

Investigation of severe acute respiratory syndrome coronavirus 2 antibodies among the paediatric population in Mogadishu, Somalia

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Background: We undertook this cross-sectional study to determine the level of circulating anti-severe acute respiratory syndrome coronavirus 2 immunoglobulins (IgM and IgG) in children, as well as to evaluate other potential risk factors.

Methods: Children attending the outpatient department of the SOS and Benadir Hospitals in Mogadishu from 26 July to 8 August 2021 were selected following parental consent. The children (aged <18 y) were screened using the coronavirus disease 2019 (COVID-19) rapid test lateral flow immune-assay kit.

Results: Of the 500 children screened for COVID-19, 32 (6.4%) tested positive, out of which 26 (5.2%) had IgG antibodies, while five (1%) had IgM, with the other child (0.2%) having both circulating IgG and IgM antibodies. Also, 46.9% of the COVID-19-positive children were asymptomatic without any clinical signs of the disease. Children aged >6 y and those attending school were the most affected ($p=0.002$). The most common clinical features among positive children were fever (22.6%), cough (22.2%), shortness of breath (5.8%) and loss of smell (2.6%) and taste (2.2%). Similarly, not wearing a facemask as a preventive measure was found to be a significant risk factor ($p=0.007$).

Conclusions: This study shows that children are at risk of contracting COVID-19 infection. Our study also shows evidence of a high rate of IgG antibodies in school-aged children having close contact with infected adults, in those not wearing facemasks, as well as in those with a family history of comorbidities.

Keywords: comorbidity, COVID-19, paediatric infection, public health, sociodemographic factors, Somalia

Introduction

Since the emergence of the new severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) variant (Omicron) in South Africa, the Omicron variants have now become the dominant strain in circulation in most countries. Besides South Africa, the newly identified variant has also been detected in Botswana and Hong Kong. Despite the shortage of detailed data on the new vari-

ant, its emergence goes to show the dynamics of this pandemic and its potential for becoming more deadly especially due to its genetic profile, which shows multiple genetic mutations from the already known variants in circulation.

SARS-CoV-2 infections among children appear to cause less severe disease compared with adults.¹ Despite reports indicating a lower number of cases among the paediatric population,

recent studies have shown a rise in the number of children with coronavirus disease 2019 (COVID-19) and some cases with fatal outcomes.^{2,3} Large epidemiological studies suggest that children comprise only 1% to 2% of all SARS-CoV-2 cases.⁴ The spectrum of COVID-19 among the paediatric age group ranges from an asymptomatic state devoid of any clinical signs, a carrier state that is characterised by mild symptoms that tend to have a fast recovery to a more severe life-threatening condition that clinically manifests with pulmonary, ophthalmological, neurological, renal, cardiovascular and gastrointestinal signs.^{5,6} In China, children aged <18 y accounted for 2%–5%, Italy 1.2%, the USA 7.3% and Australia 4% of all COVID-19-positive cases.^{7–9} These results should be tempered, especially because in most cases, children are only tested when they are found to present signs synonymous with COVID-19 or those requiring hospitalisation.¹⁰ In situations where children with mild or no symptoms are not detected, they can act as drivers of transmission within their families and communities.¹¹ Therefore, having a better understanding of the epidemiology of SARS-CoV-2 among children, and its transmission, is crucial for the successful prevention and control of the disease.

Although there are sparse data on the prevalence of COVID-19 in children in Africa, COVID-19 has had a significant impact on African children and the rest of the world, including school closures, home isolation, community lockdown and financial and economic consequences.¹² Somalia reported its second wave of COVID-19 in February 2021. The second wave was more contagious and had a higher mortality rate than the first wave.¹³ Moreover, there was no new lockdown, and schools and public places were open, which may have increased the risk of disease transmission.¹⁴ However, there is no study on the prevalence of COVID-19 in children in Somalia, which is currently recovering from 30 y of internal conflict. The situation is worrying, because health indicators in Somalia are among the poorest in the world today, with the population facing a chronic nutrition crisis and malnutrition rates exceeding emergency thresholds, coupled with high morbidity rates and household food insecurity, as well as suboptimal feeding and child care practices.

Although the pandemic is still unfolding, this study was undertaken to reveal more data on the prevalence, epidemiological features and potential risks for COVID-19 in children aged <18 y in Mogadishu, Somalia. We also sought to understand transmission patterns in households with an emphasis on comorbidity-related risk factors.

Methodology

Study setting

A cross-sectional survey study was conducted at SOS and Benadir hospitals, two public hospitals providing maternal and child care in Mogadishu. Benadir hospital has 700 beds while the SOS hospital has a capacity of 145 beds.

Sample size determination

We assumed a 50% prevalence because no study had previously been performed to determine the seroprevalence of COVID-19 antibodies among children in Somalia.

Therefore,

$$N = Z^2 \times P(1 - P) \div e^2,$$

where Z is 1.96 (constant), e is the desired level of precision (i.e. 5% margin of error at 95% CI), P is the estimated prevalence (50%) and q is 1–P. A minimum of 384 samples was required. However, to increase our chances of detection, 500 samples were collected.

Study procedure

A total of 500 children attended the SOS and Benadir hospitals' paediatric clinics from 26 July to 8 August 2021 (nearly 2 mo after the second wave), where a total of 250 participants (aged <18 y) were recruited from each of the hospitals' outpatient departments using a purposive sampling approach. The data were collected using the interview method with the aid of a pretested questionnaire as well as blood sample collection from the participants. Following parental consent, all the children attending the outpatient departments of the selected hospitals were included, regardless of their clinical status. However, children with a history of COVID-19 infection were excluded.

The questionnaire was prepared first in English and occasionally administered orally by translating into the Somali language where necessary and was then cross-checked daily for completeness. The administration of the questionnaires was assisted by four medical students in their clinical years who were trained earlier on how to complete the questionnaire and conduct the test. The children were screened during triage and their caretakers/parents were asked to give their written and verbal consent; only those whose caretakers/parents granted their consent were included. A structured questionnaire was completed regarding their sociodemographic, clinical status and COVID-19 exposure and preventive measures, while making sure that the information collected was anonymised.

Serological screening by IgM/IgG antibody detection

To determine the seroprevalence of COVID-19 in children, a finger prick blood specimen was collected and an OnSite COVID-19 Ag Rapid Test lateral flow immunoassay kit was used for the qualitative detection of SARS-CoV-2 virus antibodies (IgM and IgG) in the blood (Wondfo Biotech, Guangzhou, China). According to the manufacturer's information, the OnSite COVID-19 Rapid Test has a sensitivity of 87.12% and a specificity of 99.74%. The kit targets individuals with an adaptive immune response to SARS-CoV-2, indicating that recent (IgM) or prior infection (IgG) correlates with natural infection.¹⁵

Data analysis

We employed binary logistic regression in this investigation. The χ^2 test was used to investigate the association between categorical variables. At a 95% confidence level, a significant level of 0.05 was adopted. The data were analysed using SPSS (IBM-SPSS®, New York, United States) version 18.0.2.

Results

Sociodemographic characteristics of the participants

Participant characteristics are shown in Table 1. Overall, 500 children were recruited and tested for SARS-CoV-2 specific antibodies. Of the 500 participants, 256 (51.2%) were female while the remaining 244 were male. A majority of the study participants

Table 1. Sociodemographic characteristics and COVID-19 test results

Demographics	N	COVID-19 test results (IgG/IgM)		95% CI (OR)	p
		Positive (N=32)	Negative (N=468)		
Gender				RC	
Male	244 (48.8)	13 (40.6)	231 (49.4)		
Female	256 (51.2)	19 (59.4)	237 (50.6)	1.42 (0.688 to 2.951)	0.341
Age of children, y				RC	
<1	129 (25.8)	2 (6.3)	127 (27.1)		
1–5	246 (49.2)	12 (37.5)	234 (50.0)	0.31 (0.068 to 1.394)	0.126
6–18	125 (25.0)	18 (56.3)	107 (22.9)	0.14 (0.021 to 0.413)	0.002*
Educational level				RC	
Under school age	382 (76.4)	17 (53.1)	365 (78.0)		
Never went to school	29 (5.8)	1 (3.1)	28 (6.0)	1.37 (0.167 to 10.161)	
Kindergarten	8 (1.6)	0 (0.0)	8 (1.7)	-	-
School	81 (16.2)	14 (43.8)	67 (14.3)	0.21 (0.105 to 0.474)	0.001*
Number of people in the household				RC	
1–5	104 (20.8)	5 (15.6)	99 (21.2)		
6–10	302 (60.4)	19 (59.4)	283 (60.5)	0.75 (0.274 to 2.068)	0.581
>11	94 (18.8)	8 (25.0)	86 (18.4)	0.52 (0.171 to 1.722)	0.379
Z score/BMI				RC	
Normal	249 (49.8)	12 (37.5)	237 (50.6)		
Underweight	206 (41.2)	19 (59.4)	187 (40.0)	0.43 (0.236 to 1.053)	0.338
Overweight	17 (3.4)	1 (3.1)	16 (3.4)	0.81 (0.99 to 6.628)	0.844
Obese	28 (5.8)	0 (0.0)	28 (6.0)	-	-

Abbreviations: BMI, body mass index; RC, reference category.

*indicates statistical significance

were aged 1–5 y (246; 49.2%), followed by 129 (25.8%) aged <1 y, while the others were aged 6–18 y.

According to their educational level, most children were aged under school age (76.4%), 81 (16.2%) attended school, 29 (5.8%) never went to school and the other eight (1.6%) were attending kindergarten.

A total of 32 (6.4%) children tested positive for SARS-COV-2 antibodies, out of which 26 (5.2%) had positive IgG, five (1%) had IgM and the other child (0.2%) had both circulating IgG and IgM antibodies.

The results also revealed that children aged >6 y and those going to school had p-values of 0.002 and 0.001, respectively, with higher odds of acquiring the SARS-COV-2 infection (age 6–18 y: 0.094 [0.021–0.413]; attending school: 0.223 [0.105–0.474]).

Comorbidities and COVID-19 outcomes in children and their family members

As shown in Table 2, a total of 14 (2.8%) children had a history of asthma, eight (1.6%) had cardiac diseases and seven (1.4%) had diabetes.

Regarding family history of comorbidities, 117 (23.4%) of participants (according to the consenting parent) reportedly had a family history of hypertension, 35 (7.0%) had a family history of cardiovascular diseases and 43 (8.6%) a family history of

asthma. The results indicate that children with a family history of comorbidities were more likely to be SARS-COV-2 antibody positive (p=0.017, hypertension; p=0.007, cardiovascular diseases; p=0.006, asthma).

Clinical characteristics of study participants

A total of 91 (18.2%) of participants were found to have COVID-19-like symptoms and the most commonly presented symptoms were fever (22.6%), cough (22.2%), shortness of breath (5.8%) and loss of smell (13; 2.6%) and taste (11; 2.2%). This reveals the interaction between positivity and other clinical characteristics, as shown in Table 3.

In addition, binary logistic regression was performed to establish whether there is a significant association between flu-like clinical features and COVID-19 antibody positivity. In support of this, the study discovered a substantial correlation between circulating antibodies against COVID-19 and symptoms of fever, cough and shortness of breath. Children with fever were 7.7 times more likely to test positive compared with children without fever (Table 3) (OR=7.75 [3.633–16.755], p=0.0001). In a similar vein, children who were coughing during data collection had a 6.8-fold increased chance of testing positive for COVID-19 (OR=6.87 [3.257–14.638], p=0.001). Furthermore, children who reported shortness of breath as a clinical sign had a 3.5-fold higher chance of testing positive compared with those without shortness of

Table 2. Comorbidities and COVID-19 outcomes

Comorbidities	N	COVID-19 outcome (IgG/IgM)		p
		Positive (N=32)	Negative (N=468)	
Diabetes				
Yes	7 (1.4)	0 (0.0)	7 (1.5)	0.628
No	493 (98.6)	32 (100.0)	461 (98.5)	
Cardiovascular diseases				
Yes	8 (1.6)	0 (0.0)	8 (1.7)	0.587
No	492 (98.4)	32 (100.0)	460 (98.3)	
Asthma				
Yes	14 (2.8)	3 (9.4)	11 (2.4)	0.032*
No	486 (97.2)	29 (90.6)	457 (97.6)	
Family history of comorbidities				
Diabetes				
Yes	117 (23.4)	11 (34.4)	106 (22.6)	0.134
No	383 (76.6)	21 (65.6)	362 (77.4)	
Hypertension				
Yes	117 (23.4)	13 (40.6)	104 (22.2)	0.02*
No	383 (76.6)	19 (59.4)	364 (77.8)	
Cardiac				
Yes	35 (7.0)	6 (18.8)	29 (6.2)	0.007*
No	465 (93.0)	26 (81.3)	439 (93.8)	
Asthma				
Yes	43 (8.6)	7 (21.9)	36 (7.7)	0.009*
No	457 (91.4)	25 (78.1)	432 (92.3)	
Obesity				
Yes	149 (29.8)	14 (43.8)	135 (28.8)	0.079
No	351 (70.2)	18 (56.2)	333 (71.2)	

*indicates statistical significance

breath (OR=3.51 [1.309–9.415]). However, there was no significant relationship between COVID-19 antibody positivity and loss of taste (1.56 [0.536–4.571]), loss of smell (1.07 [0.031–3.66]) or upset stomach (1.55 [0.628–3.614]).

Preventive practices and COVID-19 outcomes

Children who did not wear a facemask were found to be twice as likely to be SARS-CoV-2 antibody positive (OR=2.75 [1.236–5.730]). Children who reported they were not sure whether they had any close contact with someone with COVID-19 were 2.4 times more likely to be COVID-19 antibody (IgG/IgM) positive. On the other hand, children whose family members had COVID-19 were 4.7 times more likely to be SARS-CoV-2 antibody positive. In addition, those whose family members were hospitalised because of COVID-19 were 10 times more likely to show circulating levels of SARS-CoV-2 antibodies. Also, children who lost a family member due to COVID-19 were 9.4 times more likely to be SARS-CoV-2 positive (Table 4).

Discussion

The goal of this study was to assess the COVID-19 seroprevalence in children aged <18 y who visited the SOS and Benadir hospital clinics in Mogadishu, Somalia. One important finding from this study is that children are at increased risk of infection when they live with adult family members with comorbidities. Even although most cases of COVID-19 in children are mild and very few require hospitalisation, it is important to understand their COVID-19 status to ensure that they receive the care they need.¹⁶ Unfortunately, as the number of people testing positive for COVID-19 continued to increase, the number of children contracting the virus also increased.¹⁷

The seroprevalence of specific IgM and/or IgG antibodies against SARS-CoV-2 was 6.4% in this study. There have been a few studies on COVID-19 prevalence in children aged 0–19 y, with prevalence ranging from 1%–2% up to 21.6% in the Italian epicentre.^{18–20} These findings indicate that children are also susceptible to COVID-19 infection as well. To the best of our knowledge, this is the first report of paediatric COVID-19 seroprevalence in Somalia.

Table 3. Clinical characteristics and COVID-19 outcomes

Clinical features	N	COVID-19 outcome (IgG/IgM)		95% CI (OR)	p
		Positive (N=32)	Negative (N=468)		
COVID-19-like symptoms?					
Yes	113 (22.6)	21 (65.6)	92 (19.7)	7.75 (3.633 to 16.755)	0.0001*
No	387 (77.4)	11 (34.4)	376 (80.3)	RC	
Fever					
Yes	113 (22.6)	21 (65.6)	92 (19.7)	0.13(0.06 to 0.28)	0.0001
No	387 (77.4)	11 (34.4)	376 (80.3)	RC	
Cough					
Yes	111 (22.2)	20 (62.5)	91 (19.4)	6.87 (3.257 to 14.638)	0.001*
No	389 (77.8)	12 (37.5)	377 (80.6)	RC	
Loss of smell (n=63)					
Yes	33 (52.4)	7 (21.2)	26 (78.8)	1.07 (0.031 to 3.66)	0.91
No	30 (45.6)	6 (20.0)	24 (80.0)	RC	
Loss of taste (n=61)					
Yes	29 (47.5)	11 (38.0)	18 (62.0)	1.56 (0.536 to 4.571)	0.41
No	32 (52.5)	9 (28.1)	23 (71.9)	RC	
Stomach upset					
Yes	73 (14.6)	11 (34.4)	62 (13.2)	1.55 (0.628 to 3.614)	0.358
No	427 (85.4)	21 (65.6)	406 (86.8)	RC	
Shortness of breath					
Yes	29 (5.8)	9 (28.1)	20 (4.3)	3.51(1.309 to 9.415)	0.013*
No	471 (94.2)	23 (71.9)	448 (95.7)	RC	

Abbreviation: RC, reference category.

*indicates statistical significance

The 6.4% prevalence recorded in the current study implies that children in Somali are vulnerable to contracting COVID-19. Therefore, taking appropriate measures is essential to prevent and control the disease in children. Earlier reports show that the risk factors associated with severe SARS-CoV-2 infection in children include belonging to the neonatal age group and being male, as well as having a lower respiratory tract disease and pre-existing medical conditions.^{18,21} In our investigation, we observed that school-aged children had circulating SARS-CoV-2 antibodies, which could imply active infection. Therefore, vaccinating these children has become paramount to aid in the development of their immunity, which will help protect them from contracting the disease or developing severe symptoms.²²⁻²⁴ Fortunately, Somalia is a beneficiary of the COVAX facility, where Moderna, Oxford/AstraZeneca, Johnsons & Johnson and Pfizer/BioNTech vaccines are currently being administered. The age group in our study indicated a substantial difference. When compared with other age groups, school-aged children were found to have significant levels of SARS-CoV-2 antibodies. This finding is in line with an earlier report, where adolescents displayed a higher prevalence than children (13.9% and 7.3%, respectively).²³ The lower rate of SARS-CoV-2 antibodies among younger children may be because they commonly experience recurrent episodes of seasonal viral infection, which may have primed their systems to develop strong immunity.²⁵

Fever, cough, difficulty in breathing, loss of smell and loss of taste were found to be the most common symptoms in the current study. The findings in this study are comparable with those of a study conducted in Iran, which found that fever, cough and sore throat were the most prevalent symptoms in adult patients.²⁶ In addition, a community study and review article conducted in Somalia showed that fever and dry cough were among the most common clinical presentation of COVID-19 positive cases.^{26,27} It has been established that COVID-19, like any other respiratory illness, affects the upper respiratory tract and is transmitted through respiratory droplets. Furthermore, although several studies identified gastroenteritis as a symptom,²⁸⁻³⁰ it was not significant in our analysis. This discrepancy could be because those studies had a larger sample size, and recall bias could be a factor because we asked about symptoms over the previous 3 mo.

Children who did not use protective measures, such as wearing facemasks, performing social distancing and washing their hands, were more likely to contract the disease.^{31,32} In the current study, most of the children who did not stay at home during lockdown were found to have circulating levels of COVID-19 antibodies. Children, like adults, can spread the disease and contract it. Similarly, children were reported to have a high viral load with increased chances of transmitting the disease.³³ However, this study was conducted after the second wave in the community, when the activities of daily life were being pursued without

Table 4. Preventive practices and COVID-19 outcomes

Preventive measures	N	COVID-19 outcome (IgG/IgM)		95% CI (OR)	p
		Positive (N=32)	Negative (N=468)		
Did your child regularly wear a facemask?				RC	
Yes	117 (23.4)	14 (43.8)	103 (22.0)		
No	383 (76.6)	18 (56.2)	365 (78.0)	2.75 (1.24 to 5.73)	0.007*
Did your child regularly wash their hands?				RC	
Yes	241 (48.2)	19 (59.4)	222 (47.4)		
No	259 (51.8)	13 (40.6)	246 (52.6)	1.62 (0.78 to 3.36)	0.195
Does your child keep their distance from others?				RC	
Yes	214 (42.8)	17 (53.1)	197 (42.1)		
No	286 (57.2)	15 (46.9)	271 (57.9)	1.55 (0.76 to 3.20)	0.226
Does your child avoid shaking hands?				RC	
Yes	186 (37.2)	17 (53.1)	169 (36.1)		
No	314 (62.8)	15 (46.9)	299 (63.9)	2.01 (0.98 to 4.12)	0.058
Was there a period when your child did not go to school due to the COVID-19 lockdown?				RC	
Yes	85 (17.0)	14 (43.8)	71 (15.2)		
No	415 (83.0)	18 (56.3)	397 (84.8)	4.35 (2.07 to 9.14)	0.001*
If 'YES', was he/she staying at home?				RC	
Yes	80 (16.0)	12 (37.5)	68 (14.5)		
No	5 (1.0)	2 (6.3)	3 (0.7)	0.26 (0.12 to 0.56)	0.001*
NA	415 (84.0)	18 (56.2)	397 (84.8)	0.07 (0.01 to 0.43)	0.004*
Did your child ever have close contact with someone with COVID-19?				RC	
No	140 (28.0)	5 (15.6)	135 (28.8)		
Yes	15 (3.0)	11 (34.4)	4 (0.9)	0.45 (0.11 to 1.78)	0.254
Not sure	345 (69.0)	16 (50.0)	329 (70.3)	2.464 (1.156 to 5.2252)	0.020*
Did any of his/her household have COVID-19?				RC	
Yes	13 (2.6)	3 (9.4)	10 (2.1)	4.74 (1.24 to 18.16)	0.023*
No	487 (97.4)	29 (90.6)	458 (97.9)		
Were any of his/her close contacts hospitalised for COVID-19?				RC	
Yes	13 (2.6)	5 (15.6)	8 (1.7)	10.65 (3.26 to 34.75)	0.001*
No	487 (97.4)	27 (84.4)	460 (98.3)		
Did any of his/her close contacts die from COVID-19?				RC	
Yes	11 (2.2)	4 (12.5)	7 (1.5)	9.41 (2.60 to 34.05)	0.001*
No	489 (97.8)	28 (87.5)	461 (98.5)		

Abbreviations: NA, not applicable; RC, reference category.
*indicates statistical significance

restrictions. Despite these observations, the likelihood of recall bias on behalf of the caregivers/parents providing this information could invalidate this claim.

Children with a family history of chronic illness, including hypertension, heart disease or asthma, are more likely to be SARS-CoV-2 antibody positive. Similarly, it has also been reported that individuals with comorbidities have an increased chance of being infected.³⁴ Several studies have reported that people with chronic diseases are more likely to acquire COVID-19, develop severe disease and experience a high mortality rate.³⁵⁻³⁸ Because the disease is transmitted from human to human via respiratory droplets, there is every likelihood of it spreading to members of the same household and anyone else in close contact with an infected individual. One important limitation to this observation is that family size may act as a confounding factor that increases

the risk of COVID-19 antibody positivity among children. We also observed, according to our findings, that children who had contact with a family member who had the disease were more likely to have SARS-CoV-2 antibodies. This finding is in agreement with those of Buonsenso et al., who reported that children who live with a COVID-19 positive adult were more likely to contract the disease.³⁹ Therefore, precautions should be taken to prevent children from being infected.

Conclusion

It is important to note that when this study was conducted, vaccines were not approved for children. Nonetheless, this research gives further credence to the fact that children are still at risk of acquiring COVID-19 if they come into contact with an infected

family member. The majority of participants with positive antibodies against SARS-CoV-2 in the current study were school-aged children and children who do not wear facemasks, as well as those who had close contact with infected adults among others.

Authors' contributions: NID and FAHO conceived the idea; NID, JHM, MHA and IHM designed the study methodology; NID, MHA, AMS and BG performed the formal analysis; NID, MHA and MASN conducted the investigation; NID, FAHO, JHM and HAD all contributed to writing the original draft; all the authors have read and agreed to the published version of the manuscript.

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Data availability: The data from this study are published in this article.

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