value <0.001).**

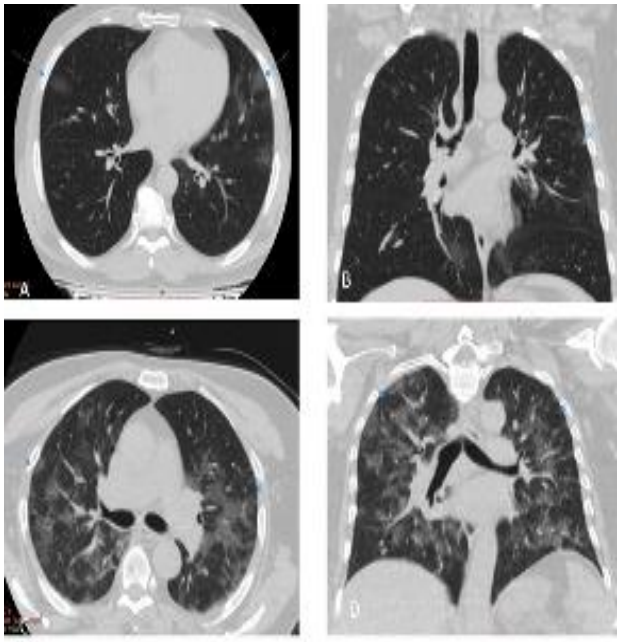

**Figure (2): Typical COVID-19 CT signs in two patients: A, B axial, and coronal chest CT (lung window) in a 30-year-old patient showing peripheral faint ground-glass opacities (arrows). C, D axial and coronal chest CT in a 54-year-old patient with multiple bilateral ground-glass opacities (arrows).**

- NB: Degrees of correlation:
- Negligible correlation r < 0.2
- Mild correlation r = 0.2 to < 0.4
- Moderate correlation r = 0.4 to < 0.7
- Strong correlation r = 0.7 to < 1
- Perfect correlation r =1
- No correlation r=0

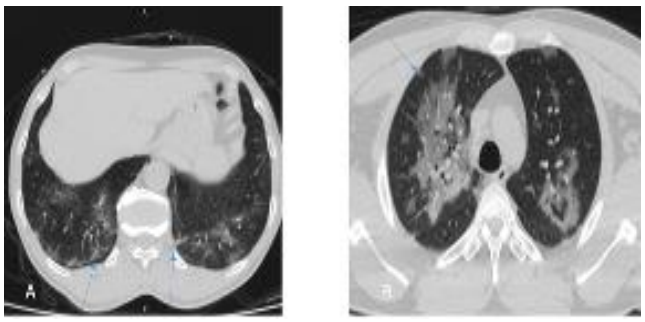

**Figure (3): A: axial CT chest of male patient 70 years old, revealed multiple GGO seen with multiple linear opacities (arrow), B: Male patient 57 years old, axial CT chest revealed multiple GGO seen with multiple interlobular and interlobar septal thickening giving crazy paving appearance (arrow).**

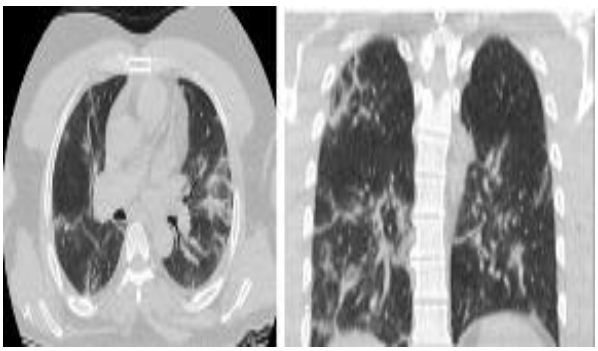

**Figure (4): A and B axial and coronal CT chest of 66 years old male COVID-19 patient showing bilateral ground-glass opacities with irregular fibrotic bands.**

## DISCUSSION

COVID-19 infection is a highly infectious viral pneumonia caused by a new coronavirus of unclear origin, called acute severe respiratory distress syndrome (SARS-CoV-2).

MSCT chest plays a very important role in the rapid recognition, control, and follow-up of COVID-19 patients [13]. The use of radiological imaging has been accepted by some countries as the most important diagnostic test [14,6], and MSCT imaging is considered the only available diagnostic test for COVID-19 infection in many developing countries due to the shortage of diagnostic laboratory kits [4].

In this study, we examined 1000 positive PCR COVID-19 patients in both first and second waves to identify the similarities and differences in MSCT radiological findings between them.

By analyzing the affected age groups, we found a difference between the two waves, as in the first wave, age group C (40-49 years) was the most commonly affected, while group F (≥ 70 years) was the least affected, but in the second wave, group E (60-69 years) and group B ( 31-39 years) were the most common and least affected age groups respectively.

Both waves showed nearly the same mean and percentage of total CT severity score (11.07±7.50, 44.35±29.93, and 11.47±5.70 45.99±22.93) with no significant difference between them as the p-value was > 0.05. However, as regards the severity of CT lung affection in different age groups, we found that there was a positive moderate correlation between age and total CT severity score of the lung in the first wave (r=0.51, p-value<0.001), while a significant positive mild correlation in the second wave ( r=0.31 and p-value <0.001), and this is not matching with results of E.K.K. Brakohiapa et al. study may be due to different sample sizes as well as different environmental and ambient conditions between the two studies [15].

According to CORADS classification, we found that CORADS 3 with typical CT findings was the most common type in all patients (43.8%, and 49.4%) and most normal patients with CORADS 0 were in young age group A (≤ 30 years) by (12.8% and 22.6%) in both first and second waves respectively. Also, some atypical findings were encountered in the second wave more than in the first wave with the most atypical finding being lung fibrosis, and this was similar to the findings in the previous studies by Samir et al., and Zhao et al. [16,17].

Finally, in this study, we found that multifocal bilateral ground-glass opacity was the most common typical MSCT finding in both waves, this is consistent with the findings of previous studies including Omar S et al., Ali TF et al., and Mohamed IA et al. [18,19,20].

## CONCLUSION

We concluded that there was a great similarity in CT radiological findings between the two COVID-19 pandemic waves. However, the main difference between them was in the severity of lung involvement in different age groups and demonstration of atypical findings which was more common in the second wave.

**Financial support and sponsorship**: Nil.
**Conflict of interest**: Nil.

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