Original Article

# An epidemiological study and trend analysis of laboratory confirmed COVID-19 cases among children in North India

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## Abstract

**Background:** The role of children in transmitting the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus is difficult to ascertain and the consequences remain unclear. This is necessary for public health or infection control purposes. The objective of this study was to describe the epidemiological, month-wise trends and clinical characteristics of coronavirus disease 2019 (COVID-19) infection among children in a tertiary care hospital. **Materials and Methods:** A cross-sectional study was performed on all pediatric samples of suspected cases of SARS-CoV-2 infection. The samples were received from the adjoining districts and our Institution in the Department of Microbiology from June to November 2020. Cases were then confirmed by real-time reverse transcriptase-polymerase chain reaction. **Results:** Of the total 62,030 pediatric samples tested, 847 (1.3%) were SARS-CoV-2 positive. The majority of positive cases were between the ages of 11–15 years. The median age of confirmed patients was 14 years. The male to female ratio was 1.5:1. Infants represented 1.6% of the positive cases. About 62.1% of all positive cases were asymptomatic. Childhood cases increased from June 2020 and peaked in September 2020 before declining. **Conclusion:** Children of all ages appeared susceptible to COVID-19 and accounted for a very small proportion of confirmed cases. Mostly, children were found to be asymptomatic. Young children can be important transmitters of SARS-CoV-2 infection in the general population. This population can be important for targeting immunization efforts throughout a rapidly evolving situation. Our findings provide further evidence of the distribution of infection in children and the transmission of SARS-CoV-2.

**Keywords:** Children, COVID-19, transmission

## Introduction

Coronavirus disease 2019 (COVID-19) which started from Wuhan city, and spread across China, in December 2019 is a novel infectious disease of zoonotic origin.[1] The disease was declared a pandemic on March 11, 2020, by the world health organization (WHO), affecting the everyday life and routine working conditions of millions of people across the world,[2] and has represented a considerable change in the health of families and children.[3] Around 65.8 million cases and 1.5 million deaths have been reported globally, as of December 8, 2020.[4] Coronaviruses comprise a large family of enveloped, non-segmented, single-stranded positive-sense RNA viruses with a genome size of approximately 30 kb.[5] They belong to the family *Coronaviridae*, order *Nidovirales*. The genome of severe acute

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**Received:** 23-06-2021 **Revised:** 05-10-2021
**Accepted:** 14-10-2021 **Published:** 16-02-2022

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_1239_21



**How to cite this article:** Mussadiq S, Verma RK, Singh DP, Bajpai PK, Begum N, Kumar S. An epidemiological study and trend analysis of laboratory confirmed COVID-19 cases among children in North India. J Family Med Prim Care 2022;11:542-6.

respiratory syndrome coronavirus 2 (SARS-CoV-2) encodes four major structural proteins, including spike (S), membrane (M), envelope (E), and nucleocapsid (N).[6] Among them, SARS-CoV-2 uses S protein to bind to its host cell membrane receptor angiotensin-converting enzyme 2 (ACE2) for virus entry.[2] Modes of disease transmission are through direct contact with surfaces and fomites soiled with secretions of infected individuals, inhalation of droplets produced by patients during coughing and sneezing.[7] Nucleic acid testing is the main method of laboratory diagnosis. SARS-CoV-2 nucleic acid can be detected by real-time reverse transcriptase-polymerase chain reaction (RT-PCR) or by viral gene sequencing of nasal/pharyngeal swabs, sputum, stool, or blood samples.[8] Not enough data segregated by age, geography, and nationality are impeding efforts to fully assess the prevalence of infection, clinical manifestations of COVID-19 in children, but also the role of children in the transmission of COVID-19.[9] Although data from countries recovering from huge outbreaks of COVID-19 infection show that most children have mild clinical manifestations and rarely develop a severe or critical illness, or show increased mortality.[10] Recent COVID-19 surveillance data show a low rate of hospitalization among children (8.0 per 100,000 population) compared with adults (164.5 per 100,000 population),[11] with a case-fatality rate in children varying between <0.5% and 5%.[10,12] The fatality rates may vary depending upon the differences in worldwide healthcare services and/or epidemiological features of patients; the regularity of diagnostic screening in children with no symptoms or mild symptoms may also affect the rate.[13] Many other reasons have been detailed for the low prevalence of COVID-19 among children. Potential biological differences in susceptibility to SARS-CoV-2 infection may exist.[9] The expression of ACE2 receptors is reduced in the respiratory tract in children.[14] Age varying susceptibility of COVID-19 infection in children could result from immune-cross protection from other respiratory viruses[15] and less intense cytokine storm from the immune system.[14] Lack of extensive testing in children, focusing on testing in adults and those with severe symptoms,[11] may reflect different practice patterns other than disease biology.[16] Most coronavirus species demonstrate a seasonal pattern. Despite all our endeavors and measures to contain the virus, due to its mutational escalation, it appears to be spreading globally, breaching all climate and environmental barriers.[17] The disease is not yet under control, as many countries are facing a resurgence of the disease in the adult and the pediatric population as of now which needs virtual primary care from healthcare professionals at the basic level. COVID-19 studies are imperative as for the unknown influence of the disease on child health, transmission, risk factors, complications that are yet to be evaluated fully. In this study, we report the epidemiological characteristics and month-wise trend analysis in North India.

## Materials and Methods

A hospital-based cross-sectional study was performed on all the samples of suspected cases of SARS-CoV-2 infection. The samples were received from the adjoining districts and our institution in microbiology department during the outbreak from June 1 to November 30, 2020. All the samples for the COVID-19 test of children of age up to 18 years were included in the present study. Following samples were excluded; duplicate samples, missing data for age, gender not mentioned. A laboratory-confirmed case is a person with laboratory confirmation of COVID-19 infection, irrespective of clinical features.[18] After receiving the samples in the laboratory, they were subjected to RNA extraction by automation using MagMax™ Viral/Pathogen nucleic acid isolation kit (Thermo Fisher Scientific Inc. Waltham, Massachusetts, USA), as per the manufacturer's protocol. Cases were then confirmed by RT-PCR of the respiratory specimen (nasopharyngeal and oropharyngeal swabs), targeting *E*, *N*, *ORF1ab*, *RdRp* encoding genes using RT-PCR kits approved by ICMR-NIV Pune (like LabGun™, COVISure Genetrix, ARGENE® SARS-COV-2 R-GENE®) as per the manufacturer's protocol performed on ABI 7500 Fast Dx RT-PCR thermal cycler (Applied Biosystems, USA). Patient demographic characteristics, type of exposure (travel, contact history, and visiting public places), temporal distribution, and clinical symptoms were noted from the laboratory records. Ethical approval was obtained from the Institutional Ethics Committee with the ethical clearance number 235/2020-21. Informed written consent was taken from all participants/guardians and assent was taken from the subject. Data were de-identified, coded, and recorded in the Microsoft® Excel spreadsheet program. The analysis was performed with statistical software using statistical package for the social sciences (SPSS) version 24.0 by IBM, USA. Descriptive statistics were elaborated using a median and interquartile range for continuous variables; frequencies and percentages for categorical variables.

## Results

Between June 1 and November 30, 2020, a total of 62,030 pediatric samples were tested for SARS-CoV-2; of which 847 (1.3%) had positive test results, 54079 (87.1%) were negative, and 7104 (11.5%) had inconclusive results [Figure 1, Table 1]. The median age of childhood cases was 14 years (interquartile range: 8 years). Among all positive cases, 518 (61.1%) were male patients and 329 (38.8%) were female patients, with a male to female ratio of 1.5:1. Infants represented 14 (1.6%) cases, 83 (9.7%), were of age 1–5 years, 183 (21.6%) were of age 6–10 years, with children of age 11–15 years were 286 (33.7%) and older children up to 18 years were 281 (33.1%) [Table 1]. The COVID-19 disease was confirmed across the full breadth of age categories – from infants through adolescence. Clear patterns of an age-based exponential increase in COVID-19 cases have been observed in all age groups until August 2020. Age group 11–15 years showed the maximum number of cases in September 2020, with a steep drop thereafter [Figure 2]. In the temporal distribution, using the summer and autumn data, in June 2020, 14.5% confirmed cases were reported reaching the highest 24.7% in September 2020; the percentage of positive results then decreased in the two consecutive months, reaching the lowest in November 2020 to 8.8%. The test volume nearly rose 5.5 times, from 3001 tests

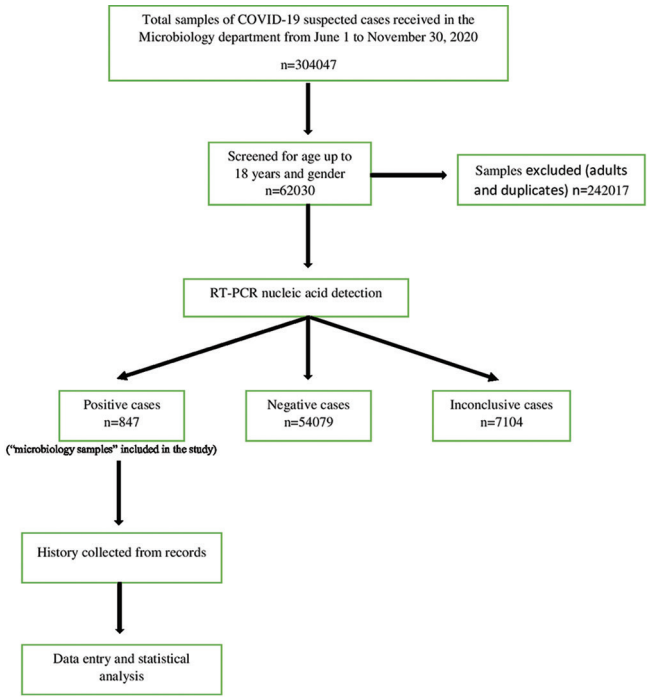


**Figure 1:** Study Flow Diagram

**Table 1: Demographic characteristics and clinical status of SARS-CoV-2 paediatric cases, Ju1-November 30, 2020**

| Characteristics | Total number of cases, *n* (%) |
|---|---|
| Test Result | |
| Positive cases | 847 (1.3) |
| Negative cases | 54079 (87.1) |
| Inconclusive cases | 7104 (11.5) |
| Age distribution (years) | |
| <1 | 14 (1.6) |
| 1-5 | 83 (9.7) |
| 6-10 | 183 (21.6) |
| 11-15 | 286 (33.7) |
| 16-18 | 281 (33.1) |
| Sex | |
| Male | 518 (61.1) |
| Female | 329 (38.8) |
| Clinical status | |
| Yes (symptomatic) | 60 (7.0) |
| No (asymptomatic) | 526 (62.1) |
| Unknown/missing values | 261 (30.8) |
| Exposure history | |
| Travel history | 49 (5.7) |
| Contact with COVID-19 +ive case | 246 (29) |
| Random selection | 358 (42.2) |
| Public places | 155 (18.2) |
| Contact with a health care worker | 4 (0.4) |
| Unknown/missing values | 35 (4.1) |

performed in June to a peak of 16,790 tests in October, and then plateaued during November 2020 [Figure 3]. Of the 847 positives, 29% were contacts of laboratory-confirmed cases, 5.7% had a history of travel, 18.2% had been exposed to public places

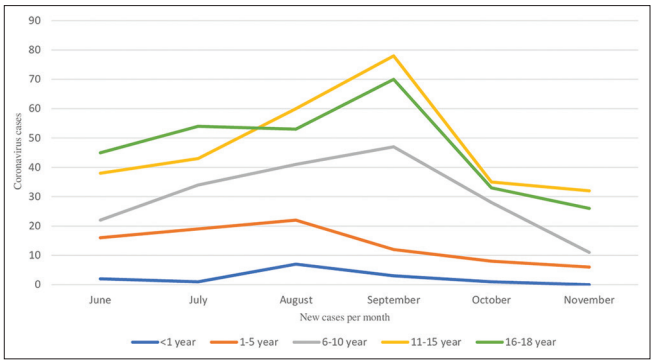


**Figure 2:** COVID-19 month-wise trends among children of different age-groups, June 01 to November 30, 2020

and 42.2% were randomly selected for testing at the screening centers, 0.4% had a history of contact with healthcare workers. Data of contact exposure were missing in 4.1% [Table 1]. Among COVID-19 positive children, 7% reported symptoms, 62.1% were asymptomatic, and information on symptoms was missing or unknown for 30.8% [Table 1]. The most prevalent symptom was fever reported in 38 (63.3%) of the cases, followed by cough in 26 (43.3%), sore throat in 6 (10%), and shortness of breath in 5 (8.3%) [Table 2].

## Discussion

COVID-19 pandemic caused by SARS-CoV-2 has led to major health and socio-economic crisis.[7] This highly communicable disease led many organizations and health administrations to adopt strict protective regulations and measures to contain its spread.[19] We have provided an initial assessment of epidemiological features and month-wise trend analysis in children suspected of COVID-19 infection. In our study, we found a small proportion of 1.3% of children affected by the disease. This is in concordance with many published summaries that have predominantly highlighted that children represent a small proportion of <2% of COVID-19, including hospital admissions and mortality.[20] It is plausible that selection bias,[9,11] exposure, and host factors[21] play a role in a lower risk of COVID-19 in children. This can also be related to mitigation measures such as the closure of schools.[9] In addition, the dissimilarity in the localization, maturation, and functioning of viral receptors such as ACE2 is frequently mentioned as a probable reason for the difference in incidence between children and adults.[22] Our results showed that most of the children were asymptomatic, these results are supported by a study done in China.[23] This might be due to that, there are no typical symptoms in children, because of which parents may not seek healthcare, or uncertainty about the presentation of symptoms may lower the index of suspicion among the clinicians.[24] The presenting symptoms in children with COVID-19 infection have been well described in the literature.[21,23] Our results are consistent with these previous reports with similar percentages of clinical symptoms of fever, and cough.[12] Ma *et al.*[25] besides clinical symptoms have also analyzed the use of the imaging method chest CT scan, as a helpful tool to identify

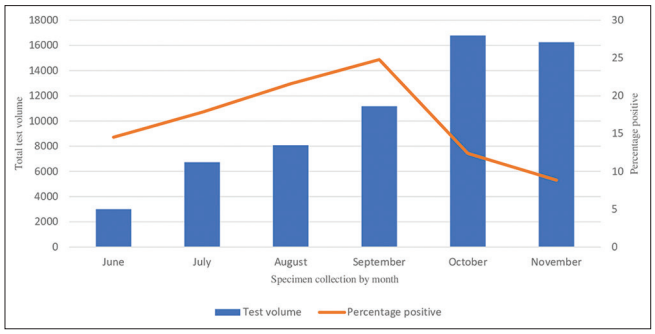


**Figure 3:** Percentage of COVID-19 Positive cases and test volume, June 01 to November 30, 2020

and distinguish COVID-19 pneumonia. They further do not recommend its use in children, unless it is necessary for low-dose ionizing radiation hazards. Infants were found to be less vulnerable to infection, with a minimum number of cases 1.6%, and the majority of positive cases 33.7% were between the ages 11–15 years with male predominance. A study conducted by Dong *et al*.[21] observed more boys than girls were affected, which is consistent with our results. The COVID-19 pandemic has led to unprecedented challenges to public health systems in all parts of the world.[26] In India, on May 30, 2020, it was announced that lockdown restrictions were to be lifted from then onwards.[27] By this country-wide COVID-19 relaxation in mitigation measures, we found the cases approximately doubled in children of age 6–10 year and 11–15 year age groups, from June to September 2020, suggesting that young children might be playing an increasingly important role in community transmission.[28] In some studies, the transmission was found to be generally family acquired.[12,23] Respiratory viruses including coronaviruses sustain a high incidence of transmission during winter.[1] Coronaviruses undergo persistent mutations and recombination, with new variants evolving that can cross the species barrier.[29] In the Indian temperate climate, there was a trend of a gradual rise in cases during the summer months. However, we found discordant results from the study done in England, in which they found cases to decline towards summer.[10] Although the disease has an asymptomatic course, some studies have reported that children with post-COVID complications such as vasculopathy, coagulopathy, interstitial pneumonia, exacerbation of arthritis, and neurological disorders.[30] Studies have shown high rates of seroconversion in children which may help in deciding the mitigation norms on children and establishing other social activities among them.[31]

During the analysis of this study, already mutant strains and more infectious variants of the virus were been reported from Europe and other parts of the world, opening new dimensions of the virus. Under the existing circumstances, the findings of this study must be interpreted with prudence, and as such the findings are not globally generalizable. This study also has a few limitations. First, we were not able to assess the clinical severity of COVID-19 in pediatric patients. Second, this study could not report patient hospitalization rates and clinical outcomes, which would be helpful data for clinicians in further managing the treatment of the disease in children.

**Table 2: Clinical symptoms of SARS-CoV-2 paediatric cases, June 1-November 30, 2020**

| Symptoms | Total number of cases=60 (%)* |
|---|---|
| Fever | 38 (63.3) |
| Cough | 26 (43.3) |
| Sore throat | 6 (10.0) |
| Shortness of breath | 5 (8.3) |

*Multi-response

## Conclusion

Although children of all ages appeared susceptible to COVID-19, in this study, we report a proportional age breakdown of COVID-19 infection in children, with mostly the disease affecting in early adolescence. Children usually act as asymptomatic carriers of the disease, raising the possibility of viral transmission and contributing to the pandemic. SARS-CoV-2 seems to have mild clinical features, commonly presenting with fever in children, and has shown to have male predominance. The rise of pediatric cases in summer indicates that SARS-CoV-2 is not restricted to winter but will continue to circulate year-round. These results can help and provide critical initial efforts for monitoring trends and assessment of mitigation strategies and vaccination prophylaxis in children. Further research needs to be done to identify the determinants of morbidity and mortality in children, discover and develop new treatment modalities, and ameliorate clinical outcomes.

## Key message

Researchers are still searching for answers to questions, which novel coronavirus has evoked. Nevertheless, COVID-19 has affected the lives of millions of children, awaiting their education to resume, accumulating evidence from the pandemic shows that children are less vulnerable to the disease and less frequently symptomatic. The study will help to adapt and improve COVID-related child healthcare strategies in the community.

## Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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