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Investigation and Analysis of Laboratory Results of Anti- SARS-COV-2 IGM and IGG Antibodies among Women and Children Admitted to Al-Batoul Maternity and Childhood Teaching Hospital, Diyala, Iraq: A Retrospective Cohort Study

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ABSTRACT

Background: The rapid spread of COVID-19 has placed over the world in an advanced-level health emergency.

Objectives: This retrospective observational study aimed to reveal the statistical profile of SARS-CoV-2 IgM and IgG using laboratory records that included COVID-19 and other viral tests at Al-Batoul Maternity and Childhood Teaching Hospital, Diyala, Iraq. **Patients and Methods**: This retrospective study was conducted from December 2021 to February 2024. The laboratory results records were used to extract serological test data and demographic information for patients who were admitted to Al-Batoul Hospital between December 1, 2021, and December 1, 2022. The study included 818 inpatient patients, women and children who underwent antibody tests for COVID-19. The data were analysed using SPSS version 20, using the chi-square test.

Results: This study included 818 hospitalized women and children with laboratory results for IgM and IgG antibodies. Among the women participating in this study, only thirty-nine (4.5%) had seropositivity for IgM antibodies, and one hundred fifty-seven (21.7%) had seropositivity for IgG antibodies. Only four children had anti-SARS-CoV-2 IgM antibodies (positive rate of 4.3%), and eighteen children had anti-SARS-CoV-2 IgG antibodies (9.3%). The seasonal attributes of COVID-19 infection remained indeterminate in this investigation.

Conclusion: To our knowledge, there are few reports on the susceptibility of women and children to SARS-CoV-2 infection. The presence of antibodies among (non) pregnant women and children is evidence of ongoing infections.

Keywords: SARS-CoV-2, IgM and IgG antibodies, Women and Children, laboratory results, Retrospective cohort study.

INTRODUCTION

Coronaviruses are a considerable family commonly found in various animal species, such as camels, cattle, cats, and bats [(1)]. Among these viruses, SARS-CoV and MERS-CoV are particularly virulent and can lead to the development of acute respiratory syndrome in humans. Both viruses had devastating repercussions on China and Saudi Arabia. The mortality rates because of infection were approximately 10% and 35%, respectively [(2- 4)]. On the other hand, the remaining four human coronaviruses (HCoV-NL63, HCoV-229E, HCoV-OC43, and HKU1) cause only mild upper respiratory tract illness in immunocompetent individuals. It was postulated that individuals infected with human coronaviruses (HCoVs) experienced only mild cold symptoms until the occurrence of SARS-CoV outbreak. However, it should be noted that some may be responsible for serious infections in infants, older children, elderly individuals, and those with chronic diseases [(5)].

In late 2019, a new virus, initially called 2019-nCoV, emerged and was subsequently renamed SARS-CoV-2 according to the World Health Organization, resulting in an ongoing global pandemic [(6)]. This novel SARS-CoV-2 virus underwent multiple mutations, resulting in the emergence of numerous variants. The WHO has divided these variants into three categories for prioritizing surveillance and investigation: variants of concern (VOCs), variants of interest (VOIs), and variants that are under surveillance (VUMs). The four VOCs were identified as alpha (B.1.1.7), beta (B.1.351), gamma (P.1), and delta (D.1). On November 26, 2021, the WHO identified the newly discovered variant Omicron (B.1.1.529) as the fifth most severe, widespread variant (VOC), raising a significant level of concern worldwide [(7)].

A viral infection causes the COVID-19 pandemic and has the potential to impact individuals across all age ranges, ranging from newborn to elderly individuals. Moreover, this disease can lead to a diverse range of clinical presentations [(8)]. In the context of the global health emergency caused by COVID-19 infection, it is important to identify groups at risk of infection [(9)], with pregnant women, children, elderly individuals, newborns of infected mothers, and those hospitalized being particularly vulnerable groups.

The measures for controlling the disease spread in various hospitals in Iraq included conducting urgent serological tests for patients seeking hospital services such as caesarean sections, natural births, or various other surgical operations. These tests are useful for identifying positive cases of infection and asymptomatic infections and have also contributed significantly to epidemiological surveillance programs [(10)]. IgG and IgM antibody tests for SARS-CoV-2 were made available in February 2020. The

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National Health Commission in China introduced serological diagnostic standards on March 4, 2020 [11]. Understanding the seroprevalence of SARS-CoV-2 infections in asymptomatic women and children with COVID-19 is crucial for formulating an informed strategy to combat the ongoing pandemic [12].

Given that the research related to epidemiological survey studies of COVID-19 are comprehensive and do not exclude women and children, this study aimed to investigate the epidemiology of COVID-19 by analysing laboratory results for IgM and IgG antibodies against SARS-CoV-2 among women and children admitted to Al-Batoul Maternity and Childhood Teaching Hospital, Diyala, Iraq.

PATIENTS AND METHODS

Participants and study design

The present retrospective, observational, and cohort study was achieved at Al-Batoul Maternity and Childhood Teaching Hospital, Diyala, Iraq. A total of 818 women and children who were hospitalized between December 2021 and November 2022 participated in the study. This study included hospitalized patients, pregnant women seeking antenatal services (natural midwifery and caesarean sections), nonpregnant women and children who matched the study criteria; these included hospitalization on the recommendation of a specialist doctor and the presence of laboratory results regarding serological testing for antibodies before performing surgical operations and natural midwifery and caesarean sections.

Demographic data, such as sex, age, month (from December 2021 and November 2022), barcode number, and results of serological tests for COVID-19, human immunodeficiency virus HIV, and Hepatitis B surface antigen HBs, were collected from hospital laboratory records. Individuals whose demographic information and serological test results were missing in the medical records were excluded.

The serological test used in the health institution under study was a COVID-19 IgG/IgM Rapid Test Device (COV-W23M)/AssureTech (Hangzhou/China) and (Lotus. B. V/Netherlands). A diagnostic tool was used to detect the presence of anti-SARS-CoV-2 IgM and anti-SARS-CoV-2 IgG in whole blood, serum, or plasma samples. This rapid immunoassay aids in the diagnosis of COVID-19 by providing direct and qualitative results. The relative sensitivity of the IgM detection method was 93%, and the relative specificity was 99.1%, with an overall consistent confidence interval (95.4%-98.9%). Concerning the IgG antibodies, the relative sensitivity was 98.8%, and the relative specificity was 98.7%, with an overall agreement confidence interval (96.7%-99.5%). The laboratory personnel, who were trained on the implementation of the test, conducted the procedure according to the instructions included with the diagnostic kit. The presence of IgM antibodies indicates recent infection and can be used for early diagnosis of infection. IgG antibodies appear gradually and increase in the late stage of infection and represent the level of immunity acquired because of the infection. [33]

The rapid test is based on the principle of visually interpreting colour development to detect the presence of anti-SARS-CoV-2 IgG/IgM antibodies. A positive result for the specific IgG and/or IgM antibodies was indicated when there was a red band(s) in the test region(s), whereas a negative result was indicated by its absence. The presence of a red band at the control region (C) acts as a procedural control, serving as an indicator that membrane wicking is functioning properly.

Ethical considerations:

The current study was conducted after obtaining prior ethical approval from the Scientific Research Ethics Committee/College of Education for Pure Sciences (ref. No CEPEC/007-1/12/2021). A letter of approval was submitted to the Board of Directors of Al-Batoul Teaching Hospital for Maternity and Childhood (place of data collection) (ref. No CEPEC/007-1/12/2021). However, consent was not needed because the design of this study was retrospective, cohort, observational and did not include medical procedures or blood or swab sampling, which may contribute to the spread of the disease. The data of the study participants were retrospectively collected while ensuring that the participants' identities (personal information) were protected.

Statistical methods

All the data in the current study were entered into the SPSS program (version 20). Quantitative data were presented as mean and standard deviation (SD). Qualitative data were presented as frequency and percentage and were analyzed using chi-square test. A P value ≤ 0.05 was considered to indicate statistical significance.

RESULTS

This section presents the significant and other relevant results for the data analysis, which are included in the figures and tables for achieving the aims of this study. Table (1) shows that the most common age of the studied women (47.03%) was $\leq$ 25 years with a mean age of 28 ± 7.7 years. In addition, the most common age of the studied children was $\leq$2 or $\geq$12 years (Both 27.96%), with a mean age of 6.6 ± 4.9 years. On the other hand, many of the children were males (58.06%), and the remainder were females (41.94%).

Table (1): Demographic characteristics of women and children admitted to Al-Batoul Maternity and Childhood Hospital from December 2021 to November 2022 (*n*=818):

Sociodemographic Data		Freq.	%
Age Groups for Women (Years)	<= 25	341	47.03
	26 - 30	184	25.38
	31 - 35	99	13.66
	36 - 40	48	6.62
	41 and more	53	7.31
	Mean ± SD	28 ± 7.7	
Total		**725**	**100%**
Age Groups for Children (Years)	<=2	26	27.96
	3-5	24	25.81
	6-8	9	9.68
	9-11	8	8.6
	12 and more	26	27.96
	Mean ± SD	6.6 ± 4.9	
Gender for Children	Males	54	58.06
	Females	39	41.94
Total		**93**	**100%**

As table 2 shows, 39 (5.4%) women were seropositive for IgM antibodies, and 157 (21.7%) were seropositive for IgG antibodies. The results of the serological tests conducted for the children showed that IgM antibodies were observed in 4 (4.3%) patients only and that IgG antibodies were observed in 18 (9.3%). All study participants were negative for HIV and HBs.

Table (2): Laboratory results for anti-SARS-CoV-2 antibodies in women screened and children at hospital admission.

Laboratory results of anti-SARS-CoV-2 antibodies		COVID19 - IgM				COVID19 - IgG			
		Negative		Positive		Negative		Positive	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Participants	**Women**	686	94.6	39	5.4	568	78.3	157	21.7
	Children	89	95.7	4	4.3	75	80.7	18	9.3

Figure (4) shows the seropositivity of IgM for COVID-19 among women according to the months from December 2021 to November 2022. The present study revealed that IgM antibodies among women were detected in very few patients in the last month of 2021 and in the first two months of 2022, after which they gradually increased to reach their peak in the seventh month and decreased sharply in the eighth month of 2022.

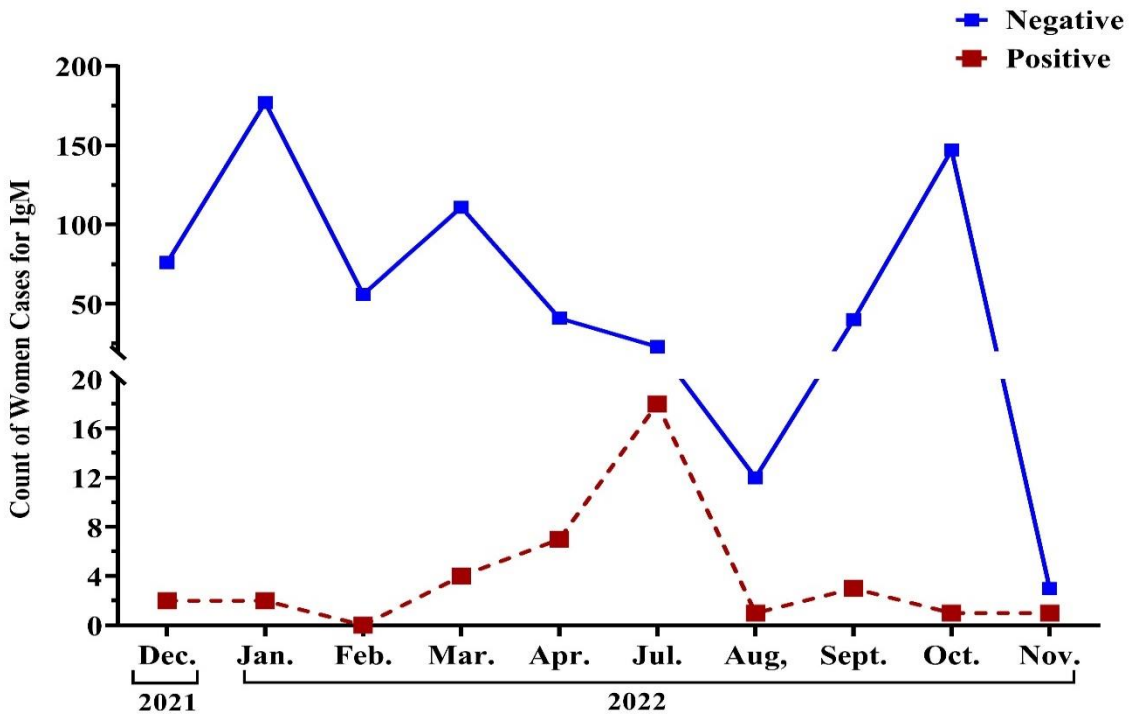

Figure (4): Polygon chart of IgM seropositivity for COVID-19 among women from December 2021 to November 2022 (*n*=725).

Figure 5 shows the seropositivity of IgG for COVID-19 among women according to the months from December 2021 to November 2022. The present study revealed that IgG antibodies gradually increased in the last month of 2021 and in the first two months of 2022, reached their peak in the third month, then decreased in the fourth month, and disappeared in the remaining 2022 months.

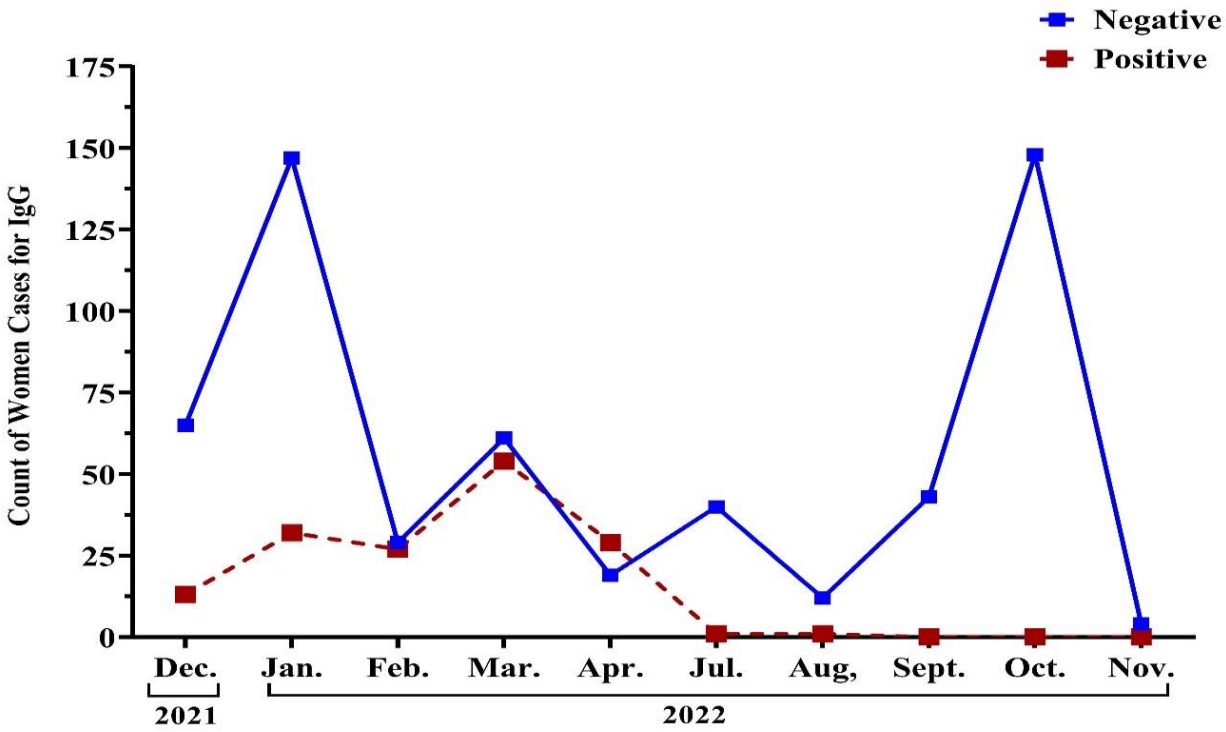

Figure (5): Polygon chart showing the seropositivity of IgG for COVID-19 among women according to the months from December 2021 to November 2022 (*n*=725).

Figure (6) shows the polygon chart of the seropositivity of IgM for COVID-19 among children according to the months from December 2021 to November 2022. The present study revealed that IgM antibodies among children were not detected in the last month of 2021 and the first four months of 2022 but were detected in July; however, they reached their peak in August and disappeared in the September and October of 2022.

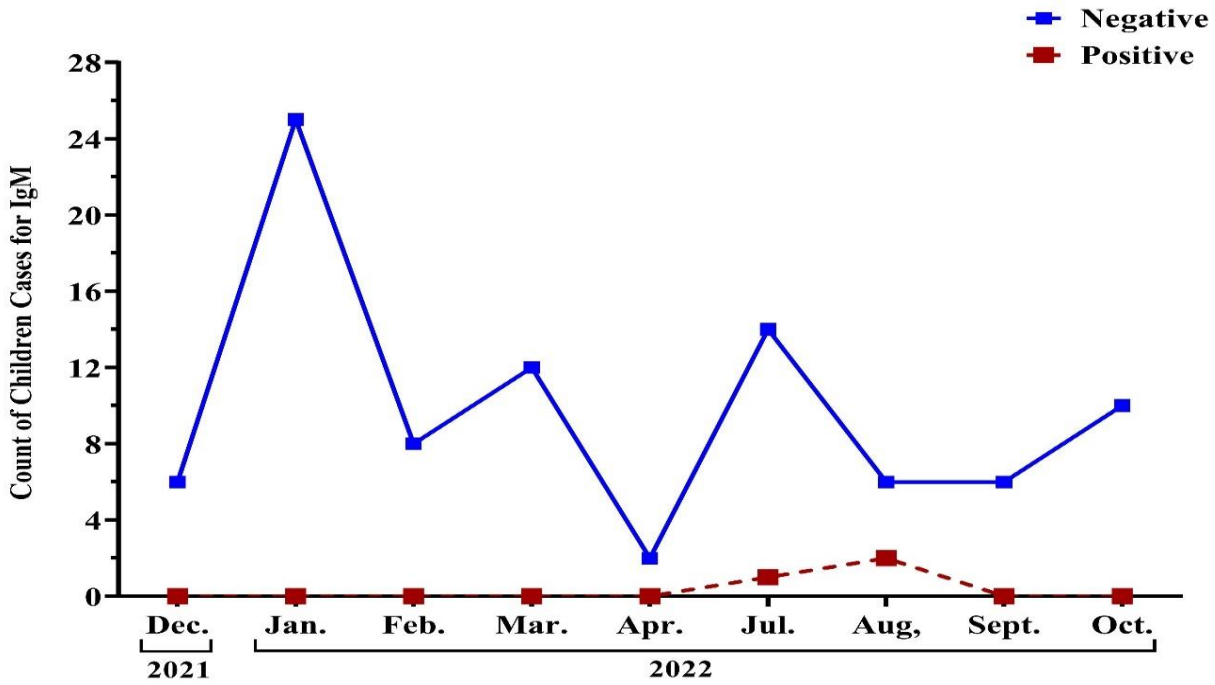

Figure (6): Polygon chart of the seropositivity of IgM for COVID-19 among children according to the months from December 2021 to November 2022 (*n*=93).

Figure (7) shows the polygon chart of the seropositivity of IgG for COVID-19 among children according to the months from December 2021 to November 2022. The present study revealed that IgG antibodies gradually increased in the last month of 2021 and in the first two months of 2022, peaking in March, decreasing in the fourth month, and disappearing in September and October of 2022.

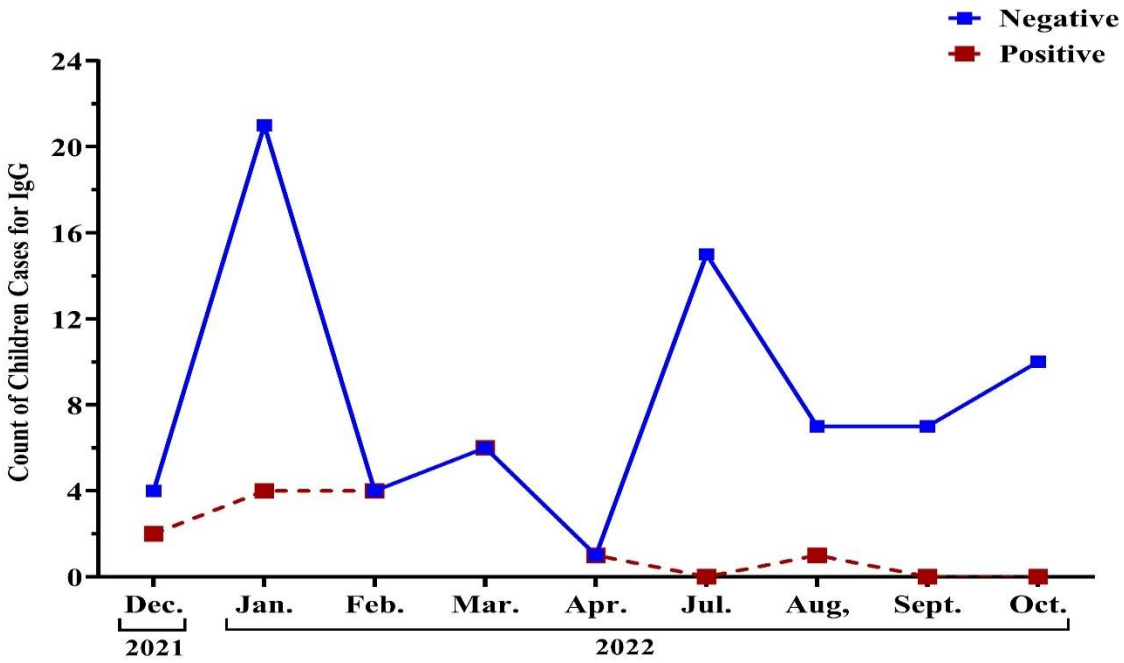

Figure (7): Polygon chart of the seropositivity of IgG for COVID-19 among children according to the months from December 2021 to November 2022 (*n*=93).

Table 3 shows that there was no statistically significant relationship between seropositivity of IgM and IgG and the demographic data of the studied women.

Table (3): Relationships between demographic data and positivity of IgM and IgG for COVID-19 in women admitted to Al-Batoul Maternity and Childhood Hospital from December 2021 to November 2022

Demographic Data of Women		COVID19 - IgM				COVID19 - IgG			
		Negative		Positive		Negative		Positive	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Age Groups (Years)	<= 25	318	46.36	23	58.97	264	46.48	77	49.04
	26 - 30	173	25.22	11	28.21	147	25.88	37	23.57
	31 - 35	96	13.99	3	7.69	76	13.38	23	14.65
	36 - 40	46	6.71	2	5.13	36	6.34	12	7.64
	41 and more	53	7.73	0	0	45	7.92	8	5.10
Statistical Test		Chi-square = 5.604, df=4, *p* value=0.231 (**NS**)				Chi-square = 2.238, df=4, *p* value=0.692 (**NS**)			

df= degrees of freedom; NS=nonsignificant.

Table (4) shows that there was no statistically significant relationship between the presence of seropositivity for IgM and IgG and demographic data of the studied children.

Table (4-3): Relationships between demographic data of children who are admitted to Al-Batoul Maternity and Childhood Hospital from December 2021 to November 2022 and positivity for both IgM and IgG for COVID-19 according to the chi-square test.

Demographic Data of Children		COVID19 - IgM				COVID19 - IgG			
		Negative		Positive		Negative		Positive	
		Freq.	%	Freq.	%	Freq.	%	Freq.	%
Age Groups (Years)	**<=2**	25	28.09	1	25	24	32	2	11.11
	3-5	24	26.97	0	0	20	26.67	4	22.22
	6-8	9	10.11	0	0	7	9.33	2	11.11
	9-11	7	7.87	1	25	7	9.33	1	5.56
	12 and more	24	26.97	2	50	17	22.67	9	50
		Chi-square = 3.529, df=4,*p* value=0.473 (**NS**)				Chi-square = 6.544, df =4, *p* value=0.162 (**NS**)			
Gender	**Males**	52	58.43	2	50	44	58.67	10	55.56
	Females	37	41.57	2	50	31	41.33	8	44.44

df= degrees of freedom; NS=nonsignificant.

DISCUSSION

Despite the extensive amount of research conducted on COVID-19 since the start of the pandemic, there is still a lack of understanding regarding epidemiological surveys and the effects of infection on women (pregnant and nonpregnant), neonates and children. Given that the age group with the highest mortality rate from SARS-CoV-2 was among individuals older than 65 years, it is understandable that the emphasis has primarily been on this topic [13]. As in the previous SARS and MERS epidemics, children were the population least at risk of severe infections, but there is reason for continued concern: children may suffer from very severe respiratory diseases, which is what is observed in hospital emergency departments. On the other hand, pregnant or postpartum women are more susceptible to influenza infection than are other women [14].

The current study included 93 children with laboratory results for IgM and IgG antibodies. Among the women participating in this study, only thirty-nine (4.5%) were seropositive for IgM antibodies, while one hundred fifty-seven (21.7%) were seropositive for IgG antibodies. At the beginning of the introduction of vaccines against COVID-19, both pregnant women and children were excluded for fear of unsafe vaccines, especially for pregnant women. Therefore, the positive serological results for IgM and IgG antibodies among the participants in the present study are a result of natural infections caused by SARS-CoV-2.

Research on the immunological aspects of SARS-CoV-2 infection in pregnant women has shown increased levels of SARS-CoV-2 IgM and IgG antibodies among pregnant women who have been infected [15]. In Brazil, a previous study of 195 asymptomatic pregnant women who visited the outpatient clinic for antenatal care and the emergency obstetric department revealed that 17 (8.71%) were positive for antibodies [16]. In Peru, 2419 pregnant women underwent serological examination. The prevalence rate of antibodies was 7.0%, IgM was detected in 10%, and IgG was detected in 11.2%. Most pregnant women who had positive results were asymptomatic [17]. In another study, rapid tests indicated that 18.5% of women in the delivery room were positive for antibodies [18]. Almost all of them showed no symptoms. Seroprevalence studies have revealed a high prevalence of COVID-19 infection in pregnant women who had not been identified as infected [19]. Although COVID-19 may result in negative outcomes such as ICU admission or patient death, most women experience a mild clinical course [20].

Only four children had anti-SARS-CoV-2 IgM antibodies (positivity rate of 4.3%), and eighteen children had anti-SARS-CoV-2 IgG antibodies (positivity rate of 9.3%). These results also showed that the 12 and older age group had the highest seropositivity for antibodies. The results of this study indicate that most children are susceptible to infection with SARS-CoV-2. This was confirmed by **Wang *et al.***, [21], who suggested strengthening preventive and control measures against COVID-19 to prevent this disease in children. The severity of the disease in paediatric patients is relatively mild compared to that in adults, and they may show few or no symptoms [22]. This may be due to several factors. Children may harbor antibodies that have already resulted from seasonal coronavirus infection and that have a protective effect against SARS-CoV-2 infection **[23-26]**. On the other hand, studies have shown that the activity of angiotensin-converting enzyme 2 is less strong in children [27]. Additionally, compared with that in adults, the immune system in children is incomplete [28,29]. It is possible that the children's infections with COVID-19 were the result of transmission from an infected family member. A previous study showed that the transmission rate of infection to children from family members who had a laboratory-confirmed infection was approximately 35% **[30-32]**.

According to the month of hospitalization, the rate of IgM antibody seropositivity among children was detected in July and peaked in August. On the other hand, the incidence of IgG antibodies gradually increased in the last month of 2021 and the first two months of 2022, peaking in March. These findings are consistent with those of a previous study conducted at Beijing Children's Hospital, China, which showed that the rate of IgM seropositivity was highest in August and July **[21]**. However, the results of the current study cannot explain any seasonal characteristics of COVID-19 infection; therefore, further epidemiological investigations are needed [21]. The results of this retrospective study did not reveal a statistically significant difference in seropositivity between male and female children.

CONCLUSION

To our knowledge, there are few reports on the susceptibility of women and children to infection with SARS-CoV-2. The presence of antibodies among pregnant and nonpregnant women and children is evidence of ongoing infections. Advanced serological and molecular techniques are necessary for diagnosis in hospitals. It is necessary to conduct future survey-epidemiological studies on mothers and newborns.

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