

COVID-19 Infection and Children: A Comprehensive Review

Abstract

Nowadays, COVID-19 is in pandemic stage, and concerns about the infection of children are on the rise. At first, it has been believed that children are not at risk while some evidences have shown that the risk of infection is lower in children than adults. The COVID-19 children indicated milder symptoms including cough, fever, sore throat, myalgia sneezing, and fatigue than COVID-19 adults. Lymphopenia, which is prevalent in adult cases, has not been reported in pediatric patients. The COVID-19 can also occur in neonates although vertical transmission from mothers to fetuses during pregnancy is rare. Overall, the outcome is better in children than adults. Thus far, there has been neither specific treatment for eradicating the infection nor any preventative vaccine for COVID-19. Preventive measures such as frequent hand washing, social distancing and wearing face mask are the best ways.

Keywords: COVID-19, pediatric, newborn

Introduction

Coronaviruses are a big family of enveloped, non-segmented and single-stranded RNA viruses.^[1] Two previous coronaviruses, Middle East Respiratory Syndrome (MERS, introduced in 2012) and Severe Acute Respiratory Syndrome (SARS, introduced in 2003) infected 2,429 and 8,000 individuals, respectively.^[2,3] In December 2019, a new coronavirus known as COVID-19 with high transmissibility and infectivity rates was found in Wuhan, China.^[4] Transmission happens through large droplets from coughing or sneezing via both asymptomatic and symptomatic cases.^[5] The droplets can spread over a distance of 1–2 m and remain on surfaces. Inhalation of the droplets and touching contaminated surfaces are the main routes of transmission. Aerosol, fecal-oral, and transplacental transmissions are also hypothesized.^[6,7] The COVID-19, which is a group 2c β -coronavirus, has pangolin as its intermediate host and is inactivated at 56°C heat for 30 min and in 75% ethanol as well as in disinfectants containing chlorine.^[8] The COVID-19 can influence all age groups. The most common affected locations by the virus are nasal cavities and throats.^[9]

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Its basic reproduction number (R_0) is between 2 and 3.6, which is the average number of secondary infections produced by an affected case without any protection.^[10,11] An asymptomatic case can infect many others because the incubation period of the COVID-19 is estimated about 14 days.

The stage of the infection is pandemic at this time, and most countries are affected. By March 16, 2020, the number of infected countries was 143 as reported by the World Health Organization (WHO).^[12] The higher rate of the COVID-19 related to pneumonia among males and Asians could be due to their having more angiotensin-converting enzyme 2 (ACE2) receptors.^[13,14] The COVID-19 virus uses SARS–coronavirus and ACE2 receptors to enter into the host cells.^[15]

The COVID-19 presentation ranges from an asymptomatic state to acute respiratory distress syndrome. Most patients have clinical symptoms including shortness of breath, fever, headache, cough, myalgia, and fatigue.^[16] At the end of the first week, based on cytokines levels (IL2, GCSF, IL7, IP10, IL10, MCP1, TNF α and MIP1A), some patients can develop pneumonia and respiratory failure, and in severe cases, death may occur.^[17] Near one-third of patients need intensive care unit admission.^[18] The mortality rate has been reported 2–3%, while it can rise

How to cite this article: Mehrabani S. COVID-19 infection and children: A comprehensive review. *Int J Prev Med* 2020;11:157.

Sanaz Mehrabani

Non-Communicable Pediatric Diseases Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, IR Iran

Address for correspondence:

Dr. Sanaz Mehrabani,
Non-Communicable Pediatric Diseases Research Center,
No 19, Amirkola Children's Hospital, Amirkola, Babol, Mazandaran Province, 47317-41151, IR Iran.
E-mail: mehrabanisanz@gmail.com

Access this article online

Website:
www.ijpvmjournal.net/www.ijpvm.net

DOI:
10.4103/ijpvm.IJPVM_277_20

Quick Response Code:



as high as 4–11% in patients admitted to intensive care units.^[19]

The COVID-19 is diagnosed using molecular tests on respiratory samples (swab samples from nose and throat, sputum, endotracheal aspirates as well as bronchoalveolar lavage).^[18] Laboratory test results, indicating COVID-19 infection include lymphopenia (a lymphocyte count <1,000) and elevated levels of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). In some cases, thrombocytopenia and elevated levels of aspartate transaminase/alanine aminotransferase (AST/ALT), prothrombin time, creatinine, D-dimer, creatine phosphokinase (CPK), and lactate dehydrogenase (LDH) are evident.^[18]

Although the chest X-ray can be normal in the early stages, it represents bilateral infiltrates. The computed tomography (CT) scans show ground-glass opacities, infiltration, and subsegmental consolidation. The CT scans from suspected or asymptomatic patients can be abnormal.^[20]

The evidence suggests that this disease was milder among patients outside Wuhan province in China and among those living in countries other than China.^[21]

No specific treatment or prevention has yet been found for the virus. Provision of oxygen may be needed via nasal prongs, high flow nasal cannula (HFNC), face mask as well as non-invasive ventilation, and in severe cases, mechanical ventilation and even extracorporeal membrane oxygenation (ECMO). Based on previous SARS experience, the ribavirin and lopinavir/ritonavir can be administered.^[18] In the case of coinfection, antibiotic or antifungal treatments are recommended. There is no proof of benefit from corticosteroid treatment.^[17] Other possible treatments are interferons (IFNs), intravenous immunoglobulin, and chloroquine.^[22,23] Hydroxychloroquine (an analogue of chloroquine) has indicated *in vitro* efficacy against COVID-19.^[24] Gautret *et al.* found that azithromycin plus hydroxychloroquine is more efficient to eliminate the COVID-19,^[25] but not effective to prevent the disease occurrence.^[26]

According to the European Medicines Agency, as fever is a common and good prognostic symptom, the administration of non-steroidal anti-inflammatory drugs (NSAIDs) is safe for some patients with COVID-19 to control fever.^[27] Lopinavir which is used to treat the HIV and contraindicated in patients with severe hepatic insufficiency has been a useful treatment for SARS and MERS and now for COVID-19 based on some evidences.^[28-30] IFN- α which has antiviral effects inhibits viral spread and replication.^[30] In patients infected by MERS, the combination of INF- α and ribavirin has reduced viral replication and improved clinical responses.^[31] Ribavirin has broad-spectrum antiviral effects on viruses with RNA and DNA. Its intravenous

infusion at a dose of 10 mg/kg every time (2–3 times daily) is recommended for children with COVID-19.^[32]

Remdesivir as an antiviral medication is used for patients with COVID-19 and demonstrates favorable results to shorten the duration of the recovery in hospitalized patients.^[33]

It has been proposed that the Bacillus Calmette-Guérin (BCG) vaccine be effective for preventing COVID-19, whereas a recent study has illustrated that the BCG vaccination does not protect against COVID-19.^[34]

To date, no preventative vaccine has been found for COVID-19; therefore, the best way is to avoid exposure to this virus.^[35] Prevention strategies include: wearing surgical face masks or N-95 respirators, washing hands regularly with soap or 75% alcohol solutions, keeping the room ventilated, avoiding unnecessary communications, staying away from infected person as much as possible, avoiding raw foods, reducing restaurant food deliveries, covering coughs and sneezes with a tissue and then throwing it away in a healthy way, keeping the unwashed hands away from eye, nose and mouth as well as keeping away from animals.^[35,36] Mobile phone usage restriction, especially in health care situations and its proper disinfection are recommended.^[37]

Clinical and Research Effects

COVID-19 and Children

At first, it was supposed that children were immune to COVID-19, but a study in China on 44,672 confirmed cases illustrated that 2% of patients were children aged 0–19 years old.^[38] An Italian study represented that only 1.2% of 22,512 affected cases were children, whereas this infected rate was 5% for children in an American study.^[39]

Children compared to adults have milder symptoms including cough, fever, sore throat, myalgia, sneezing, and fatigue.^[18] A study in China suggested that only 34% of children with confirmed COVID-19 had clinical symptoms.^[40] In children, the fever is less than 38°C,^[41,42] and other symptoms include diarrhea, rhinorrhea, fatigue, tachypnea, vomiting, and tachycardia.^[42] Dong *et al.* reported that out of 2,241 children with confirmed COVID-19 which was more common in children younger than 1 year old, 52% of cases were severe and 0.06% were critical.^[40] In a study from the USA, the intensive care admission rate was 2.5% for COVID-19 children.^[43]

In the other study, 34 (20 females and 14 males) COVID-19 children with the mean age of 8 years were admitted to a hospital in Shenzhen, China. Among them, 26 (76.4%) cases were residents of Hubei province or had a travel history to there, and their most common symptom was fever.^[44]

Zachariah *et al.* reviewed medical records of 50 children with COVID-19 symptoms and expressed that the fever

and respiratory symptoms were the most frequent ones. Gastrointestinal symptoms were found in 6% of cases. Obesity was the most common comorbidity. Infants and immune-compromised patients were not at increased risk of severe disease. Patients with severe form of the disease had significantly higher CRP and procalcitonin (PCT) levels.^[45]

In COVID-19 children, the radiological findings typically indicate ground-glass opacities and nodules mostly in the lower lobe of lungs while the disease is not severe. In about 50–80% of the affected children, the CT scans demonstrate the typical findings.^[46-48]

Xia *et al.* reported consolidation with a surrounding halo in half of the infected children. It was correlated to a higher level of calcitonin (bacterial co-infection) which was only observed in pediatric cases.^[49]

Moreover, there is a difference between pediatric and adult patients in terms of laboratory findings.

The lymphopenia (reduced numbers of CD4 and CD8) which is prevalent and can predict disease severity in adult cases has not often been seen in pediatric patients as well as changes in neutrophil-to-lymphocyte and T-cell subtypes are more common in adults.^[16,47] On the other hand, adult patients with COPD, diabetes, hypertension, and smoking history are at higher risk due to the upregulation of angiotensin-converting enzyme 2 (ACE2) receptor, which is not the case for children.^[50] However, it should be taken care of children with underlying lung diseases such as cystic fibrosis.^[51]

Henry *et al.* stated that among 66 confirmed pediatric cases, near 70% of them had normal leukocyte counts as well as neutrophils and neutrophilia were rare. Furthermore, the elevated levels of CRP and PCT were found in 13% and 10% of the pediatric patients, respectively.^[52] According to a study by Lu *et al.*, ground-glass opacity was present in one-third of the affected children, and near 15% of them had no symptoms or radiological features of COVID-19. Nevertheless, another study demonstrated that 60% of infected children had patchy ground-glass opacities on their CT scans.^[33,42]

Treatments in children are supportive, antibiotic for bacterial superinfection, and anti-viral. Shen *et al.*'s study on hospitalized children with COVID-19 displayed that the lopinavir/ritonavir and azithromycin were used for treatment.^[53]

Shi *et al.* reported the isolation of 2 specific human neutralizing monoclonal antibodies against SARS-CoV-2 from convalescent adult patients.^[54]

Because infected children, like asymptomatic and mild symptomatic individuals, are a source of disease transmission, preventive behaviors are also recommended for them.^[55]

COVID-19 and neonates

Since COVID-19 is in a pandemic stage; hence, the pregnant women are at risk of infection, but whether COVID-19 increases the risk of stillbirth, miscarriage, preterm delivery, and fetal problems is not clear.^[56]

To date, three cases of infected neonates were reported in China.^[47] Although the symptoms are different in neonates, fever, runny nose, cough, respiratory distress and vomiting are reported for them.^[57] In Iran, three neonates were born from infected mothers, two of them died after delivery while their tests were negative.^[56] Chen *et al.* reported no COVID-19 nucleic acid in the placenta or throat of the neonates born from infected women.^[58] In the other study, Chen *et al.* found that pregnant infected women had symptoms similar to non-pregnant cases, and all had live births with no death or pregnancy complications.^[7] Zhang *et al.* compared 16 COVID-19 infected pregnant women with 45 non-infected ones. They achieved similar neonatal outcomes between two groups.^[59]

Yu *et al.* retrospectively reviewed medical records of 7 pregnant women with COVID-19 at a gestational age of 39 weeks. They all had cesarean section within 3 days, and the most common symptoms were fever, shortness of breath, cough, and diarrhea. The outcome was good for all mothers and neonates.^[60]

Conclusion

The COVID-19 can occur in children and neonates. The vertical transmission from infected mothers to neonates is rare, and the outcomes are better in children than adults.

Up to now, there has been no preventative vaccine or specific drug for COVID-19, and the preventive strategies are the main goal.

Ethical approval

This study was approved by the Health Research Institute of Babol University of Medical Sciences (IR.MUBABOL.REC.1399.129).

Acknowledgment

Authors would like to thank Dr. Maryam Nikpour in Non-Communicable Pediatric Diseases Research Center at Babol University of Medical Sciences who helped to submit this manuscript.

Financial support and sponsorship

Nil.

Conflict of interest

There are no conflicts of interest.

Received: 17 May 20 **Accepted:** 15 Jul 20

Published: 22 Sep 20

References

- Li G, Fan Y, Lai Y, Han T, Li Z, Zhou P, *et al.* Coronavirus infections and immune responses. *J Med Virol* 2020;92:424-32.
- Chan-Yeung M, Xu R. SARS: Epidemiology. *Respirology* 2003;8(Suppl 1) S9-14.
- Lee J, Chowell G, Jung E. A dynamic compartmental model for the Middle East respiratory syndrome outbreak in the Republic of Korea: A retrospective analysis on control interventions and superspreading events. *J Theor Biology* 2016;408:118-26.
- Liu Y, Gayle AA, Wilder-Smith A, Rocklöv J. The reproductive number of COVID-19 is higher compared to SARS coronavirus. *J Travel Med* 2020;27:taaa021.
- Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, *et al.* Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *N Engl J Med* 2020;382:970-1.
- Available from: <https://WHOSrAa>, www.who.int/emergencies/diseases/novel-coronavirus-2019/, 2020. s-rAF.
- Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W, *et al.* Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: A retrospective review of medical records. *Lancet* 2020;395:809-15.
- National Health Commission of the people's Republic of China, Handbook NAoTCM, Novel oPaTotPCbt, 5) C-nTv.
- Zou L, Ruan F, Huang M, Liang L, Huang H, Hong Z, *et al.* SARS-CoV-2 viral load in upper respiratory specimens of infected patients. *N Engl J Med* 2020;382:1177-9.
- Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: A modelling study. *Lancet* 2020;395:689-97.
- Majumder M, Mandl KD. Early transmissibility assessment of a novel coronavirus in Wuhan, China. *China* (January 23, 2020). 2020.
- WHO. Coronavirus disease (COVID-2019) situation reports. Situation report—55. March 15 hwwidd-scs-r-s--c.
- Zhang Q, Cong M, Wang N, Li X, Zhang H, Zhang K, *et al.* Association of angiotensin-converting enzyme 2 gene polymorphism and enzymatic activity with essential hypertension in different gender: A case-control study. *Medicine* 2018;97:e12917.
- Zhao Y, Zhao Z, Wang Y, Zhou Y, Ma Y, Zuo W. Single-cell RNA expression profiling of ACE2, the putative receptor of Wuhan 2019-nCoV. *BioRxiv* 2020.
- Lu Q, Shi Y. Coronavirus disease (COVID-19) and neonate: What neonatologist need to know. *J Med Virol* 2020;92:564-7.
- Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al.* Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet* 2020;395(497-506).
- Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, *et al.* Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *Lancet* 2020;395(507-13).
- Singhal T. A review of coronavirus disease-2019 (COVID-19). *Indian J Pediatr* 2020;87:281-6.
- Available from: <https://www.worldometers>. COAa, 2020. icAF.
- Huang P, Liu T, Huang L, Liu H, Lei M, Xu W, *et al.* Use of chest CT in combination with negative RT-PCR assay for the 2019 novel coronavirus but high clinical suspicion. *Radiology* 2020;295:22-3.
- Xu XW, Wu XX, Jiang XG, Xu KJ, Ying LJ, Ma CL, *et al.* Clinical findings in a group of patients infected with the 2019 novel coronavirus (SARS-Cov-2) outside of Wuhan, China: Retrospective case series. *Bmj* 2020;368.
- Jin Y-H, Cai L, Cheng Z-S, Cheng H, Deng T, Fan YP, *et al.* A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Military Med Res* 2020;7:4.
- Zhang L, Liu Y. Potential interventions for novel coronavirus in China: A systematic review. *J Med Virol* 2020;95:479-90.
- Biot C, Daher W, Chavain N, Fandeur T, Khalife J, Dive D, *et al.* Design and synthesis of hydroxyferroquine derivatives with antimalarial and antiviral activities. *J Med Chem* 2006;49:2845-9.
- Gautret P, Lagier JC, Parola P, Hoang VT, Meddeb L, Mailhe M, *et al.* Hydroxychloroquine and azithromycin as a treatment of COVID-19: Results of an open-label non-randomized clinical trial. *Int J Antimicrob Agents* 2020:105949. doi: 10.1016/j.ijantimicag.2020.105949.
- Boulware DR, Pullen MF, Bangdiwala AS, Pastick KA, Lofgren SM, Okafor EC, *et al.* A randomized trial of hydroxychloroquine as postexposure prophylaxis for Covid-19. *N Engl J Med* 2020. doi: 10.1056/NEJMoa2016638.
- Day M. Covid-19: European drugs agency to review safety of ibuprofen. *BMJ* 2020;368:m1168.
- Que T, Wong V, Yuen K. Treatment of severe acute respiratory syndrome with lopinavir/ritonavir: A multicentre retrospective matched cohort study. *Hong Kong Med J* 2003;9:399-406.
- Chong YP, Song JY, Seo YB, Choi JP, Shin HS, Team RR. Antiviral treatment guidelines for Middle East respiratory syndrome. *Infect Chemother* 2015;47:212-22.
- Wang Y, Zhu LQ. Pharmaceutical care recommendations for antiviral treatments in children with coronavirus disease 2019. *World J Pediatr* 2020;16:271-4.
- Falzarano D, De Wit E, Rasmussen AL, Feldmann F, Okumura A, Scott DP, *et al.* Treatment with interferon- α 2b and ribavirin improves outcome in MERS-CoV-infected rhesus macaques. *Nat Med* 2013;19:1313-7.
- Chen Z, Fu J, Shu Q, Chen Y, Hua C, Li F, *et al.* [Diagnosis and treatment recommendation for pediatric coronavirus disease-19]. *Zhejiang Da Xue Xue Bao Yi Xue Ban* 2020;49:1-8.
- Beigel JH, Tomashek KM, Dodd LE, Mehta AK, Zingman BS, Kalil AC, *et al.* Remdesivir for the treatment of Covid-19—preliminary report. *N Engl J Med* 2020. doi: 10.1056/NEJMoa2007764.
- Hamiel U, Kozler E, Youngster I. SARS-CoV-2 rates in BCG-vaccinated and unvaccinated young adults. *JAMA* 2020;323:2340-1.
- Adhikari SP, Meng S, Wu Y-J, Mao YP, Ye RX, Wang QZ, *et al.* Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: A scoping review. *Infect Dis Poverty* 2020;9:1-12.
- Yan Y, Shin WI, Pang YX, Meng Y, Lai J, You C, *et al.* The first 75 days of novel coronavirus (SARS-CoV-2) outbreak: Recent advances, prevention, and treatment. *Int J Environ Res Public Health* 2020;17:2323.
- Panigrahi SK, Pathak VK, Kumar MM, Raj U, Priya PK. Covid-19 and mobile phone hygiene in healthcare settings. *BMJ Glob Health* 2020;5:e002505.
- [The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China]. *Zhonghua Liu Xing Bing Xue Za Zhi* 2020;41:145-51.
- Livingston E, Bucher K. Coronavirus disease 2019 (COVID-19) in Italy. *JAMA* 2020. doi: 10.1001/jama.2020.4344.
- Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, *et al.*

- Epidemiological characteristics of 2143 pediatric patients with 2019 coronavirus disease in China. *Pediatrics*. 2020.
41. Cai J, Xu J, Lin D, Yang Z, Xu L, Qu Z, *et al*. A case series of children with 2019 novel coronavirus infection: Clinical and epidemiological features. *Clin Infect Dis* 2020. doi: 10.1093/cid/ciaa198.
 42. Lu X, Zhang L, Du H, *et al*. SARS-CoV-2 infection in children. *N Engl J Med* 2020;382:1663-5.
 43. United States of America, Centers for Disease Control and Prevention (CDC COVID-19 Response Team). Morbidity and Mortality, Weekly Report March 18.
 44. Chen F, Liu Z, Zhang F, Xiong RH, Chen Y, Cheng XF, *et al*. First case of severe childhood novel coronavirus pneumonia in China. *Zhonghua Er Ke Za Zhi* 2020;58:E005.
 45. Zachariah P, Johnson CL, Halabi KC, Ahn D, Sen AI, Fischer A, *et al*. Epidemiology, clinical features, and disease severity in patients with coronavirus disease 2019 (COVID-19) in a children's hospital in New York City, New York. *JAMA Pediatr* 2020:e202430.
 46. Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, *et al*. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. *Sci China Life Sci* 2020;63:76-11.
 47. Cao Q, Chen Y-C, Chen C-L, Chiu C-H. SARS-CoV-2 infection in children: Transmission dynamics and clinical characteristics. *J Formos Med Assoc* 2020;119:670-3.
 48. Wang Y, Wang Y, Chen Y, Qin Q. Unique epidemiological and clinical features of the emerging 2019 novel coronavirus pneumonia (COVID-19) implicate special control measures. *J Med Virol* 2020;92:568-76.
 49. Xia W, Shao J, Guo Y, Peng X, Li Z, Hu D. Clinical and CT features in pediatric patients with COVID-19 infection: Different points from adults. *Pediatr Pulmonol* 2020;55:1169-74.
 50. Hoffmann M, Kleine-Weber H, Schroeder S, Krüger N, Herrler T, Erichsen S, *et al*. SARS-CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor. *Cell* 2020;181:271-80.e8.
 51. Yonker LM, Shen K, Kinane TB. Lessons unfolding from pediatric cases of COVID-19 disease caused by SARS-CoV-2 infection. *Pediatr Pulmonol* 2020;55:1085-6.
 52. Henry BM, Lippi G, Plebani M. Laboratory abnormalities in children with novel coronavirus disease 2019. *Clin Chem Lab Med* 2020;58:1135-8.
 53. Shen Q, Guo W, Guo T, Li J, He W, Ni S, *et al*. Novel coronavirus infection in children outside of Wuhan, China. *Pediatr Pulmonol* 2020;55:1424-9.
 54. Shi R, Shan C, Duan X, Chen Z, Liu P, Song J, *et al*. A human neutralizing antibody targets the receptor binding site of SARS-CoV-2. *Nature* 2020;584(7819):120-4.
 55. CDC COVID-19 Response Team. Coronavirus Disease 2019 in Children—United States, February 12–April 2, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:422-6.
 56. Karimi-Zarchi M, Neamatzadeh H, Dastgheib SA, Abbasi H, Mirjalili SR, Behforouz A, *et al*. Vertical transmission of coronavirus disease 19 (COVID-19) from infected pregnant mothers to neonates: A review. *Fetal Pediatr Pathol* 2020;39:246-50.
 57. Ludvigsson JF. Systematic review of COVID-19 in children show milder cases and a better prognosis than adults. *Acta Paediatr* 2020;109:1088-95.
 58. Chen S, Huang B, Luo D, Li X, Yang F, Zhao Y, *et al*. Pregnant women with new coronavirus infection: A clinical characteristics and placental pathological analysis of three cases. *Zhonghua Bing Li Xue Za Zhi* 2020;8;49(5):418-23.
 59. Zhang L, Jiang Y, Wei M, Cheng BH, Zhou XC, *et al*. Analysis of the pregnancy outcomes in pregnant women with COVID-19 in Hubei Province. *Zhonghua Fu Chan Ke Za Zhi* 2020;55:166-171.
 60. Yu N, Li W, Kang Q, Xiong Z, Wang S, Lin X, *et al*. Clinical features and obstetric and neonatal outcomes of pregnant patients with COVID-19 in Wuhan, China: A retrospective, single-centre, descriptive study. *Lancet Infect Dis* 2020;20:559-64.