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Research article

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# The effect of national restrictions on computed tomography severity score and the prognosis of COVID-19

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**Ethics Committee Approval**
The study was approved by Giresun University Clinical Studies Ethics Committee (Approval number: 2020/11-191).
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

**Conflict of Interest**
No conflict of interest was declared by the authors.

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## Abstract

**Background/Aim:** The SARS-CoV-2 pandemic is spreading rapidly all over the world and has high mortality rates. Governments implement quarantine or restrictions to prevent the virus from getting out of control. Computed Tomography (CT) has an important place in the diagnosis of COVID-19 and patient management. This study aimed to evaluate the changes in chest CT findings and the disease prognosis of COVID-19 pneumonia during the restriction and post-restriction periods.

**Methods:** A total of 1150 patients whose COVID-19 disease was confirmed by a reverse transcriptase-polymerase chain reaction and who underwent chest CT examination between April 1-September 30, 2020 were included in this retrospective cohort study. The participants were categorized into two groups according to CT examination dates, as during (April 1-May 31), and after the restriction periods (June 1-September 30). Each patient's CT severity score (CTSS) was calculated, and the need for admission to the intensive care unit (ICU) and mortality related to COVID-19 were noted for statistical analysis.

**Results:** Of the 1150 cases, 213 were in the restriction period group (RPG), while 937 were in the post-restriction period group (PRPG). The median value of CTSS was 5 in the RPG, and 6 in the PRPG ($P$=0.095). In the RPG and PRPG, the number of patients who needed ICU admission were 20 (9.4%), and 50 (5.3%), respectively, while 12 (7%) and 39 (4.2%) patients, respectively, died from COVID-19. Both parameters were comparable between the two groups ($P$=0.073, $P$=0.060 respectively).

**Conclusion:** The restrictions did not change the severity of the COVID-19 disease, ICU hospitalization rate, and death rate.

**Keywords:** COVID-19, Computed tomography, Restriction period, Post-restriction period

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## Introduction

The first novel coronavirus SARS-CoV-2 outbreak was reported to WHO on December 31 2019 from the Hubei Province of the People's Republic of China [1, 2]. On January 30, 2020, the WHO declared COVID-19 as an international emergency that threatened public health, as a pandemic on March 11, 2020 [3]. COVID-19 may be asymptomatic or mild or may have a clinical course that may cause severe pneumonia requiring hospitalization and even intensive care [4]. The disease is associated with high mortality rates [5, 6]. Computed Tomography (CT) is a well-known modality to show the parenchymal changes associated with viral pneumonia in COVID-19 cases and helps patient management [7].

As COVID-19 has rapidly spread around the world, governments in many countries have implemented quarantine rules on an unprecedented scale. The first restrictions were imposed in China, where the epidemic started, and entry and exit bans were imposed on all cities [8]. Turkey also imposed restrictions. Shortly after the disease emerged, a curfew was imposed for people over 65 and under 18 years of age. Partial quarantine rules were gradually enacted as of April 1, 2020, and the restrictions were over as of June 1. Since the onset of the infection, community-based preventive rules such as the use of masks, social distancing, and personal hygiene continued. To the best of our knowledge, no studies determined the temporal changes in the prognosis of the disease and compared the CT severity scores (CTSS) in COVID-19 pneumonia between the restriction and post-restriction periods (i.e., when only personal protection strategies such as mask use, social distancing, and personal hygiene are implemented).

This study aimed to comparatively evaluate the changes in chest CT findings and the prognosis of COVID-19 pneumonia between the restriction and the post-restriction periods.

## Materials and methods

### Study design

This retrospective study was approved by the Ethics Committee for Clinical Studies, Giresun University (Approval number: 2020/11-191) and adhered to the principles of the Helsinki Declaration. Adult patients over 18 years of age who had received a chest CT scan for the initial diagnosis of COVID-19 pneumonia between April 1 and September 30, 2020, and confirmed to have COVID-19 disease by reverse transcriptase-polymerase chain reaction (rT-PCR) were included. Sixteen patients' CT images were excluded due to movement artifacts and a study group consisting of 1150 patients was formed. The patients' demographic features including gender, age, and comorbidities (chronic heart disease, chronic lung disease, diabetes, cerebrovascular disease, anxiety) were noted. To analyze the differences in the severity of lung involvement in chest CTs and the prognosis of COVID-19, the patients were grouped into two, as during (April, 1 – May, 30) and after the restriction period (June, 1 – September, 30).

### Image acquisition

All CT examinations were performed with a 16-slice spiral CT scanner (Emotion 16, Siemens Healthineers) from the apex to the base of the lung, during deep inspiration and breath-hold, without contrast administration. We used the following parameters: Tube voltage: 80 kVp, tube current: 35–50 mA, rotation time: 0.75 s, pitch: 1.5, slice thickness: 3 mm, and detector width: 1.5 mm.

### CT image analysis

The images were analyzed by two radiologists with experiences of 10 and 11 years, who were blinded to the study and clinical data. All discrepancies were resolved by consensus. CTSS, which is a semi-quantitative scoring suggested by Pan et al., was used to predict the severity of pulmonary parenchymal involvement (7). Each of the five lung lobes were visually scored between 0 and 5, as follows: 0) No involvement; 1) <5% involvement, 2) 5-25% involvement, 3) 26-49% involvement, 4) 50-75% involvement, and 5) >75% involvement. Total CTSS was the sum of the individual lobar scores, and it ranged from 0 (no involvement) to 25 (maximum involvement). The following features of CT findings were also recorded: (a) Lesion characteristics- ground-glass opacity (GGO), consolidation, mixed GGO (GGO and consolidation) crazy paving, reticular pattern, (b) lesion location- peripheral, central, mixed, (c) extrapulmonary findings- lymph node enlargement (short-axis diameter 10 mm) and pleural effusion.

The regions with increased lung parenchymal density were defined as GGO if the veins and bronchial walls under the density were distinguished, and as consolidation if not. Crazy paving indicated the appearance of ground-glass opacity with superimposed inter-and intralobular septal thickening. The reticular pattern was characterized by the appearance of ground-glass opacity with superimposed intralobular septal thickening.

### Comparison between groups

Restriction period group (RPG) and post-restriction period group (PRPG) were compared in terms of the presence and severity of pulmonary involvement, CT features of the lesions, intensive care unit (ICU) need, and mortality.

### Statistical analysis

Statistical analyses were performed with IBM SPSS V23. Normality distributions of quantitative data were assessed with the Kolmogorov-Smirnov test. The Mann-Whitney U test was used to compare the abnormal distribution of quantitative data. Pearson Chi-square test was used to compare qualitative data. The data were presented as n (%), mean (standard deviation), median (minimum-maximum), and median (interquartile range). $P<0.05$ was considered statistically significant.

## Results

### Demographic features

Among 1150 cases, 213 (18.5%) were in the RPG, and 937 (81.5%) were in the PRPG. Table 1 shows the demographic features of both groups. The mean age of the study group was 56 (18-95) years. The most frequent comorbid diseases were chronic heart disease, chronic pulmonary disease, and diabetes mellitus in both groups. No significant differences were found between the groups in terms of age, gender, and frequency of comorbid diseases ($P>0.05$).

Table 1: Demographic and prognosis features in the restriction and post-restriction period

| | | Restriction period | Post-restriction period | *P*-value |
|---|---|---|---|---|
| Age, y, mean(SD) | | 54 (19.2) | 56 (17.2) | 0.836 |
| | | n% | n% | |
| Gender* | Male | 94 (44.1) | 445 (47.5) | 0.375 |
| | Female | 119 (55.9) | 492 (52.5) | |
| Comorbidities* | | | | |
| | Chronic heart disease | 94 (44.2) | 381 (40.7) | 0.610 |
| | Chronic lung disease | 45 (20.9) | 158 (16.9) | 0.130 |
| | Diabetes | 30 (14.0) | 80 (8.5) | 0.378 |
| | Cerebro-vascular disease | 20 (9.3) | 96 (10.2) | 0.884 |
| | Anxiety | 15 (7) | 80 (8.5) | 0.781 |
| Prognosis* | | | | |
| | Survive | 198 (93) | 898 (95.8) | 0.073 |
| | Exitus | 15 (7) | 39 (4.2) | |
| ICU* | | | | |
| | None | 193 (90.6) | 887 (94.7) | 0.060 |
| | Yes | 20 (9.4) | 50 (5.3) | |

* n (%)

### CT findings

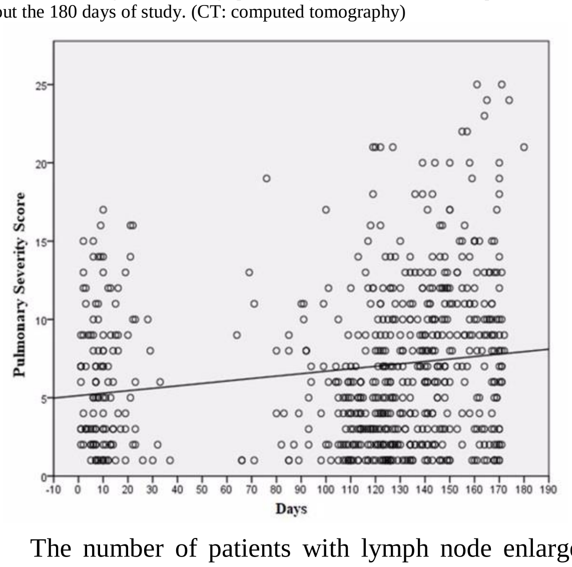
Among all patients, 673 (58.9%) had CT findings of pneumonia, 61.1% (130/213) of the RPG patients, and 58% (543/937) of the PRPG patients (*P*>0.05). Table 2 shows the extent of lung involvement in terms of the lobe, segment, CTSS, and lesion distribution. The median (IQR) CTSS values were 5 (7) in the RPG and 6 (7) in the PRPG (Figure 1) (*P*=0.095). The most common CT lesion in both groups was GGO (Figure 2). GGO was significantly more common in the PRPG, while consolidation and reticular patterns were more common in the RPG (*P*=0.009). The lesions were mostly peripheral in both groups (Figure 3). Central and mix distribution were significantly more common in the PRPG (*P*=0.038).

Table 2: CT features in the restriction period and post-restriction period

| | Restriction period | Post-restriction period | *P*-value |
|---|---|---|---|
| CT positive findings* | 130 (61) | 543 (58) | 0.410 |
| Number of Lobes Held** | 3 (1 - 5) | 4 (1 - 5) | 0.045 |
| Number of Segment Held ** | 6 (1 - 17) | 7 (1 - 18) | 0.050 |
| CTSS*** | 5 (7) | 6 (7) | 0.095 |
| Ground glass opacity (GGO) | 98 (64.5) | 418 (77.6) | <0.001 |
| Consolidation* | 24 (15.8) | 25 (4.6) | 0.001 |
| Mixed (GGO+Consolidation) * | 30 (19.7) | 96 (17.8) | 0.561 |
| Reticular Pattern* | 13 (10) | 23 (4.3) | 0.009 |
| Crazy Paving* | 15 (11.5) | 47 (8.7) | 0.317 |
| Effusion* | 13 (10.8) | 11 (2) | <0.001 |
| Lymphadenopathy* | 2 (1.5) | 5 (0.9) | 0.537 |

* n (%),** Median (minimum-maximum), *** median (IQR)

Figure 1: Scatter diagram showing pulmonary severity score on patients' CT scans throughout the 180 days of study. (CT: computed tomography)




The number of patients with lymph node enlargement was comparable between the two groups (*P*=0.537). Effusion was significantly more common in the RPG (*P*<0.001).

Figure 2: Axial CT image of a 48-year-old man in the restriction period group shows bilateral ground-glass opacities with a peripheral distribution. The pulmonary severity score was 12.

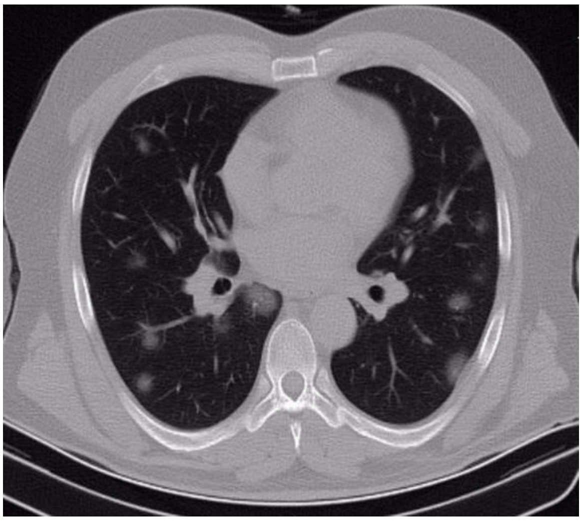
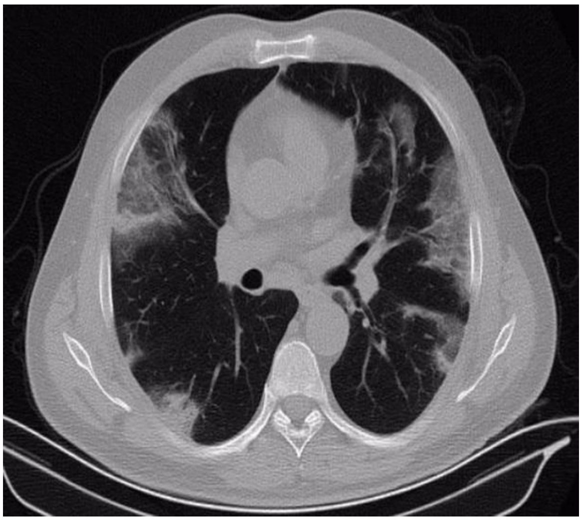


Figure 3: Axial CT image of a 62-year-old man in the post-restriction period group shows bilateral mixed pattern (ground-glass opacities and consolidation) with a peripheral distribution. The pulmonary severity score was 13.



### Disease prognosis

Seventy (6%) patients needed admission to the ICU and 54 (4.6%) patients died. In the RPG, 20 (9.4%) patients needed admission to the ICU and 15 (7%) died, while in the PRPG, 50 (5.3%) needed admission to the ICU and 39 (4.2%) died. Both parameters were comparable between the groups (*P*=0.073, *P*=0.060 respectively).

## Discussion

In our research, although there was an increase in the number of patients in the PRPG, no significant difference was found between RPG and PRPG in terms of ICU need, death rates, and CTSS.

COVID 19, which is transmitted by inhalation of SARS-CoV-2, is an airborne disease [9]. However, there is no consensus about whether the virus is transmitted through droplets or aerosol [10-12]. In China, cases related to air conditioning in a restaurant in Guangzhou and a bus trip in Hubei strengthened the thesis that the disease is transmitted through aerosols [13, 14]. Aerosol particles are smaller than droplets (<5 μm), and they can circulate in air-conditioning and ventilation systems and migrate through human airways to penetrate the alveolar space [15]. Human coronaviruses can survive on surfaces between 2 hours-9 days, and people who touch such fomites are at risk of becoming infected if they then touch their eyes, noses, or mouths [16]. Due to the fast transmission of SARS-CoV-2, crowded and closed spaces, as well as lack of hygiene, present a favorable environment for the virus to spread faster [15]. In addition, people are exposed to the viral pathogen for longer in such spaces, which may increase the viral load [17]. Studies show that the SARS-CoV-2 viral load is associated with disease severity and prognosis [18-21].

Mainly, the use of a mask, social distancing, and personal hygiene practices are recommended to reduce the spread of the virus [22, 23]. Personal protective rules can reduce its spread to a certain extent. Experts argue that community-based public guidelines such as social distancing, contact tracing, and isolation are equally successful and that such rules will be less effective than movement restriction [24]. Governments need to implement quarantine and restriction rules to prevent the virus from getting out of control and the health system from collapsing [8].

As a result of the removal of restrictions and the increase of density in crowded and closed environments, individuals are exposed to the virus longer. In parallel with this view, in our study, there was an increase in the number of cases in the PRPG. However, no significant difference was found between the two groups in terms of CTSS score, the need for ICU admission, and death rates. One of the possible reasons for this may be the decrease in the virulence of SARS-CoV-2. It is known that the genetic material of viruses can mutate in a way that makes them more or less lethal [25, 26]. Since there are six months between the RPG and PRPG, the mutation of the virus during this time is one of the possible reasons, although the probability is low.

It is possible these results may be associated with the effect of society-based preventive rules, such as mask use, social distancing, and personal hygiene, encouraged since the infection started in Turkey. It has been shown that the transmission of viruses, including SARS-CoV-2, is reduced by protective rules, such as social measures and the use of face masks [27]. Such personal protective habits can decrease viral load and thus cause a decreased rate of disease transmission and clinical severity.

Another reason could be the fact that people spend less time indoors in the summer months, and infected people are exposed to less viral load. Another factor may be the progress in treatment strategies due to clinical management of cases and accumulated experience related to the disease. For example, studies show that systemic corticosteroids improve the outcome in COVID-19 patients [28].

No studies compared the changes in disease prognosis and CT findings between RPG and PRPG. In the United Kingdom, the fatality rate (death rate per positive test) was lower in May and June when compared with March and April, with a steady decline through July and August [29]. Burgess et al. [30] reported that although there was a sharp increase in the number of SARS-CoV-2 positive tests during the summer months in many European countries, the rates of hospital admission and mortality from COVID-19 were not as high as those in March and April. They stated that the possible causes may include public health measures taken to prevent the spread of SARS-CoV-2, the decrease in the number of cases in the elderly population and the resulting decrease in mortality, and advances in treatment methods and protective rules – such as masks and social distancing – causing a decrease in viral load and therefore decreasing disease severity.

The limitations of our study include the fact that the seasonal effect on the cases in both study groups was not ruled out and that the full compliance of individuals within the restriction period was fully known.

**Conclusion**

Since there is no significant difference in the CTSS scores, death rates, and ICU need in individuals who had COVID-19 disease before and after the restriction, it can be stated that restrictions do not affect these parameters. However, it should be kept in mind that the lack of restrictions may increase the patient number and collapse the health system.

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