

# Chapter 7

## Coronavirus Infection Among Children and Adolescents



Sujita Kumar Kar, Nishant Verma, and Shailendra K. Saxena 

**Abstract** Coronavirus infection is a global emergency. Over the past few months, there is a rapid increase in the number of cases and deaths due to coronavirus infection. It has been observed that elderly individuals and those with medical co-morbidities are maximally affected. In children and adolescents, coronavirus infection has low mortality as well as the severity of symptoms are less. Children and adolescents with immunocompromised state, malnutrition, medical co-morbidities and poor hygiene are at higher risk of contracting coronavirus infection. Minimizing this risk factors and adopting appropriate prevention measures will be helpful in limiting the spread of infection as there is no specific treatment and immunization available to date to address this serious issue. This chapter highlights the issues and challenges of coronavirus infection in children and adolescents.

**Keywords** Coronavirus infection · Children · Adolescents · Prevention

---

Sujita Kumar Kar and Shailendra K. Saxena contributed equally as first author.

S. K. Kar (✉)

Department of Psychiatry, Faculty of Medicine, King George's Medical University (KGMU), Lucknow, India

N. Verma

Department of Pediatrics, Faculty of Medicine, King George's Medical University (KGMU), Lucknow, India

S. K. Saxena

Centre for Advanced Research (CFAR)-Stem Cell/Cell Culture Unit, Faculty of Medicine, King George's Medical University (KGMU), Lucknow, India

e-mail: [shailen@kgmcindia.edu](mailto:shailen@kgmcindia.edu)

## 7.1 Introduction

Novel coronavirus (COVID-19) infection, recently declared as a pandemic by the World Health Organization (WHO), is a global threat. According to the situation report of the WHO, by the end of the third week of March 2020, there are more than 266,000 confirmed cases and 11,184 deaths over 182 countries globally (WHO 2020). The above data depict the grievousness of the endemic in the contemporary world. People of all ages are affected with the deadly coronavirus infection, though the risk of infection is higher among older people and those with medical co-morbidities (Wu et al. 2020a). As per the initial report from Wuhan, China, less number of children were affected with coronavirus infection than adult patients (Liu et al. 2020).

## 7.2 Coronavirus Infection Among Children

As per the WHO report in February 2020, there was no fatality due to coronavirus infection in the 0–9 years age group and the death rate was 0.2% in the age group of 10–19 years; however in the age group of 70–79 years and >80 years the death rates are 8.0% and 14.8%, respectively (World Health Organization 2020; Worldometers 2020). Though children and adolescents have lower death rate, they can be potential agents of transmission. As the degree of mobility is higher in this age group of population, the probability of contracting infection and transmitting to others (particularly the high-risk population of elderly) is high. Children infected with coronavirus often present with fever, cough and breathing difficulties. Many children also report vomiting, diarrhoea and the aforementioned symptoms (Yang et al. 2020). Children born from infected mothers have higher risk of contracting the infection from mother (Yang et al. 2020). The clinical symptoms and investigation findings in children with coronavirus infection often resemble with viral pneumonia (Yang et al. 2020). It has been reported that children often have milder symptoms than adults and the elderly (Chen et al. 2020a; American Academy of Pediatrics 2020; Lu and Shi 2020). The biochemical changes and chest computed tomography (CT) changes of children with coronavirus infection also differ from those of adults (Xia et al. 2020). Children often have more upper respiratory infection than lower respiratory infection, which increases their ability to transmit the infection (American Academy of Pediatrics 2020). A report mentions that even an apparently healthy infant had heavy viral load which indicates that children can even transmit infection without manifesting the illness (Kam et al. 2020).

## **7.3 Risk Factors Specific to Children and Adolescents**

### **7.3.1 *Immunocompromised State***

Immunocompromised state is a potential risk factor for acquiring highly contagious infections like novel coronavirus infection. Children and adolescents with poor immune function or on immune-suppressant medications need to be cautious. Preterm babies and newborn babies with low birth weight are also at risk due to their immunocompromised state.

### **7.3.2 *Malnutrition***

Malnutrition is still a common problem in the developing and underdeveloped countries. Children with protein-energy malnutrition (Marasmus and Kwashiorkor) or specific vitamin and micronutrient deficiency are at risk of acquiring infections due to their poor body immunity.

### **7.3.3 *Medical Co-morbidities***

Specific medical co-morbidities increase the risk of coronavirus infection. Children and adolescents with cardiac disease (mostly congenital heart diseases) and respiratory diseases (bronchial asthma, bronchiectasis) are more vulnerable as coronavirus mostly infects the respiratory system. Patients with haematological disorders like anaemia, leukaemia, etc. also have a compromised immune system, which makes them vulnerable to coronavirus infection.

### **7.3.4 *Poor Hygiene***

Small children are often dependent on their cares for personal hygiene. Lack of understanding about the importance of personal hygiene makes them vulnerable to acquire infections.

### **7.3.5 *Lack of Sensitization***

Small children are not aware of the concept of pandemic, its seriousness and importance of all preventive measures recommended. Unfortunately, the sensitization activities run by various government and non-government agencies mostly

target adults and youths. Many parents seldom discuss or explain the issue of coronavirus infection with their children. All the above factors result in improper sensitization of children as a result of which they are at risk of contracting as well as spreading infection.

### **7.3.6 Age-Specific Issues**

Children are often playful. They talk loudly and express themselves without restraints. Evidence suggests that talking loudly and shouting may cause the spread of the infection through droplets (Chen et al. 2020a). Similarly, touching the face, nose and mouth with hand is common during play among children. It also increases the risk of transmission of coronavirus infection (Chen et al. 2020a). Similarly, children often spend a significant proportion of their time out of home (in school, play activities) and may come in contact with individuals with coronavirus infection.

## **7.4 Prevention of Coronavirus Infection Among Children and Adolescents**

There is no specific treatment for coronavirus infection to date. The evidences gathered in favour of certain anti-retroviral agents and antimalarial agents are not robust yet. Patients with coronavirus infection need to be treated symptomatically and monitoring needs to be done for organ failures. As there is no definite treatment to date for this illness, prevention becomes the top priority.

The Centre for Disease Control and Prevention had issued certain instructions in the public interest that intends to create awareness among the public about coronavirus infection and its prevention among children (Centers for Disease Control and Prevention 2020). As small children may not be able to take their own responsibility, parents, teachers and sensitive citizens of this civilized society should take responsibility to prevent the spread of coronavirus infection. They need to monitor the activities of children at home, school and outside the home setting. There is a need to restrict large group activities, limit play time and keep distance during play and interaction. Similarly in the home and school setting, there is a need to keep the surfaces and objects (walls, toilets, chairs, tables, boards, play items, reading materials) sanitized through repeated cleaning as these remain the medium of transfer of pathogens from infected individuals to healthy ones (Centers for Disease Control and Prevention 2020). Choosing outdoor game in small groups may be more beneficial than indoor games as the ventilation is better outside and the possibility of maintaining distance during play is higher in outdoor play. Group travel, picnics and study tours are to be strictly discouraged. Children need to be taught about hygiene regularly, and they need to be monitored for the implementation of hygiene in practice.



**Fig. 7.1** Recommended preventive measures against coronavirus infection in children

Healthcare professionals on the other hand have a pivotal role in providing health education to child and parents and conducting awareness camps in schools and community, as well as regular health check-up for the early identification and prompt treatment of health ailments. Figure 7.1 provides a summary of preventive measures against coronavirus infection in children.

It is of paramount importance to ensure that children should properly sanitize themselves before coming in contact with other family members (particularly elderly and those who have medical illnesses) to limit the possible transmission of coronavirus infection.

Older children and adolescents are trainable and educable about the basics of hygiene and its relevance in the context of coronavirus infection. The above recommendations also stand valid for older children and adolescents for the prevention of coronavirus infection transmission.

Additionally children should avoid contact with persons or other children with recent travel history or contact with persons with recent travel history or those with respiratory infections or fever (Chen et al. 2020a). It is important to target various risk factors (predisposing factors, precipitating factors and perpetuating factors) to limit the chances of getting infected (Kar and Tripathy 2019). Table 7.1 summarizes the potential risk factors that can be targets of intervention.

**Table 7.1** Potential risk factors, which can be targets of intervention

Nature of risk factors	Examples	Preventive measures
Predisposing factors	<ul style="list-style-type: none"> <li>• Low immunity</li> <li>• Malnutrition</li> <li>• Medical co-morbidity</li> <li>• Poor hygiene</li> </ul>	<ul style="list-style-type: none"> <li>• Dietary supplementation</li> <li>• Adequate treatment of medical co-morbidity</li> <li>• Hygiene</li> </ul>
Precipitating factors	<ul style="list-style-type: none"> <li>• Contact with infected persons, contaminated surfaces and objects</li> </ul>	<ul style="list-style-type: none"> <li>• Social distancing</li> <li>• Restricting play, tour, travel, picnic, etc.</li> <li>• Proper sanitation</li> </ul>
Perpetuating (maintaining) factors	<ul style="list-style-type: none"> <li>• Low immunity</li> <li>• Malnutrition</li> <li>• Medical co-morbidity</li> <li>• Poor hygiene</li> </ul>	<ul style="list-style-type: none"> <li>• Dietary supplementation</li> <li>• Adequate treatment of medical co-morbidity</li> <li>• Hygiene</li> <li>• Early identification, isolation and prompt treatment</li> </ul>

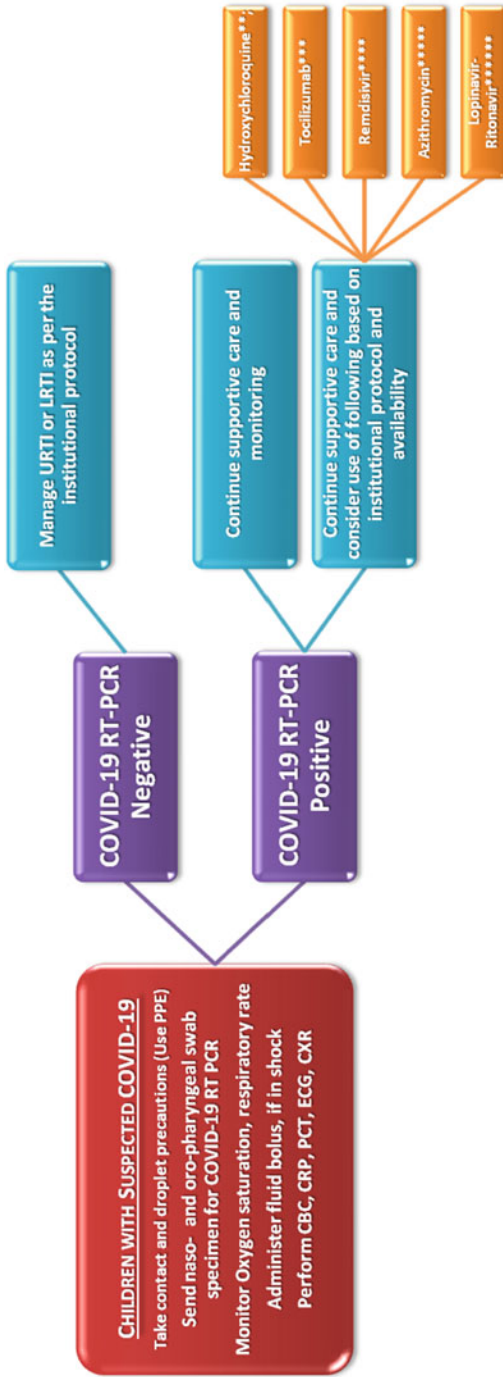
Children and adolescents, who develop fever and respiratory infections, need to consult for evaluation at the nearest health centres with appropriate precautions till coronavirus infection is ruled out.

## 7.5 Evidence-Based Management Approach

There is no specific treatment for novel coronavirus disease (COVID-19) supported with evidence to date. Patients with coronavirus infection are often given symptomatic treatment and supportive care (Wu et al. 2020a, b). However, probable management approach against coronavirus infection in children has been exhibited in Fig. 7.2. Researchers found the possible roles of hydroxychloroquine, anti-retroviral medications and interferon in the management of coronavirus infection (Yang et al. 2020). Antibiotics are recommended for secondary bacterial infection and pneumonia. Corticosteroids are to be avoided, except exceptional situations like septic shock, rapidly deteriorating chest imaging, and presence of obvious toxic symptoms like encephalitis or encephalopathy (Chen et al. 2020a).

There is no specific vaccine available for the prevention of COVID-19 infection. Many vaccine trials are going on globally; however, it has been recommended that uninfected people and health workers need to get vaccinated for influenza (Zhang and Liu 2020). There is a possible role of convalescent plasma (if available) in the management of COVID-19 infection (Zhang and Liu 2020).

As of now, prevention is the best option for controlling the rapidly spreading infection of coronavirus. It has been recommended that newborn babies of mothers infected with COVID-19 need to be isolated immediately after delivery to prevent them from acquiring infection (Yang et al. 2020). However, there is no evidence that



**Fig. 7.2** Current probable management approach against coronavirus infection in children. *PPE* personal protective equipment, *CBC* complete blood count, *CRP* C-reactive protein, *PCT* procalcitonin, *ECG* electrocardiogram, *CXR* chest X-ray, *URTI* upper respiratory tract infection, *LRTI* lower respiratory tract infection. *\*\**Worsening: Increasing respiratory distress, worsening gas exchange, hypoxia, radiological deterioration. *\*\**Hydroxychloroquine (HCQ): Dose 10–13 mg/kg (max: 600 mg/dose) PO BID x2 (load), then 6.5 mg/kg PO BD (max: 200 mg/dose). Certain guidelines recommend initiation of HCQ for all hospitalized patients with COVID-19. *\*\*\**Tocilizumab: Dose 8–12 mg/kg single dose. Interleukin-6 inhibitor; useful for children with rapid deterioration due to COVID-19. *\*\*\*\**Remdesivir: Investigational antiviral drug for COVID-19. *\*\*\*\**Azithromycin: Dose 10 mg/kg/day for 1 day, then 5 mg/kg/day for 4 days. *\*\*\*\*\**Lopinavir-Ritonavir: Dose 15–25 kg: 200 mg–50 mg; 26–35 kg: 300 mg–75 mg; >35 kg: 400 mg–100 mg PO BID for 5 days

vertical transmission of infection from mother to foetus occurs in the intrauterine environment (Lu and Shi 2020; Chen et al. 2020b). Early isolation is also recommended for children with underlying disease manifestations (Yang et al. 2020).

## 7.6 Conclusions

Despite low mortality and low infection rate among children and adolescents, they play a crucial role in the spread of infection in this ongoing pandemic of coronavirus disease. Adequate prevention measures, early identification and isolation will be helpful in altering the course of this pandemic.

## 7.7 Future Perspectives

There is a paucity of research on coronavirus infection in children and adolescents. There is a need to monitor the long-term impact of the virus exposure on the growth, development and other health measures. There is also an intense need to explore treatment options and vaccination for the effective control of coronavirus infection.

### Executive Summary

- Children and adolescents with coronavirus infection have milder symptoms.
- Compromised immune function, malnutrition, co-morbid medical illnesses and poor hygiene are potential risk factors for contracting coronavirus infection in children and adolescents.
- Social distancing, limiting group activities, play time, tours, picnics and adequate hygiene training may be beneficial in limiting the chances of getting coronavirus infection in children and adolescents.

## References

- American Academy of Pediatrics (2020) COVID-19 in children: initial characterization of the pediatric disease. *Pediatrics* 145(4):e20200834
- Centers for Disease Control and Prevention (2020) Coronavirus disease 2019 (COVID-19). Centers for Disease Control and Prevention. [cited 2020 Mar 22]. [https://www.cdc.gov/Coronavirus/2019-ncov/faq.html?CDC\\_AA\\_refVal=https%3A%2F%2Fwww.cdc.gov%2FCoronavirus%2F2019-ncov%2Fprepare%2Fchildren-faq.html#school-dismissals](https://www.cdc.gov/Coronavirus/2019-ncov/faq.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2FCoronavirus%2F2019-ncov%2Fprepare%2Fchildren-faq.html#school-dismissals)
- Chen Z-M, Fu J-F, Shu Q, Chen Y-H, Hua C-Z, Li F-B et al (2020a) Diagnosis and treatment recommendations for pediatric respiratory infection caused by the 2019 novel coronavirus. *World J Pediatr*. 10.1007/s12519-020-00345-5. Advance online publication. <https://doi.org/10.1007/s12519-020-00345-5>



- Chen H, Guo J, Wang C, Luo F, Yu X, Zhang W et al (2020b) Clinical characteristics and intrauterine vertical transmission potential of COVID-19 infection in nine pregnant women: a retrospective review of medical records. *Lancet* 395(10226):809–815. [cited 2020 Mar 23]. <http://www.sciencedirect.com/science/article/pii/S0140673620303603>
- Kam K, Yung CF, Cui L, Lin Tzer Pin R, Mak TM, Maiwald M et al (2020) A well infant with coronavirus disease 2019 (COVID-19) with high viral load. *Clin Infect Dis*. ciaa201. Advance online publication. <https://doi.org/10.1093/cid/ciaa201>. [cited 2020 Mar 23]. <https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciaa201/5766416>
- Kar SK, Tripathy S (2019) Risk factors. In: Shackelford TK, Weekes-Shackelford VA (eds) *Encyclopedia of evolutionary psychological science*. Springer International Publishing, Cham, pp 1–4. [https://doi.org/10.1007/978-3-319-16999-6\\_800-1](https://doi.org/10.1007/978-3-319-16999-6_800-1)
- Liu W, Zhang Q, Chen J, Xiang R, Song H, Shu S et al. (2020) Detection of COVID-19 in children in early January 2020 in Wuhan, China. *N Engl J Med* 382(14):1370–1371 [cited 2020 Mar 23]. <https://doi.org/10.1056/NEJMc2003717>
- Lu Q, Shi Y (2020) Coronavirus disease (COVID-19) and neonate: what neonatologist need to know. *J Med Virol*. 10.1002/jmv.25740. Advance online publication. <https://doi.org/10.1002/jmv.25740>. [cited 2020 Mar 23]. <https://onlinelibrary.wiley.com/doi/abs/10.1002/jmv.25740>
- WHO (2020) Novel coronavirus (COVID-19) situation. [cited 2020 Mar 21]. <https://experience.arcgis.com/experience/685d0ace521648f8a5beeee1b9125cd>
- World Health Organization (2020) Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19). World Health Organization. [cited 2020 Mar 22]. <https://www.who.int/docs/default-source/Coronaviruse/who-china-joint-mission-on-covid-19-final-report.pdf>
- Worldometers (2020) Age, sex, existing conditions of COVID-19 cases and deaths. February 29, 4:40 GMT [cited 2020 Mar 22]. <https://www.worldometers.info/Coronavirus/Coronavirus-age-sex-demographics/#ref-2>
- Wu JT, Leung K, Bushman M, Kishore N, Niehus R, de Salazar PM et al (2020a) Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China. *Nat Med* 26(4):506–510. <https://doi.org/10.1038/s41591-020-0822-7>. [cited 2020 Mar 21]. <https://www.nature.com/articles/s41591-020-0822-7>
- Wu D, Wu T, Liu Q, Yang Z (2020b) The SARS-CoV-2 outbreak: what we know. *Int J Infect Dis*. Advance online publication. <https://doi.org/10.1016/j.ijid.2020.03.004> [cited 2020 Mar 22]. [https://www.ijidonline.com/article/S1201-9712\(20\)30123-5/abstract](https://www.ijidonline.com/article/S1201-9712(20)30123-5/abstract)
- Xia W, Shao J, Guo Y, Peng X, Li Z, Hu D (2020) Clinical and CT features in pediatric patients with COVID-19 infection: different points from adults. *Pediatr Pulmonol* 55(5):1169–1174. <https://doi.org/10.1002/ppul.24718>. [cited 2020 Mar 23]. <https://onlinelibrary.wiley.com/doi/abs/10.1002/ppul.24718>
- Yang P, Liu P, Li D, Zhao D (2020) Corona virus disease 2019, a growing threat to children? *J Infect*. Advance online publication. <https://doi.org/10.1016/j.jinf.2020.02.024>
- Zhang L, Liu Y (2020) Potential interventions for novel coronavirus in China: a systemic review. *J Med Virol* 92(5):479–490