Clinical Characteristics of Pregnant Women with Coronavirus Disease 2019 in Wuhan, China

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Abstract

**Background:** Coronavirus disease 2019 (COVID-19) has become a pandemic. Despite the growing number of patients with COVID-19 infection, data on the clinical characteristics of pregnant patients is still limited.

**Methods:** We retrospectively included childbearing-age women patients with laboratory-confirmed COVID-19 at Renmin Hospital of Wuhan University from January 15 to February 23, 2020. Demographic, clinical, radiological, laboratory, and treatment data were reviewed. Clinical characteristics of pregnant and non-pregnant patients were compared.

**Results:** 111 childbearing-age women with COVID-19 were included, including severe or critical disease in 16 patients (14.4%). Compared with non-pregnant patients (n = 80), pregnant patients (n = 31) were less likely to have dyspnea (16.1% vs 37.5%), asthenia (3.2% vs 33.8%), and symptoms number ≥ 3 (22.6% vs 45.0%), had significantly higher neutrophil count (5.2 vs $2.5 \times 10^{9}/L$), higher percentage of CD3+ cells (76.7% vs 73.7%) and CD8+ cells (32.3% vs 28.4%), and had dramatically lower percentage of lymphocyte (18.2% vs 31.8%), lower CD4+/CD8+ ratio (1.2 vs 1.4), lower level of IgG (9.8 vs 11.9 g/L). Of note, pregnant patients had significantly lower percentage of severe disease (3.2% vs 18.8%) and substantially higher level of inflammation markers including neutrophil-to-lymphocyte ratio (4.4 vs 1.9) and systematic inflammatory index (812.8 vs 354.7) than non-pregnant patients. Seventeen livebirths were recorded and all of them showed negative results of postnatal COVID-19 detection together with a normal Apgar score.

**Conclusion:** Pregnant patients with COVID-19 had less level of severity together with enhanced inflammatory response and cell immunity when compared with non-pregnant patients.

**Key words:** COVID-2019; Pregnant Women; Clinical Characteristics; Severity.

**Key points:** Pregnant patients with COVID-19 were less severe together with enhanced inflammatory response and cell immunity when compared with non-pregnant childbearing-age female patients, the clarification of the mechanisms might shed a light for preventive or therapeutic research to overcome COVID-19.
Coronavirus disease 2019 (COVID-19) occurred in Wuhan, the capital city of Hubei Province, China, since December 2019, and rapidly spread throughout China.\(^{(1-4)}\) The World Health Organization (WHO) has declared COVID-19 as a public health emergency of international concern. Now, COVID-19 tends to become a global outbreak. Recently, most of published studies collected and analyzed clinical data from non-pregnant adults.\(^{(1-4)}\) To date, only a limited number of pregnant women with COVID-19 infection was included to investigate the possibility of intrauterine vertical transmission and no evidence for intrauterine infection was found.\(^{(5, 6)}\)

Current knowledge and clinical management of pregnant women with COVID-19 were mainly based on information from the general population.\(^{(7)}\) In spite of the growing number of pregnant women with COVID-19, data on the clinical characteristics and disease severity of pregnant patients is still limited. Considering the particularity of immune status and physiological features in pregnant women, there is urgent need to investigate the differences of clinical characteristics and severity of COVID-19 between pregnant and non-pregnant women, and the potential impact of COVID-19 infection on the clinical outcomes of fetus and neonate. Answering these questions is useful to develop effective preventive and therapeutic strategies in clinical setting. Herein, we retrospectively and simultaneously identified clinical data from pregnant and childbearing-age non-pregnant women with laboratory-confirmed COVID-19 infection at Renmin Hospital of Wuhan University, Wuhan, China. In this study, we compare the detailed clinical characteristics of pregnant patients with non-pregnant patients, and also present the neonatal outcomes in pregnant patients.

**METHODS**

**Study design and included patients**

Firstly, we retrospectively reviewed the electronic medical records of patients with laboratory-confirmed COVID-19 admitted to Renmin Hospital of Wuhan University from January 15 to February 23, 2020. As previously studies reported\(^{(1)}\), diagnosis of COVID-19 was based on the result of real-time reverse-transcriptase polymerase-chain-reaction (RT-PCR) detection for routine nasal and pharyngeal swab specimens or the serum IgM and IgG antibody detection (≥10 AU/mL was defined
as a positive result) using fully automatic chemical luminescence immunoanalysis technology under the manufactory instruction according to the New Coronavirus Pneumonia Prevention and Control Program published by the National Health Commission of China.(8) Then female patients with age from 22 to 41 years were included for further analysis. This study was approved by the Research Ethics Committee of Renmin Hospital of Wuhan University (approval number: WDRY2020-K076).

Considering the urgent need for public health outbreak investigation, written informed consent was waived. All data were anonymously collected and analyzed. All studies and treatments administered were given as part of routine standard of care.

Data collection

Demographic, clinical, laboratory, and radiological parameters and treatment data including age, gestation, exposure history, co-existing disorders, signs, symptoms, chest computed tomographic (CT) scans, laboratory findings and treatments (e.g. antiviral therapy, antibiotics/antifungal medication, systemic corticosteroid therapy, oxygen therapy, mechanical ventilation, kidney replacement therapy, extracorporeal membrane oxygenation) were identified from electronic medical records. Laboratory analyses included complete blood count, liver and renal function, electrolytes test, coagulation function, C-reactive protein, procalcitonin, lactate dehydrogenase, myocardial enzymes, and cell and humoral immunity index. Inflammation indexes including neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR) and systematic inflammatory index (SII) were calculated by using specific parameters of blood tests. NLR was defined as the absolute neutrophil count divides lymphocyte count. PLR was calculated by dividing the absolute platelet count by the lymphocyte count. SII was defined as platelet count × neutrophil count/lymphocyte count (/μL). Radiological analyses included X-ray and CT scans. Pregnant women received CT scans need to sign the written informed consent. For pregnant women, we collected the neonatal outcomes including gestational age at delivery, birthweight, Apgar score (1 minute, 5 minute), records of premature delivery, severe neonatal asphyxia and neonatal death. A team of experienced obstetrician and gynecologists, respiratory physicians reviewed and extracted the data. Last follow-up was March 10, 2020.
Statistical analysis

Categorical variables were expressed as the counts and percentages. Continuous variables were described as medians and interquartile range (IQR) values or simple ranges. Category variables were adopted by using the Chi-squared test or Fisher’s exact test. Continuous variables were compared by using independent group t tests or the Mann-Whitney test. All the analyses were performed with the use of SPSS (Statistical Package for the Social Sciences) version 20.0 software and GraphPad Prism version 6.0. For unadjusted comparisons, a two-sided \( P < 0.05 \) was considered statistically significant. Considering the possibility of type I error and analyses not adjusted for multiple comparisons, the results should be descriptively interpreted.

RESULTS

In total, 111 hospitalized childbearing-age women with laboratory-confirmed COVID-19 were included (Table 1). The median age was 31.0 years (range, 22.0-41.0 years). Fifteen (13.5%) had co-existing disorders including cardiovascular disease (5 [4.5%]), diabetes (4 [3.6%]), renal disease (2 [1.8%]), respiratory disease (1 [0.9%]), gastric ulcer (1 [0.9%]), mental sickness (1 [0.9%]) and malignancy (1 [0.9%]). Common symptoms included fever (64 [57.7%]), cough (62 [55.9%]), dyspnea (35 [31.5%]), asthenia (28 [25.2%]) and digestive tract symptoms (26 [23.4%]). Chest CT scans showed unilateral or bilateral abnormalities in the lungs of 103 (92.8%) patients, five patients with mild disease showed no abnormalities in both lungs (one in pregnant group and four in non-pregnant group) and three pregnant patients refused the CT scan. Laboratory analyses (Table 2) showed that lymphopenia (lymphocyte count, $1.3 \times 10^9$/L [IQR, 1.0-1.7]) occurred in 36 patients (32.4%), neutropenia (neutrophil count, $2.9 \times 10^9$/L [IQR, 2.0-4.8]) in 24 patients (21.6%), hypoalbuminemia (41 g/L [IQR, 37-43]) in 48 patients (43.2%), hypokalemia (3.9 mmol/L [IQR, 3.6-4.2]) in 12 patients (10.8%), prolonged prothrombin time (11.5 seconds [IQR, 11.0-12.0]) in 9 patients (8.1%), and elevated lactate dehydrogenase (189 U/L [IQR, 160-223]) in 22 patients (19.8%). Mild disease emerged in 5 patients (4.5%), moderate disease in 90 patients (81.1%), severe disease in 12 patients (10.8%) and critical disease in 4 patients (3.6%) according to the New Coronavirus Pneumonia Prevention and Control Program (5th edition) published by the National Health
Commission of China. Uncomplicated illness occurred in 5 patients (4.5%), mild pneumonia in 89 patients (80.2%), severe pneumonia in 12 patients (10.8%) and acute respiratory distress syndrome (ARDS) in 5 patients (4.5%) following WHO guideline for COVID-19. Most patients received antiviral therapy (104 [93.7%]), antibacterial therapy (89 [80.2%]), glucocorticoid therapy (41 [36.9%]), intravenous immune globulin (41 [36.9%]) and oxygen therapy (37 [33.3%]). One patient was transferred to the intensive care unit (ICU) and one received continuous renal-replacement therapy (Table 1).

Thirty-one pregnant patients and 80 non-pregnant patients were included (Table 1). Compared with non-pregnant patients, pregnant patients were younger (median age, 29.0 vs 33.0 years, \( P < 0.001 \)), less likely to have dyspnea (5 [16.1%] vs 30 [37.5%], \( P = 0.030 \)), asthenia (1 [3.2%] vs 27 [33.8%], \( P = 0.002 \)), less symptomatic (symptoms number \( \geq 3 \): 7 [22.6%] vs 36 [45.0%], \( P = 0.030 \)), (no symptom: 9 [29.0%] vs 5 [6.3%], \( P = 0.001 \)). Respiratory rate (20/minute vs 20/minute, \( P = 0.248 \); Figure 1A) and oxygen saturation (95% vs 96%, \( P = 0.293 \); Figure 1A) at initial diagnosis were analogous between two groups. Notably, pregnant patients had significantly lower percentage of severe pneumonia and ARDS according to WHO guideline for COVID-19 (1 [3.2%] vs. 16 [14.4%], \( P = 0.001 \); Figure 1B), and severe or critical disease according to China COVID-19 guideline (1 [3.2%] vs. 15 [18.8%], \( P = 0.002 \); Figure 1B), indicating lower level of severity of COVID-19 in pregnant patients.

Laboratory analyses (Table 2) showed that pregnant patients had significantly higher white blood cell count (6.9 vs 4.6 \( \times 10^{9} /L \), \( P < 0.001 \)), neutrophil count (5.2 vs 2.5 \( \times 10^{9} /L \), \( P < 0.001 \)), higher level of fibrinogen (4.43 vs 3.10 g/L, \( P < 0.001 \)), and had dramatically lower percentage of lymphocyte (18.2% vs 31.8%, \( P < 0.001 \)), lower level of albumin (37 vs 41 g/L, \( P < 0.001 \)), and shorter prothrombin time (11.0 vs 11.7 seconds, \( P < 0.001 \)). Intriguingly, pregnant patients had substantially higher level of inflammation markers including NLR ratio (4.4 vs 1.9, \( P < 0.001 \); Figure 1C) and SII (812.8 vs 354.7, \( P < 0.001 \); Figure 1C) but similar PLR ratio (150.9 vs 146.6, \( P = 0.831 \); Figure 1C) when compared with non-pregnant patients. In addition, cluster analysis of peripheral immune cells...
suggested that, in comparison with non-pregnant patients, pregnant patients had enhanced cell
immunity with increased CD3+ cells (76.7% vs 73.7%, \( P = 0.014 \); Figure 2A), CD8+ cells (32.3% vs
28.4%, \( P = 0.003 \); Figure 2A), C3 level (1.1 vs 0.9 g/L, \( P < 0.001 \); Figure 2B) but insufficient
humoral immunity with reduced CD4+/CD8+ ratio (1.2 vs 1.4, \( P = 0.023 \); Figure 2A) and IgG level
(9.76 vs 11.90 g/L, \( P < 0.001 \); Figure 2B).

Treatment options were summarized in Table 1. The percentage of pregnant patients received
oseltamivir (51.6% vs 30.0%, \( P = 0.033 \)) and glucocorticoid (64.5% vs 26.3%, \( P < 0.001 \)) was
significantly higher than non-pregnant patients. The percentage of oxygen therapy was significantly
lower in pregnant than non-pregnant group (6.5% vs 43.8%, \( P < 0.001 \)). More non-pregnant patients
received intravenous immune globulin than pregnant patients (42.5% vs 22.6%, \( P = 0.051 \)) but the
difference did not reach statistical significance. One patient was transferred to the ICU and one
received renal-replacement therapy in non-pregnant group. Only one patient died in non-pregnant
group, as of March 10, 2020.

Seventeen livebirths were recorded (Table 3). Median age of these puerperae was 29 years (range 24-
34 years). Median body length was 49 cm (range 45-52 cm) and median birthweight was 3120 g
(range 2300-3750 g). Only one premature neonate at 35 gestational weeks plus 6 days had a
birthweight lower than 2500 g (Table 3). 17 livebirths had a median 1-min Apgar score of 9 and
median 5-min Apgar score of 10. One livebirth had a 1-min Apgar score of 7 and 5-min Apgar score
of 9. All of livebirths had negative results of immediately postnatal COVID-19 detection. Two of
them had positive results of COVID-19 detection after two days of birth mainly due to the contact
transmission. Among these two livebirths, one had neonatal fever and CT scan showed viral
pneumonia. After active treatment, she has totally recovered. No neonatal hypoglycemia, neonatal
congenital malformation, severe neonatal asphyxia, or neonatal death was observed in these newborns
(Table 3).
DISCUSSION

To our knowledge, this study is one of the case series of hospitalized childbearing-age women patients with laboratory-confirmed COVID-19. In comparison with non-pregnant patients, pregnant patients were less likely to have symptoms, had significantly higher white blood cell count, neutrophil count, level of fibrinogen and C3, percentage of CD3+ and CD8+ cells, and had dramatically lower percentage of lymphocyte, level of albumin, CD4+/CD8+ ratio, level of IgG and shorter prothrombin time. Of note, pregnant patients had significantly lower percentage of severe disease according to both WHO and China COVID-19 Guidelines, and substantially higher level of inflammation markers including NLR ratio and SII than non-pregnant patients. In addition, 17 livebirths were recorded and all of them showed negative results of immediately postnatal COVID-19 detection and none of them experienced severe comorbidity.

It is well known that the morbidity and mortality of viral pneumonia is obviously higher in pregnant women compared with the general population when there is no effective antiviral therapy. The influenza epidemic of 1918 and Asian flu epidemic of 1957 had a maternal mortality rate of 30~50%. For severe acute respiratory syndrome (SARS) due to SARS-coronavirus (CoV) infection in 2003, the case-fatality rate of the pregnant cases is 25%. 50% of them needed ICU admission and 33% required endotracheal intubation, while the ICU admission rate was 17.5% \( (P = 0.012) \) and intubation rate was 12.5% \( (P = 0.065) \) in the non-pregnant group. The pregnant cases infected by Middle East respiratory syndrome coronavirus (MERS-CoV) had a case-mortality even as high as 40%. However, the current study showed that pregnant patients were less likely to be severe or critical type of COVID-19 (3.2%) according to both WHO and China COVID-19 Guidelines, which is significantly decreased than 18.8% in non-pregnant women and also significantly lower than 15.7% in the whole population from a large-scale national analysis. Moreover, this national analysis reported lower rates of severe disease among women and younger patients than among men and older patients. Similarly, Chen et al. collected 118 pregnant women with COVID-19 and reported that the risk of severe disease compared favorably with the risk in the general populations of patients with COVID-19, indicating no increased risk of severe disease among
pregnant patients. (13) Unlike influenza, SARS and MERS-CoV, pregnant patients with COVID-19 were also less likely to have symptoms such as dyspnea, asthenia and so on, suggesting COVID-19 have distinct clinical features for pregnant women. Even though more pregnant patients received oseltamivir and glucocorticoid than non-pregnant group, these is still no evidence that two drugs could effectively inhibit SARS-CoV-2 and therefore rarely affect the disease progression.

We also surveyed the distinct immunological features between pregnant and non-pregnant patients. In spites of lower percentage of lymphocyte, pregnant patients had substantially higher percentage of CD3+ and CD8+ cells, and inflammation markers including NLR, SII and C3 level when compared with non-pregnant patients. Previous studies together with the pathological examination found that cytokine release storm was the main cause for the severe disease. (14-16) Therefore, the different immunological features found in this study might contribute to the mild effect of COVID-19 in pregnant women. Furthermore, 14.4% of the females and 18.8% of non-pregnant women in our study were found to have severe disease, which is lower than 22.0-31.6% of the total population in Wuhan city during the period of January to February, 2020. (1-3) Consistently, previous study found that female patients with COVID-19 have significantly lower rate of death and severe disease than male patients. (2) As is known, COVID-19 infected the human body through binding angiotensin converting enzyme II (ACE2) and ACE2 expression was significantly higher in the male than female. (17-19) Meanwhile, it was reported that oestrogen was a protective factor from severe pneumonia in animal model. (20, 21) Collectively, the unique immune and pathophysiological features found in this study might contribute to the finding that pregnant women are less likely to develop severe COVID-19 infection. The clarification of the related mechanisms might provide clues for the development of novel preventive or therapeutic strategy in the condition that effective methods are still undetermined to overcome COVID-19 infection.
Among the 31 pregnant women group, 17 livebirths were recorded and all of them showed negative results of postnatal COVID-19 detection at the first testing and two of them became positive thereafter, indicating that vertical transmission is rarely happened. Consistently, a case of newborn infant has been reported on 5 February 2020 that was tested positive for COVID-19 at the Wuhan Children’s Hospital in Hubei Province 30 hours following its birth, suggesting strict quarantine is need to prevent mother-to-child coronavirus transmission during the delivery. As for the newborn infant, all of them were livebirths with a normal Apgar score, and no severe neonatal asphyxia was observed. While, it is reported that a high incidence of preterm delivery, admission to the ICU, spontaneous abortion or perinatal death were observed in pregnant women with SARS. The discrepancy of obstetrical outcomes might due to the severe hypoxia cause by the SARS disease, while it was less likely happened in pregnant women with COVID-19 in this study.

There are several limitations of this study that should be acknowledged. First, the sample size was relatively small and the retrospective feature of this study will inevitably have selection bias. Hence, we should cautiously interpret these findings and large-scale, multicenter study is still needed. Second, all of the included cases were from Wuhan, it would be better to collected patients in other cities of China, and even in other countries to obtain a more comprehensive understanding of the clinical characteristics in pregnant and non-pregnant childbearing-age women with COVID-19. Third, because of the short follow-up period, a small part of patients remained in the hospital. The potential impact of distinct disease severity between pregnant and non-pregnant patients on clinical outcomes was not evaluated. Forth, data collection was clinically driven and not systematic so that the findings should be descriptively interpreted. Given the novel infection, no systematic management protocols were in place and the decision to perform certain laboratories or to administer certain treatments was the clinician's, and some therapies were not based on known efficacy/recommendations. Last but not least, clinical interpretation of laboratory comparisons between pregnant and non-pregnant groups would be limited because of the inherent changes that occur in a normal pregnancy. The optimal comparisons should be conducted between mild/moderate and severe/critical disease groups in future investigations.
In conclusion, this single-center investigation involving 111 childbearing-age women with COVID-19 revealed that pregnant patients had less level of severity of COVID-19 together with enhanced inflammatory response and cell immunity when compared with non-pregnant patients. These findings would provide the useful information for understanding the pathogenesis and clinical course of pregnant patients with COVID-19 and be helpful to formulate the principles of obstetric treatment for pregnant women with COVID-19 infection.
Note

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**Potential conflicts of interest:** We declare no competing interests.

**Contributors:** JY, SR, and GW made same contributions to the study concept and design, and are the co-senior authors. BC and TJ was in charge of the manuscript draft. LZ, RH, JT, YJ, BH, JL and MW took responsibility for obtaining written consent from patients, obtaining ethical approval, collecting samples, and confirming data accuracy. TJ and SR made contributions to data acquisition, analysis, and interpretation. BC and LZ was the pediatrician in charge of treatment of the newborn babies. RH, JT, and YJ were the obstetricians of the pregnant women, and were responsible for data collection and confirmation. JL and MW were in charge of the laboratory tasks, including sample processing and detection. JY and GW made substantial revisions to the manuscript.
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Figure legends

Figure 1. Comparison of disease severity between Pregnant and Non-pregnant Women with COVID-2019. A. Comparison of respiratory rate and oxygen saturation between P and NP women with COVID-2019; B. Comparison of disease severity classification between P and NP women with COVID-2019 according to WHO guideline for COVID-19 and China guideline for COVID-19; C. Comparison of NLR ratio, PLR ratio and SII index at initial diagnosis between P and NP Women with COVID-2019. NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; SII, systematic inflammatory index; P, pregnant; NP, non-pregnant.

Figure 2. Comparison of cell and humoral immunity between Pregnant and Non-pregnant Women with COVID-2019. A. Comparison of the percentage of CD3+ cells, CD4+ cells and CD8+ cells, CD19+ cell, CD16+CD56+ cell and CD4+/CD8+ ratio at initial diagnosis between P and NP women with COVID-2019; B. Comparison of the level of IgG, IgM, IgA, IgE, C3 and C4 at initial diagnosis between P and NP women with COVID-2019. P, pregnant; NP, non-pregnant.
Table 1. Clinical Characteristics of the Study Patients.

|                          | Total (n=111) | Pregnant (n=31) | Non-pregnant (n=80) | \( P \text{ value} \) |
|--------------------------|--------------|----------------|---------------------|----------------------|
| Age (yrs)                |              |                |                     |                      |
| Median (range)           | 32.0 (22.0-41.0) | 29.0 (24.0-41.0) | 33.0 (22.0-41.0)    | 0.001                |
| Distribution — no. (%)   |              |                |                     |                      |
| 22–29 years              | 39 (35.1%)   | 17 (54.8%)     | 22 (27.5%)          | 0.007                |
| 30–39 years              | 63 (56.8%)   | 13 (41.9%)     | 50 (62.5%)          | 0.050                |
| 40–41 years              | 9 (8.1%)     | 1 (3.2%)       | 8 (10.0%)           | 0.432                |
| Gestation (weeks) — no. (%) |            |                |                     |                      |
| 1–13 (+6 days)           | 5 (4.5%)     | 5 (16.1%)      | /                   | /                    |
| 14–27 (+6 days)          | 6 (5.4%)     | 6 (19.4%)      | /                   | /                    |
| 28–40                    | 20 (18.0%)   | 20 (64.5%)     | /                   | /                    |
| Co-existing disorders — no. (%) |        |                |                     |                      |
| Cardiovascular diseases  | 5 (4.5%)     | 1 (3.2%)       | 4 (5.0%)            | 0.916                |
| Respiratory diseases     | 1 (0.9%)     | 0 (0.0%)       | 1 (1.3%)            | 0.621                |
| Diabetes                 | 4 (3.6%)     | 3 (9.7%)       | 1 (1.3%)            | 0.117                |
| Malignancy               | 1 (0.9%)     | 0 (0.0%)       | 1 (1.3%)            | 0.621                |
| Renal diseases           | 2 (1.8%)     | 1 (3.2%)       | 1 (1.3%)            | 0.926                |
| Gastric ulcer            | 1 (0.9%)     | 0 (0.0%)       | 1 (1.3%)            | 0.621                |
| Mental sickness          | 1 (0.9%)     | 1 (3.2%)       | 0 (0.0%)            | 0.621                |
| Total                    | 15 (13.5%)   | 6 (19.4%)      | 9 (11.3%)           | 0.263                |
| Signs and symptoms — no. (%) |        |                |                     |                      |
| Fever on admission       | 64 (57.7%)   | 15 (48.4%)     | 49 (61.3%)          | 0.219                |
| Cough                    | 62 (55.9%)   | 14 (45.2)      | 48 (60.0%)          | 0.158                |
| Nasal congestion         | 2 (1.8%)     | 0 (0.0%)       | 2 (2.5%)            | 0.926                |
| Rhinorrhea               | 1 (0.9%)     | 1 (3.2%)       | 0 (0.0%)            | 0.621                |
| Sore throat              | 14 (12.6%)   | 1 (3.2%)       | 13 (16.3%)          | 0.125                |
| Myalgia or arthritis     | 9 (8.1%)     | 1 (3.2%)       | 8 (10.0%)           | 0.432                |
| Headache                 | 2 (1.8%)     | 0 (0.0%)       | 2 (2.5%)            | 0.926                |
| Dizziness                | 3 (2.7%)     | 0 (0.0%)       | 3 (3.8%)            | 0.659                |
| Dyspnea                  | 35 (31.5%)   | 5 (16.1%)      | 30 (37.5%)          | 0.030                |
| Asthenia                 | 28 (25.2%)   | 1 (3.2%)       | 27 (33.8%)          | 0.002                |
| Digestive tract symptoms | 26 (23.4%) | 3 (9.7%) | 23 (28.8%) | 0.060 |
|--------------------------|------------|----------|------------|-------|
| No symptoms              | 14 (12.6%) | 9 (29.0%) | 5 (6.3%)   | 0.001 |
| Symptoms number≥3        | 43 (38.7%) | 7 (22.6%) | 36 (45.0%) | 0.030 |

| Abnormalities on chest CT — no. (%) |
|-------------------------------------|
| Normal                              | 5 (4.5%) | 1 (3.2%) | 4 (5.0%) | 0.067 |
| Unilateral                          | 32 (28.8%) | 11 (35.5%) | 21 (26.3%) | 0.335 |
| Bilateral                           | 71 (64.0%) | 16 (51.6%) | 55 (68.8%) | 0.092 |
| Not applicable                      | 3 (2.7%) | 3 (9.7%) | 0 (0.0%) | 0.030 |

| Treatments |
|------------|
| Antiviral medication — no. (%)   | 104 (93.7%) | 29 (93.5%) | 75 (93.8%) | 0.692 |
| Oseltamivir — no. (%)            | 40 (36.0%) | 16 (51.6%) | 24 (30.0%) | 0.033 |
| Arbidol — no. (%)                | 92 (82.9%) | 25 (80.6%) | 67 (83.8%) | 0.697 |
| Ribavirin — no. (%)              | 22 (19.8%) | 8 (25.8%) | 14 (17.5%) | 0.325 |
| Intravenous antibiotics — no. (%)| 89 (80.2%) | 29 (93.5%) | 60 (75.0%) | 0.053 |
| Antifungal medication — no. (%)  | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | / |
| Systemic glucocorticoids — no. (%)| 41 (36.9%) | 20 (64.5%) | 21 (26.3%) | <0.001 |
| Oxygen therapy — no. (%)         | 37 (33.3%) | 2 (6.5%) | 35 (43.8%) | <0.001 |
| Mechanical ventilation — no. (%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | / |
| Invasive — no. (%)               | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | / |
| Non-invasive — no. (%)           | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | / |
| Use of ECMO — no. (%)            | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | / |
| Use of intravenous immune globulin — no. (%) | 41 (36.9%) | 7 (22.6%) | 34 (42.5%) | 0.051 |
| Use of CRRT — no. (%)            | 1 (0.9%) | 0 (0.0%) | 1 (1.3%) | 0.621 |
| Admission to intensive care unit — no. (%) | 1 (0.9%) | 0 (0.0%) | 1 (1.3%) | 0.621 |

CRRT: continuous renal-replacement therapy
Table 2. Laboratory Findings of the Study Patients.

| Blood cell count | Normal Range | Median (IQR) | P value | Total (n=111) | Pregnant (n=31) | Non-pregnant (n=80) |
|------------------|--------------|--------------|---------|--------------|-----------------|--------------------|
| White blood cell count (*10^9/L) | 3.5-9.5 | 5.2 (3.8-7.2) | 6.9 (5.6-9.1) | 4.6 (3.5-6.1) | 0.001 |
| Lymphocyte count (*10^9/L) | 1.1-3.2 | 1.3 (1.0-1.7) | 1.1 (0.9-1.5) | 1.3 (1.1-1.8) | 0.113 |
| Lymphocyte % | 20.0-50.0 | 28.4 (19.2-36.7) | 18.2 (12.4-23.9) | 31.8 (24.9-38.7) | <0.001 |
| White blood cell count - lymphocyte count (*10^9/L) | 0.3-8.4 | 3.6 (2.6-5.6) | 5.6 (4.1-8.0) | 3.2 (2.2-4.3) | <0.001 |
| Neutrophil count (*10^9/L) | 1.8-6.3 | 2.9 (2.0-4.8) | 5.2 (3.6-7.4) | 2.5 (1.7-3.3) | <0.001 |
| Neutrophil % | 50.0-70.0 | 61.8 (52.4-72.4) | 73.6 (68.5-81.9) | 56.6 (50.1-65.2) | <0.001 |
| Platelet count (*10^9/L) | 125-350 | 205 (158-255) | 180 (165-233) | 213 (157-257) | 0.414 |
| Hemoglobin (g/L) | 115-150 | 125 (115-133) | 120 (112-130) | 127 (117-133) | 0.779 |

Blood biochemical analysis

| C-reactive protein (mg/L) | <10.0 | 2.5 (2.5-15.0) | 8.8 (2.5-33.4) | 2.5 (2.5-10.3) | 0.480 |
| Procalcitonin (ng/mL) | <0.10 | 0.034 (0.023-0.056) | 0.068 (0.043-0.090) | 0.03 (0.01-0.04) | 0.715 |
| Sodium (mmol/L) | 137-147 | 140 (139-144) | 140 (137-144) | 140 (139-143) | 0.610 |
| Potassium (mmol/L) | 3.5-5.3 | 3.9 (3.6-4.2) | 3.9 (3.6-4.0) | 4.0 (3.6-4.3) | 0.086 |
| Chloride (mmol/L) | 99-110 | 108 (105-109) | 107 (105-109) | 107 (105-109) | 0.324 |
| Albumin (g/L) | 40-55 | 41 (37-43) | 37 (33-39) | 41 (39-43) | <0.001 |
| Total bilirubin (μmol/L) | 0-23 | 7.8 (6.0-10.3) | 8.4 (7.3-11.9) | 7.3 (5.6-9.4) | 0.624 |
| Test                                      | Min  | Result (Reference)     | Result (Reference)     | Result (Reference)     | p    |
|-------------------------------------------|------|------------------------|------------------------|------------------------|------|
| Alanine aminotransferase (U/L)            | 7-40 | 15.5 (10.8-22.0)       | 15.5 (11.0-24.3)       | 15.5 (10.0-20.8)       | 0.411|
| Aspartate aminotransferase (U/L)          | 13-35| 19.5 (16.0-24.0)       | 21.0 (16.0-25.8)       | 19.0 (16.0-23.0)       | 0.313|
| Lactate dehydrogenase (U/L)               | 10-250| 189 (160-223)          | 200 (181-254)          | 182 (152-218)          | 0.311|
| Blood urea nitrogen (mmol/L)              |       |                        |                        |                        |      |
| Creatinine (μmol/L)                       | 41-73| 47.5 (42.0-53.0)       | 43.0 (37.3-49.8)       | 50.0 (44.0-53.0)       | 0.380|
| Creatine kinase-MB (ng/mL)                | <5.00| 0.58 (0.43-0.73)       | 0.61 (0.35-1.12)       | 0.54 (0.45-0.67)       | 0.531|
| Myohemoglobin (μg/L)                      | 0-110| 20 (14-28)             | 16 (11-29)             | 22 (16-28)             | 0.356|
| NT-pro B-type natriuretic peptide (pg/mL) | 0-450| 30 (17-62)             | 45 (18-91)             | 22 (12-47)             | 0.268|
| Prothrombin time (second)                 | 9.0-13.0| 11.5 (11.0-12.0)     | 11.0 (10.7-11.3)       | 11.7 (11.2-12.4)       | <0.001|
| Activated partial thromboplastin time (second) | 25.0-31.3| 28.2 (26.2-30.3)  | 27.8 (25.0-29.7)       | 28.2 (26.5-30.4)       | 0.332|
| Fibrinogen (g/L)                          | 2.00-4.00| 3.64 (2.84-4.43)      | 4.43 (3.99-5.12)       | 3.10 (2.51-3.81)       | <0.001|
| D-dimer (mg/L)                            | 0.0-0.6| 0.5 (0.2-1.4)          | 1.8 (0.8-3.3)          | 0.3 (0.2-0.5)          | 0.015|
| Fibrinogen degradation products (mg/L)    | 0.00-5.00| 1.49 (0.56-4.57)      | 5.15 (2.19-9.66)       | 0.70 (0.37-1.56)       | 0.211|
| Antithrombin-3 (%)                        | 80.0-120.0| 92.4 (82.6-99.9)      | 92.9 (82.3-102.9)      | 91.9 (83.1-97.6)       | 0.329|
| **Cell immunity, \*109/L**               |      |                        |                        |                        |      |
| CD3+ cell %                               | 56.0-86.0| 74.9 (69.8-78.6)      | 76.7 (73.5-80.0)       | 73.7 (68.4-77.4)       | 0.014|
| CD3+ cell count                           | 723.0-2737.0| 858.0 (704.8-1131.0) | 938.5 (741.5-1061.8)  | 845.0 (635.8-1138.5)  | 0.717|
| CD4+ cell %                               | 33.0-58.0| 40.3 (35.9-45.8)      | 39.7 (35.3-41.5)       | 41.1 (36.0-46.1)       | 0.313|
| CD4+ cell count                           | 404.0-1612.0| 477.5 (341.8-640.8)  | 463.0 (360.5-597.25)  | 481.0 (325.3-653.3)   | 0.606|
| CD8+ cell %                               | 13.0-39.0| 29.5 (23.8-34.2)      | 32.3 (26.6-38.0)       | 28.4 (22.3-32.4)       | 0.003|
| Test                          | Lower Limit | Upper Limit | Median | IQR | P-value  |
|-------------------------------|-------------|-------------|--------|-----|----------|
| CD8+ cell count               | 220.0-1129.0| 357.5(233.0-458.8)| 426.0 (344.3-465.3) | 329.0 (228.3-452.5) | 0.079    |
| CD4+/CD8+ ratio               | 0.9-2.0     | 1.4 (1.1-1.8) | 1.2 (0.9-1.6) | 1.4 (1.1-2.0) | 0.023    |
| CD19+ cell %                  | 5.0-22.0    | 12.2 (9.5-15.0) | 10.3 (8.7-13.7) | 12.7 (9.9-16.5) | 0.091    |
| CD19+ cell count              | 80.0-616.0  | 129.0 (96.3-185.5) | 127.5 (94.0-163.3) | 132.0 (96.5-209.0) | 0.324    |
| CD16+CD56+ cell %             | 5.0-26.0    | 11.1 (7.9-14.9) | 9.7 (7.8-14.8) | 11.2 (8.2-14.8) | 0.244    |
| CD16+CD56+ cell count         | 84.0-724.0  | 123.0 (81.3-171.8) | 123.0 (74.0-163.8) | 123.0 (85.8-171.8) | 0.361    |
| **Humoral immunity, g/L**     |             |             |        |     |          |
| IgG                           | 7.0-16.0    | 11.35 (10.10-12.88) | 9.76 (8.19-11.13) | 11.90 (10.90-13.50) | <0.001   |
| IgM                           | 0.4-2.3     | 1.25 (0.91-1.56) | 1.08 (0.90-1.44) | 1.27 (0.92-1.71) | 0.170    |
| IgA                           | 0.7-4.0     | 2.01 (1.52-2.33) | 1.83 (1.45-2.18) | 2.05 (1.56-2.44) | 0.179    |
| IgE (IU/mL)                   | <100.0      | 34.7 (9.15-118.5) | 29.9 (9.15-59.65) | 37.7 99.2-125.8 | 0.174    |
| C3                            | 0.9-1.8     | 1.0 (0.8-1.1) | 1.1 (1.0-1.2) | 0.9 (0.8-1.0) | <0.001   |
| C4                            | 0.1-0.4     | 0.2 (0.2-0.3) | 0.2 (0.2-0.4) | 0.2 (0.2-0.3) | 0.255    |
| Patient ID | P1  | P2  | P3  | P4  | P5  | P6  | P7  | P8  | P9  | P10 | P11 | P12 | P13 | P14 | P15 | P16 | P17 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Puerpera age (years) | 29  | 32  | 34  | 29  | 26  | 31  | 28  | 27  | 28  | 30  | 28  | 31  | 29  | 27  | 26  | 30  | 28  |
| Gestational age at delivery | 37 weeks, 1 days | 39 weeks, 1 days | 37 weeks, 6 days | 35 weeks, 6 days | 40 weeks, 1 days | 41 weeks, 2 days | 39 weeks, 4 days | 40 weeks, 3 days | 37 weeks, 1 days | 38 weeks, 4 days | 39 weeks, 3 days | 39 weeks, 1 days | 39 weeks, 1 days | 38 weeks, 1 days | 37 weeks, 1 days | 36 weeks, 3 days |
| Premature delivery | No | No | No | Yes | Yes | No | No | No | Yes | No | No | No | No | No | No | No | No |
| Neonatal sex | Female | Female | Female | Female | Female | Male | Female | Female | Male | Male | Male | Female | Male | Male | Male | Female |
| Apgar score (1 min) | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 7 | 9 | 9 |
| Apgar score (5 min) | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 10 | 10 | 10 |
| Birthweight (g) | 2890 | 3750 | 3400 | 2830 | 2300 | 3360 | 3450 | 3140 | 2900 | 2650 | 3680 | 3720 | 2940 | 3570 | 2650 | 3000 | 3120 |
| Neonatal body length | 49 | 51 | 50 | 46 | 50 | 50 | 52 | 48 | 48 | 49 | 52 | 51 | 49 | 50 | 47 | 49 | 45 |
| Neonatal congenital malformation | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Neonatal fever | No | No | No | No | No | No | No | No | No | No | No | No | Yes | No | No | No | No |
| Neonatal hypoglycemia | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Severe neonatal asphyxia | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Neonatal death | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Postnatal admission to intensive care unit | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
| Postnatal mechanical ventilation | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No | No |
Figure 1

(A) Respiratory rate

(B) SpO₂

(C) NLR, PLR, SII index
Figure 2

**A. Cell immunity**

- CD3+ cell
  - Percentage (%): $P = 0.014$
- CD4+ cell
  - Percentage (%): $P = 0.313$
- CD8+ cell
  - Percentage (%): $P = 0.003$
- CD4+CD8+ ratio
  - Ratio: $P = 0.003$
- CD19+ cell
  - Percentage (%): $P = 0.001$
- CD16+CD56+ ratio
  - Ratio: $P = 0.044$

**B. Humoral immunity**

- IgG
  - Concentration (IU/L): $P = 0.001$
- IgM
  - Concentration (IU/L): $P = 0.170$
- IgA
  - Concentration (IU/L): $P = 0.170$
- IgE
  - Concentration (IU/L): $P = 0.174$
- C3
  - Concentration (g/L): $P < 0.001$
- C4
  - Concentration (g/L): $P = 0.250$