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Research article

# Comparing radiological presentations of first and second strains of COVID-19 infections in a low-resource country

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ABSTRACT

*Introduction:* The novel corona virus popularly referred to as COVID-19 disease and SARS-CoV-2 was first detected in Wuhan, China in December 2019. It was declared a pandemic by the World Health Organization (WHO) on March 11, 2020. In Ghana, the first two cases of COVID-19 infection were recorded on March 13, 2020 with a strain imported from Europe. In December 2020, a new strain from South Africa was detected in Ghana which was associated with higher transmission rates, severity of the disease, and higher number of recorded deaths. Our study aimed to record notable differences and similarities between infections due to the initial, and second strains of COVID-19 infections detected in Ghana during the last 12-months.

*Method:* This was a retrospective study involving 50 patients infected with the first strain, and another 50 patients infected with the second strain of the SARS-CoV-2 virus. Microsoft Excel-2013 was the analytical tool.

*Results:* The data analysis supported publications suggesting that the new strain of the virus caused more severe infections, which were manifested on high resolution CT (HRCT) scans as more widespread alveolar disease, most commonly presenting as large areas of consolidation.

*Conclusion:* Despite numerous similarities in terms of the manifestation of COVID-19 infection on HRCT scans, notable difference supporting the notion of increased virulence and severity of disease were also recorded. The study findings demonstrate the need for heightened and sustained preventive measures needed to reduce, and eventually curb COVID-19 infection and mortality rates associated with the introduction of new virulent strains.

## 1. Introduction

In 2020 the daily routines of most humans were changed significantly by the appearance of the novel corona virus 2019 (also commonly referred to as SARS-CoV-2 and COVID-19) in many countries all over the world. The novel corona virus is the third incidence of transmission of an acute respiratory tract infection from animal to man in 3 decades. It was first discovered in December 2019, in people who had all visited a Wuhan (China) seafood market. The viral genome was sequenced and showed up to 80% similarity to severe acute respiratory syndrome coronavirus (SARS-CoV) and other coronaviruses in bats [1]. The World Health Organization (WHO) declared the disease a pandemic on March 11, 2020 [2]. In Ghana, the first two cases of the virus were recorded on March 13, 2020 [3]. By the 18$^{th}$ of April, 2020, Ghana had recorded 834 COVID cases and 9 deaths, with the numbers rising to 43,622 infections and 263 deaths by 24$^{th}$ August 2020 [2, 4]. COVID-19 is the first pandemic to be caused by a coronavirus [5].

SARS-CoV-2 patients present with numerous signs and symptoms, usually of a nonspecific nature. More common clinical presentations include ageusia, dyspnea, anosmia, fever, nasal congestion and cough. Others present less commonly with myalgia, arthralgia, diarrhea and vomiting, sore throat and pleuritic pain. Most patients however appear to

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be asymptomatic and are diagnosed during voluntary testing or after contact tracing using the reverse transcriptase-polymerase chain reaction (RT-PCR) test [6, 7, 8]. This contrasts with a publication by the Chinese Center for Disease Control and Prevention, which found only 1.2% of 72, 314 reported COVID-19 cases were asymptomatic [9]. There have also been few reports of microthrombi in coronary, cerebral and pulmonary arteries in COVID-19 patients [10, 11, 12]. Significant risk factors have been found to be associated with the development of pulmonary embolism in COVID-19 patients. They are obesity, high values for C-reactive protein and D-dimer [12]. The median age for COVID-19 infected Chinese patients was reported as 47 years, and males were more affected 58.1% [13].

In resource poor communities such as Ghana, RT-PCR testing centers are few, causing diagnostic delays. The use of existent plain radiography and computer tomography (CT) scan facilities, in some instances, have aided in the early detection and isolation of COVID-19 patients awaiting RT-PCR test results. Standardized categories for reporting of radiographic and CT appearance of COVID-19 have been developed by radiologists in Britain and the United States of America [14, 15, 16].

Radiological findings in the lungs of patients with COVID-19 infection have been extensively reported over the past 14 months. The lungs may appear normal. Bilateral lung changes are more common than unilateral lung involvement. The commonest radiological findings being peripheral or subpleural, focal or diffuse areas of consolidation, septal thickening, ground glass opacities on plain frontal radiographs, and ground glass attenuation on high resolution CT (HRCT) scans. The foci of consolidation and septal thickening are most commonly noted in the lower lobes, but may occur in all lobes. Pleural effusions, calcifications, pneumothorax, cavitation, lung collapse, mediastinal enlargement, cardiomegaly and diaphragmatic abnormalities are not characteristic or frequent findings of COVID-19 infections [2, 4, 17].

Genome sequencing conducted in Ghana in the early stages (March 12-April 1, 2020) and later stages (25–27 May, 2020) of the epidemic, showed there were 2 predominant strains/clades, the 19B and 20B clades [18]. From the last week of December 2020 to the last week of January 2021, COVID-19 cases and deaths soared significantly. The WHO attributed the sharp rise in infections and deaths to the introduction of the South African, 501Y.V2 variant of the virus to Ghana, Zambia, Botswana, and the Comoro islands [19]. Our study seeks to document any significant similarities or differences in HRCT scan findings of suspected or confirmed COVID-19 patients, infected with the old and new COVID-19 strain variants in Accra, Ghana.

## 2. Method

### 2.1. Study area, design and population

This was a retrospective study that involved the random selection of 100 COVID-19 patients confirmed with RT-PCR testing from May 2020 to February 2021. These patients tested positive before or immediately after undergoing HRCT examinations at two health facilities in Accra based on physician referrals. Fifty HRCT reports representing infections believed to be due to the initial strains of the virus were selected from 1$^{st}$ May to 31$^{st}$ August, 2020. Another 50 HRCT reports representing infections due to the newer more virulent and infectious strains were selected from 1$^{st}$ January to 28$^{th}$ February, 2021. The relevant information retrieved from the patients' request forms was entered into a database for later analysis. The data included the age, sex, clinical history/indication for the exam. Imaging findings were recorded for analysis and included the presence, type, distribution and severity of lung disease.

The HRCT scans were performed using a 64-slice, multi-detector computed tomography scanner (GE lightspeed VCT, November 2008, Milwaukee, Wisconsin, USA), and a 640-slice/320-detector row, multi-detector computed tomography scanner (Toshiba Aquilion One, TSX-301A, 2012, Toshiba Medical Systems, Tokyo, Japan).

**Inclusion criteria**

i. All non-Caucasian patients with Ghanaian nationality, of any age, referred for HRCT on account of having COVID-19 infection diagnosed by RT-PCR testing were included in the study.
ii. All non-Caucasian patients with Ghanaian nationality, of any age, referred for HRCT on suspicion of having COVID-19 infection, and diagnosed with a positive RT-PCR test, from throat and nasal swab samples taken immediately after HRCT scanning, were also included in the study.

**Exclusion criteria**

i. Caucasians and non-Ghanaians of African descent were excluded from the study.
ii. Request forms with inadequate clinical information were also excluded from the study.
iii. RT-PCR negative patients who presented for HRCT.

As this study retrospectively reviewed data, informed consent was not obtained directly from individual patients/participants, however, ethical approval for this study was appropriately sought and granted by the Euracare Ethics and Research protocol committee (Ref Number EADHC 103/20-21).

### 2.2. Data analysis

Descriptive statistics were used to analyze that data. Frequencies, mean, standard deviations, minimum and maximum data points were derived and presented using graphs and tables. These analyses were achieved with Microsoft Excel version 2016.

## 3. Results

The study descriptively compared clinical data and radiographic findings of patients who presented for HRCT examinations in 2020 and 2021 on the account of the suspicion or confirmation of having COVID-19 infection. A total of 100 individuals were included in the study comprising of 62 males and 38 females. Similar gender distribution patterns are depicted in Figure 1 for patients who presented in 2020 and 2021. The age of the study participants ranged from 14 to 84 years with a mean of 51.8 $\pm$ 15.6 years. Two patients were younger than 20 years of age and 4 patients were aged between 20 and 29 years (Figure 2). The modal age group for the study was the 40–49 year age group.

**Frequency of symptoms:** Asymptomatic patients formed 58% and 72% of the study population in 2020 and 2021 respectively. Males aged 40–60 years exhibited the most in 2020, whilst males aged 60–69 years exhibited the most in 2021 (Table 1).

**Distribution of lung involvement:** Most patients presented with bilateral lung involvement, forming 58% and 74% in 2020 and 2021 respectively. Unilateral lung involvement was observed in 4% of patients in both 2020 and 2021 (Table 2).

**Distribution of Affected zones of the lungs:** Involvement of all zones of both lungs was noted in 30% and 60% of patients in 2020 and 2021 respectively. The lower zones were the next most commonly affected area in 2020, whereas the upper and lower zones were the next most commonly affected area in 2021 (Table 3).

**Frequency of Comorbidities presented by patients:** In 2020 the commonest comorbidity recorded was diabetes mellitus ($n = 8$) and was seen most commonly in males aged 60–69 years of age. In 2021, the

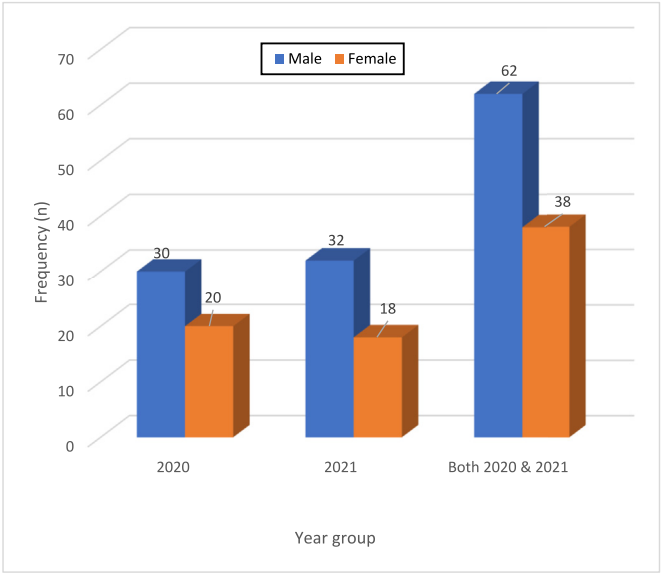


**Figure 1.** Gender distribution of patients.

commonest comorbidity was hypertension ($n = 5$). Table 4 shows details of the various age groups during the first and second strain of COVID-19 infections.

**Frequency of radiologically diagnosed COVID-19 infection:** Table 5 shows that 70 were diagnosed radiologically as suffering from the infection, with 31 and 39 positive diagnosis being made in 2020 and 2021, respectively.

**Severity of disease:** More people presented with moderate and severe disease in 2021 than in 2020. Both years had 18 patients presenting with mild disease. Normal chest CT images were seen in 19 and 10 patients in 2020 and 2021, respectively (Table 6).

**Frequency of CT findings**: Consolidation was the commonest radiographic pattern, followed by ground glass attenuation in both the 2020 and 2021 study populations. Table 7 shows the frequencies of CT patterns recorded during the study.

**History**: The clinal history of patients showed the two most common reasons for diagnostic imaging referral was on account of suspected exposure to the COVID-19 virus, and laboratory confirmation of actual infection with the COVID-19 virus. Twenty-eight (28) males and 20 females had a positive history of COVID-19 infection. In females, confirmed disease was fairly evenly distributed from 20 to 79 years, whereas in males, confirmed infection was highest in the 40–49 year group and the 60–69 year groups. Details of history are listed in Tables 8 and 9.

## 4. Discussion

In March of 2020, Ghana recorded its first two cases of COVID-19 infection in two individuals who had flown into the country from Europe. This spiraled into large numbers of infections over the next 7 months, resulting in about a little over 300 COVID-19 related deaths by the end of December 2020 [3]. In the latter half of December 2020, a new wave of COVID-19 infections was witnessed, resulting from the importation of two new variant strains of the virus. This second wave of the infections appeared to be more virulent and resulted in a total of 740 deaths by 22$^{nd}$ March 2021 [20]. This study sought to identify any similarities or differences in radiological presentations of individuals suspected, or confirmed to have been infected with the SARS-Cov-2 virus during the first and second waves of the disease. A total of 100 patients were involved in this study, 50 each from each wave of infection. The gender distribution patterns are depicted in Figure 1 and show that for both groups there were more males than females. This contrasts the findings of Vandyke-Sey et al [21], but is consistent with updates from the Ghana Health Service [21, 22]. The age of the study participants ranged from 14 to 84 years with a mean of 51.8 ± 15.6 years (Figure 2).

Majority of patients were asymptomatic in both groups, 29 (58%) in the first wave, and 36 (72%) in the second wave infections as shown in Table 1. This finding is consistent with that recorded by Vandyke-Sey et al [21]. Both groups demonstrated a lack of symptoms in patients younger than 30 years old, and older than 79 years old. In both study cohorts there were more symptomatic males than females. Men in the 40-49, 50-59 and the 60-69 age groups exhibited most symptoms in the first wave of infections, while the second wave of infections showed symptomatic males in the 40-49 and 60-69 age groups being most affected.

Information recorded from the request forms of patients showed most individuals (28 males and 20 females) presented with a positive RT-PCR test result. More confirmed cases of COVID-19 disease were recorded in the 2021 group ($n = 34$) than in the 2020 group ($n = 14$).

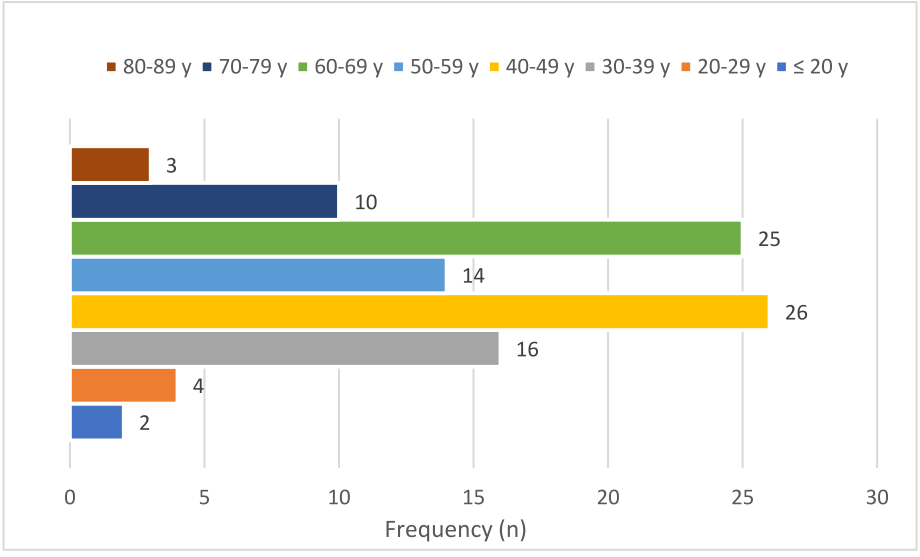


**Figure 2.** Age range distribution of patients.

**Table 1.** Distribution of symptoms presented by patients.

| Age | Gender | 2020 | | 2021 | |
|---|---|---|---|---|---|
| | | Asymptomatic (n) | Symptomatic (n) | Asymptomatic (n) | Symptomatic (n) |
| <20 | Male | - | - | 1 | - |
| | Female | 1 | - | 1 | - |
| 20–29 | Male | 1 | - | 1 | - |
| | Female | 1 | - | 1 | - |
| 30–39 | Male | 2 | 2 | 3 | 1 |
| | Female | 2 | 2 | 2 | 2 |
| 40–49 | Male | 3 | 4 | 8 | 3 |
| | Female | 3 | 2 | 1 | 2 |
| 50–59 | Male | 3 | 4 | 3 | - |
| | Female | 1 | - | 2 | 1 |
| 60–69 | Male | 5 | 3 | 6 | 4 |
| | Female | 4 | 1 | 1 | - |
| 70–79 | Male | 2 | 1 | 2 | - |
| | Female | - | 2 | 3 | 1 |
| 80–89 | Male | 1 | 0 | 1 | - |
| | Female | 0 | 0 | 1 | - |
| Total | | 29 | 21 | 36 | 14 |

**Table 2.** Distribution of lung involvement.

| Age | Gender | 2020 | | | 2021 | | |
|---|---|---|---|---|---|---|---|
| | | None (n) | Unilateral (n) | Bilateral (n) | None (n) | Unilateral (n) | Bilateral (n) |
| <20 | Male | - | - | - | 1 | - | - |
| | Female | 1 | - | - | 1 | - | - |
| 20–29 | Male | - | - | - | - | - | 1 |
| | Female | 2 | - | - | 1 | - | - |
| 30–39 | Male | 3 | - | 1 | - | - | 4 |
| | Female | 4 | - | - | 2 | - | 2 |
| 40–49 | Male | - | - | 7 | 3 | - | 8 |
| | Female | 4 | - | 1 | 1 | - | 2 |
| 50–59 | Male | 1 | - | 6 | - | - | 3 |
| | Female | - | 1 | - | 1 | - | 2 |
| 60–69 | Male | 1 | - | 8 | 1 | 2 | 6 |
| | Female | 2 | - | 3 | - | - | 1 |
| 70–79 | Male | 1 | - | 2 | - | - | 2 |
| | Female | - | 1 | - | - | - | 4 |
| 80–89 | Male | - | - | 1 | - | - | 1 |
| | Female | - | - | - | - | - | 1 |
| Total | | 19 | 2 | 29 | 11 | 2 | 37 |

Whereas more females than males were confirmed COVID positive in 2020, more males than females were COVID positive in 2021. The next most common clinical history recorded was of a suspicion of possible COVID-19 infection. Fourteen and 2 patients in the 2020 and 2021 groups respectively, reported to our imaging departments with suspicions of being infected with the COVID-19 virus. This was seen in 10 males and 6 females of all the study participants. Other less common but frequently recorded patient histories were shortness of breath or dyspnea, cough, chest discomfort or pain and cough with a fever in 5, 4, 4, and 4 patients, respectively [6, 8]. In females, the highest numbers of recorded clinical histories were in the 30-39 and 40-49 age groups, whereas in male the highest numbers were in the 60–69 years age group. Overall, all histories recorded showed higher numbers in males (Tables 8 and 9).

Co-morbidities recorded on request forms included, diabetes mellitus (DM), hypertension, (HPT) asthma, deep vein thrombosis/pulmonary embolism and cancer. The most frequent co-morbidity in the 2020 group was DM seen in 3 males. HPT was the commonest co-morbidity in the 2021 group, and seen in 3 males and 1 female. No co-morbidities were noted in 45 and 43 individuals in the 2020 and 2021 groups respectively, with comorbidities being recorded in 12 patients in the study (Table 4) [12, 13].

Table 5 depicts the frequencies of radiological diagnosis recorded during the first and second waves of infection. There were slightly more patients diagnosed on HRCT as having features of COVID-19 infection in 2021 ($n = 39$) than in 2020 ($n = 31$). This supports reports of an increase in infectivity and virulence of the new viral strain [19].

The severity of the inflammatory process as depicted on HRCT images is presented in Table 6, and graded as none, mild, moderate and severe. More people in the first wave of infection had no evidence of disease ($n = 18$) than patients in the second wave ($n = 10$). Moderate and severe disease were more frequent in second wave infections than in first wave

**Table 3.** Distribution of Affected zones of the lungs.

| Age | Gender | 2020 | | | | | | | | 2021 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Affected zones | | | | | | | | Affected zones (n) | | | | | | | |
| | | None | UZ | MZ | LZ | LUZ | LMZ | MUZ | AZ | None | UZ | MZ | LZ | LUZ | LMZ | MUZ | AZ |
| | | (n) | | | | | | | | (n) | | | | | | | |
| <20 | Male | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - |
| | Female | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - |
| 20–29 | Male | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | 1 |
| | Female | 2 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - |
| 30–39 | Male | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 |
| | Female | 4 | - | - | - | - | - | - | - | 2 | - | - | - | 1 | 1 | - | - |
| 40–49 | Male | - | - | - | 2 | - | - | 1 | 4 | 3 | - | - | - | - | - | - | 8 |
| | Female | 4 | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | 2 |
| 50–59 | Male | - | - | - | 2 | 2 | 1 | 1 | 1 | - | - | - | - | 2 | - | - | 1 |
| | Female | - | - | - | 1 | - | - | - | - | 1 | - | - | - | 1 | - | - | 1 |
| 60–69 | Male | 1 | - | - | 3 | - | - | - | 5 | 1 | 1 | - | 1 | - | - | - | 6 |
| | Female | 2 | - | - | - | 2 | - | - | 1 | - | - | - | - | - | - | - | 1 |
| 70–79 | Male | 1 | - | - | - | - | - | - | 2 | - | - | - | - | - | 1 | - | 1 |
| | Female | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 4 |
| 80–89 | Male | - | - | - | | 1 | - | - | - | - | - | - | - | - | - | - | 1 |
| | Female | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - |
| Total | | 18 | 1 | 0 | 8 | 5 | 1 | 2 | 15 | 10 | 1 | 0 | 2 | 4 | 3 | 0 | 30 |

**Distribution key:** UZ = upper zone; MZ = mid zone; LZ = lower zone; LUZ = low + upper zone; LMZ = low + mid zone; MUZ = mid + upper zone; AZ = all zones.

**Table 4.** Distribution of comorbidities presented by patients.

| Age | Gender | 2020 | | | | | | 2021 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Comorbidity (n) | | | | | | Comorbidity (n) | | | | | |
| | | None | dm | htn | asthma | DVT/PE | Ca | None | dm | htn | asthma | DVT/PE | Ca |
| <20 | Male | - | - | - | - | - | - | 1 | - | - | - | - | - |
| | Female | 1 | - | - | - | - | - | 1 | - | - | - | - | - |
| 20–29 | Male | - | - | - | - | - | - | 1 | - | - | - | - | - |
| | Female | 2 | - | - | - | - | - | 1 | - | - | - | - | - |
| 30–39 | Male | 3 | - | - | - | - | - | 3 | - | 1 | - | - | - |
| | Female | 4 | - | - | - | - | - | 2 | - | 1 | - | - | 2 |
| 40–49 | Male | 7 | - | - | - | - | - | 10 | 1 | 1 | - | - | - |
| | Female | 5 | - | - | - | - | - | 1 | - | - | - | 1 | - |
| 50–59 | Male | 5 | 1 | 1 | - | - | 1 | 3 | - | - | - | - | - |
| | Female | 1 | - | - | - | - | - | 3 | - | - | - | - | - |
| 60–69 | Male | 7 | 2 | 1 | 1 | - | - | 8 | 1 | 1 | - | - | - |
| | Female | 5 | - | - | - | - | - | 1 | - | - | - | - | - |
| 70–79 | Male | 3 | - | - | - | - | - | 2 | - | - | - | - | - |
| | Female | 1 | - | - | - | - | - | 2 | - | 0 | - | 1 | - |
| 80–89 | Male | 1 | - | - | - | 1 | - | 1 | - | - | - | - | - |
| | Female | 0 | - | - | - | - | - | 1 | - | - | - | - | - |
| Total | | 45 | 3 | 2 | 1 | 1 | 1 | 43 | 2 | 4 | 0 | 2 | 2 |

**Key:** dm = diabetes; htn = hypertension; DVT/PE = deep vein thrombosis/pulmonary embolism; Ca= Cancer.

infections. Mild disease however recorded similar numbers ($n = 18$) in both waves of infection.

The radiological findings are reported in Table 7, and consolidation was the most common finding in both the 2020 and 2021 infections. Consolidation was seen 26 and 31 patients in the 2020 and 2021 study population groups. This is consistent with findings recorded in the literature. Most lesions were seen in males, where the highest numbers were recorded in the 50–59 year group in the first wave of infection, and in the 40–49 year group in the second wave. This demonstrates a shift in vulnerability to include the younger, previously asymptomatic age group. The next commonest radiological finding was ground glass attenuation seen in 8 patients in 2020, and 7 patients in 2021. Christian Booz et al reported in a recent study that minimum intensity projection chest CT reconstructions demonstrate ground glass attenuation better than standard CT scan axial and multiplanar image reformats [23]. Tables 2 and 3 shows that more than half of the patients in each group presented with bilateral lung involvement, 29 (58%) and 37 (74%) in the 2020 and 2021 groups, respectively. Both groups had 2 patients each with unilateral disease in people aged 50 years or older. Most of the recorded radiological findings suggestive COVID-19 infection were noted

**Table 5.** Frequency of high resolution computed tomography (HRCT) findings suggestive of COVID-19 infection.

| Age | Gender | 2020 | | 2021 | |
|---|---|---|---|---|---|
| | | COVID-19 +ve (n) | COVID-19 −ve (n) | COVID-19 +ve (n) | COVID-19 −ve (n) |
| <20 | Male | - | - | - | 1 |
| | Female | - | 1 | - | 1 |
| 20–29 | Male | - | - | 1 | - |
| | Female | - | 2 | - | 1 |
| 30–39 | Male | - | 4 | 4 | - |
| | Female | - | 4 | 2 | 2 |
| 40–49 | Male | 6 | - | 8 | 3 |
| | Female | 2 | 4 | 2 | 1 |
| 50–59 | Male | 7 | - | 3 | - |
| | Female | 1 | - | 2 | 1 |
| 60–69 | Male | 8 | 1 | 8 | 1 |
| | Female | 3 | 2 | 1 | - |
| 70–79 | Male | 2 | 1 | 1 | - |
| | Female | 1 | - | 5 | - |
| 80–89 | Male | 1 | - | 1 | - |
| | Female | - | - | 1 | - |
| Total | | 31 | 19 | 39 | 11 |

**Key:** COVID-19 +ve = CT features suggestive of COVID-19 infection; COVID-19 −ve = CT features suggestive of no COVID-19 infection on HRCT images. Note: All patients were RT-PCR positive for COVID-19.

**Table 6.** Distribution of severity of disease.

| Age | Gender | 2020 | | | | 2021 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Severity (n) | | | | Severity (n) | | | |
| | | Nil of note | Mild | Moderate | Severe | Nil of note | Mild | Moderate | Severe |
| <20 | Male | - | - | - | - | 1 | - | - | - |
| | Female | 1 | - | - | - | 1 | - | - | - |
| 20–29 | Male | - | - | - | - | - | 1 | - | - |
| | Female | 2 | - | - | - | 1 | - | - | - |
| 30–39 | Male | 3 | 1 | - | - | - | 2 | 2 | - |
| | Female | 4 | - | - | - | 2 | 1 | 1 | - |
| 40–49 | Male | - | 3 | 4 | - | 3 | 4 | 4 | - |
| | Female | 4 | - | - | 1 | - | 2 | 1 | - |
| 50–59 | Male | - | 5 | 2 | - | - | 2 | 1 | - |
| | Female | - | 1 | - | - | 1 | - | 2 | - |
| 60–69 | Male | 1 | 6 | 2 | - | 1 | 3 | 3 | 2 |
| | Female | 3 | - | 2 | - | - | - | 1 | - |
| 70–79 | Male | 1 | - | 2 | - | - | 2 | - | - |
| | Female | - | 1 | - | - | - | - | 2 | 2 |
| 80–89 | Male | - | 1 | - | - | - | - | - | 1 |
| | Female | - | - | - | - | - | 1 | - | - |
| Total | | 19 | 18 | 12 | 1 | 10 | 18 | 17 | 5 |

in the lower zones of both lungs during both the first and second waves of infection [2, 4, 17, 24].

## 5. Conclusion

Our study documented both similarities and differences in HRCT findings between the two groups of study participants. There were differences in the number of positive COVID-19 cases diagnosed on HRCT and the severity of radiological manifestations during the first and second waves of infection. Similarities between both cohorts were the large numbers of asymptomatic patients, and the demonstration of consolidation as the commonest radiological presentation in both groups. The study elicits the unpredictable nature of different strains of the novel COVID-19 infection with regard to severity of radiological findings observed. There is therefore the continued need to cautiously protect lives through strict adherence to social distancing protocols, frequent hand washing and participation in the newly introduced vaccination programs. A limitation of this study was our inability to assess the significance levels of our data sets, as the segmented data sets were small, and hence statistical power would be too small to detect the differences. Another limitation was that we based our assumption of the different viral strains during the study periods on publications of other molecular tests during the specified periods, and the lack of molecular test results confirming the strain types of the patients in the study.

**Table 7.** Distribution of CT findings.

| Age | Gender | 2020 | | | | | | | 2021 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CT findings | | | | | | | CT findings | | | | | | |
| | | None | Cons. | Fibr. | GG den. | Cavity | Pleural eff. | C | None | Cons. | Fibr. | GG den. | Cavity | Pleural eff. | DC |
| | | (n) | | | | | | | (n) | | | | | | |
| <20 | Male | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| | Female | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| 20–29 | Male | - | - | - | - | - | - | - | | 1 | - | - | - | - | - |
| | Female | 2 | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| 30–39 | Male | 3 | 1 | - | - | - | - | - | - | 4 | - | - | - | - | - |
| | Female | 4 | - | - | - | - | - | - | 2 | 1 | - | 1 | - | - | - |
| 40–49 | Male | - | 5 | - | 2 | - | - | - | 3 | 7 | - | 1 | - | - | - |
| | Female | 4 | 1 | - | - | - | - | - | - | 1 | 1 | 1 | - | - | 1 |
| 50–59 | Male | - | 7 | - | 1 | - | - | - | - | 3 | 1 | - | - | - | - |
| | Female | - | 1 | - | - | | | - | 1 | 2 | - | - | - | - | - |
| 60–69 | Male | 1 | 5 | 3 | 4 | 1 | 1 | - | 1 | 6 | 1 | - | - | - | - |
| | Female | 2 | 2 | 1 | - | - | - | - | - | 1 | - | - | - | - | - |
| 70–79 | Male | 1 | 2 | 1 | - | - | - | - | - | - | - | 2 | - | - | 1 |
| | Female | - | 1 | - | - | - | - | - | - | 3 | 1 | 1 | - | 1 | - |
| 80–89 | Male | - | 1 | - | 1 | - | - | - | - | 1 | - | | - | - | - |
| | Female | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - |
| Total | | 18 | 26 | 5 | 8 | 1 | 1 | 0 | 9 | 31 | 4 | 7 | 0 | 1 | 2 |

**Key:** Cons = consolidation; Fibr. = fibrosis; GG den. = ground glass densities; Pleural eff. = pleural effusion; C = Cardiomegaly.

**Table 8.** History-frequency for both 2020 and 2021 cases.

| History | 2020 | | | 2021 | | | Total of 2020 and 2021 (n) |
|---|---|---|---|---|---|---|---|
| | Frequency (n) | | | Frequency (n) | | | |
| | Male | Female | Total | Male | Female | Total | |
| None | - | 2 | 2 | - | - | - | 2 |
| Sore throat | - | 1 | 1 | - | - | - | 1 |
| Cough | 2 | 0 | 2 | 2 | 1 | 3 | 5 |
| SOB/dyspnea | 2 | 1 | 3 | 1 | 1 | 2 | 5 |
| Headache | - | - | - | - | - | - | 0 |
| GI symptoms | - | - | - | - | - | - | 0 |
| Chest discomfort/pain | 3 | 1 | 4 | - | - | - | 4 |
| Myalgia/arthralgia | 1 | - | 1 | - | - | - | 1 |
| COVID-19 +ve | 6 | 8 | 14 | 22 | 12 | 34 | 48 |
| ? COVID-19 | 8 | 6 | 14 | 2 | 0 | 2 | 16 |
| Fever | 2 | - | 2 | - | - | - | 2 |
| Cancer | 1 | - | 1 | - | - | - | 1 |
| General malaise | 1 | - | 1 | - | - | - | 1 |
| Cough, SOB/dyspnoea and Fever | 1 | - | 1 | - | - | - | 1 |
| Cough and SOB/dyspnoea | - | - | - | 1 | 1 | 2 | 2 |
| Cough, SOB/dyspnoea, Fever and COVID-19 +ve | - | - | - | 1 | - | 1 | 1 |
| Cough, myalgia/arthralgia and COVID +ve | - | - | - | 1 | - | 1 | 1 |
| COVID +ve and SOB/dyspnoea | - | - | - | 1 | - | 1 | 1 |
| Cough and Fever | 3 | 1 | 4 | - | - | - | 4 |
| COVID +ve and general malaise | - | - | | 1 | - | 1 | 1 |
| COVID-19 +ve and cough | - | - | - | - | - | - | - |
| COVID-19 +ve, cough and SOB/dyspnoea | - | - | - | - | 1 | 1 | 1 |
| COVID-19 +ve, cough, fever and general malaise | - | - | - | - | 1 | 1 | 1 |
| COVID-19 +ve, cough, SOB/dyspnoea and myalgia/arthralgia | - | - | - | - | 1 | 1 | 1 |
| Total | 30 | 20 | 50 | 32 | 18 | 50 | 100 |

**Key:** COVID-19 +ve = COVID-19 infection which has been confirmed by a positive PCR test prior to HRCT scanning ?COVID-19 = suspected COVID-19 infection confirmed by a positive PCR test, from throat and nasal swab samples taken immediately after HRCT scanning.

**Table 9.** Clinical history - frequency of patients with respect to age categories for 2020 & 2021 cases.

| History | Female | | | | | | | | Male | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year group | | | | | | | | Year group | | | | | | | |
| | <20 | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | 70–79 | 80–89 | <20 | 20–29 | 30–39 | 40–49 | 50–59 | 60–69 | 70–79 | 80–89 |
| | (n) | | | | | | | | (n) | | | | | | | |
| None | 2 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Sore throat | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Cough | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 3 | - | - |
| SOB/dyspnea | - | - | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 |
| Headache | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| GI symptoms | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Chest discomfort/pain | - | - | 1 | - | - | - | - | - | - | - | - | 2 | 1 | - | - | - |
| Myalgia/arthralgia | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - |
| COVID +ve | - | 3 | 3 | 2 | 3 | 4 | 4 | - | - | 1 | 5 | 8 | 4 | 7 | 2 | - |
| ?COVID | - | - | 1 | 1 | - | 3 | 1 | 1 | - | - | 1 | 3 | 2 | 3 | 1 | 1 |
| Fever | - | - | - | - | - | - | - | - | - | - | - | 1 | | 1 | - | - |
| Cancer | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - |
| General malaise | - | - | - | - | - | - | - | - | - | - | - | - | | 1 | - | - |
| Cough and fever | - | - | - | 1 | - | - | - | - | - | - | 1 | - | 1 | - | 1 | - |
| Cough, SOB/dyspnoea | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| General malaise, fever, COVID-19 +ve and cough | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| Cough, SOB/dyspnoea, myalgia/arthralgia and COVID-19 +ve | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Cough and SOB/dyspnea | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - |
| SOB/dyspnoea and COVID +ve | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - |
| COVID +ve and general malaise | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Cough, myalgia/arthralgia and COVID +ve | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| Cough, SOB/dyspnoea and fever | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - |
| Cough, SOB/dyspnoea, COVID-19 +ve and fever | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | | |
| Total | 2 | 3 | 8 | 8 | 4 | 7 | 5 | 1 | 0 | 1 | 8 | 18 | 10 | 18 | 5 | 2 |

**Key:** COVID-19 +ve = COVID-19 infection which has been confirmed by a positive PCR test prior to HRCT scanning ?COVID-19 = suspected COVID-19 infection confirmed by a positive PCR test, from throat and nasal swab samples taken immediately after HRCT scanning.

## Declarations

### *Author contribution statement*

Edmund K.K Brakohiapa: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Benjamin D. Sarkodie and Benard O. Botwe: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Klenam Dzefi-Tettey, Dorothea A. Anim, Emmanuel K.M. Edzie, Philip N. Goleku, Bashiru B. Jimah and Adu Tutu Amankwa: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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### *Data availability statement*

Data will be made available on request.

### *Declaration of interests statement*

The authors declare no conflict of interest.

### *Additional information*

No additional information is available for this paper.

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