RESEARCH ARTICLE

The age groups more affected by SARS-CoV-2 in children and the role of schools in the COVID-19 pandemic in Israel - January 2020-March 2021

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Abstract:
We analyzed data from a serological study performed on 2,765 samples from the Israeli National Sera Bank (INSB), established in 1997 in the Israel Center for Disease Control (ICDC) collected from children aged 0-<16 years during January 2020-March 2021. Trends in seropositivity rates to SARS-CoV-2 were evaluated using Joinpoint within specific age groups and compared to educational institutions activity. Seropositivity rates increased significantly in the 0-<6 and 12-<16 years age groups and were parallel in the 0-<6 years age group and partially parallel in the 12-<16 years to educational institutions activities. Non-significant increase in seropositivity rates were observed in the age groups 6-<10 and 10-<12 years. Apparently, exposure to SARS-CoV-2 in children was driven not only by educational activities but also by other factors.

Key words: SARS-CoV-2; Children; Schools; Pandemic; Seroprevalence; Trend

1. Introduction

In December 2019, respiratory syndrome coronavirus 2 (SARS-CoV-2) was first identified in Wuhan, Hubei Province, China, and since then coronavirus disease 2019 (COVID-19) has spread globally, claiming millions of lives and dramatically influencing all countries around the world. [1, 2]

In Israel, the first imported case of COVID-19 was confirmed on February 27, 2020, and by March 31, 2021, 833,151 PCR-confirmed cases were reported; of them, the proportion of children was high. [3] Three COVID-19 waves were observed by the end of March 2021 in Israel: February-May 2020 (1st wave), June-October 2020 (2nd wave) and November 2020-March 2021 (3rd wave). [3]

Following the introduction of COVID-19 in Israel, efforts to stop the spread of SARS-CoV-2 through non-pharmaceutical preventive measures such as facemask use, social distancing, high hygiene manners and self-isolation, were applied. In addition, educational institutions were closed on and off according to the pandemic dynamics, to lower the spread of SARS-CoV-2 among children.

Serosurveys carried out worldwide, [4-6] including a serosurvey conducted in Israel, [7] examined the prevalence of SARS-CoV-2 antibodies in a short time period, and were not able examine the dynamics of seropositivity rates throughout the outbreak.

The aim of the present study was to present trends of seropositivity rates within specific age groups among children aged younger than 16 years and to explore seropositivity trends in parallel to educational institutions activity between January 2020 and March 2021 in Israel.

2. Methods

We conducted a seroepidemiological study in children aged younger than 16 years. The methods used for the study were described in detail elsewhere. [8] Briefly, we included 2,765 samples from the Israeli National Sera Bank (INSB), established in 1997 in the Israel Center for Disease Control (ICDC). [9] The samples were collected between January 2020 and March 2021 from five laboratories located throughout Israel and represented all seven districts of Israel, population groups and socio-economic status. All sera samples were tested for SARS-CoV-2 specific IgG antibodies using an in-house enzyme-linked immunosorbent assay (ELISA) based on the receptor-binding domain. [10] For this assay, a sample-to cut-off ratio (S/CO) equal to or above 1.1 was considered to be positive and below, negative, demonstrated 88% sensitivity and 98% specificity. [10, 11] To increase sensitivity and specificity, 76 negative samples, with a sample to cut off ratio below 1.1, were retested using a SARS-CoV-2 Pseudo-virus Neutralization Assay.[12] Seropositivity rates were calculated for the following age groups: 0-<6 (pre-school children), 6-<10 (elementary school lower grades), 10-<12 (elementary school higher grades) and 12-<16 years (mostly junior high school students), by dividing the number of positive samples by the number of samples tested.

Trends in seropositivity rates in each age group between January 2020 and March 2021 were summarized as Monthly Percent Change (MPC), using Joinpoint software (Version 4.9.0.0, March 2021). The trend data were fitted to the simplest joinpoint model. The model specifications for the analysis were the software default with dependent variable type set to 'seropositivity rate' and the maximum

number of joinpoints set to 5. The Joinpoint analysis was applicable when the seropositivity rate was higher than 0.0%. The significance level was set to 0.05.

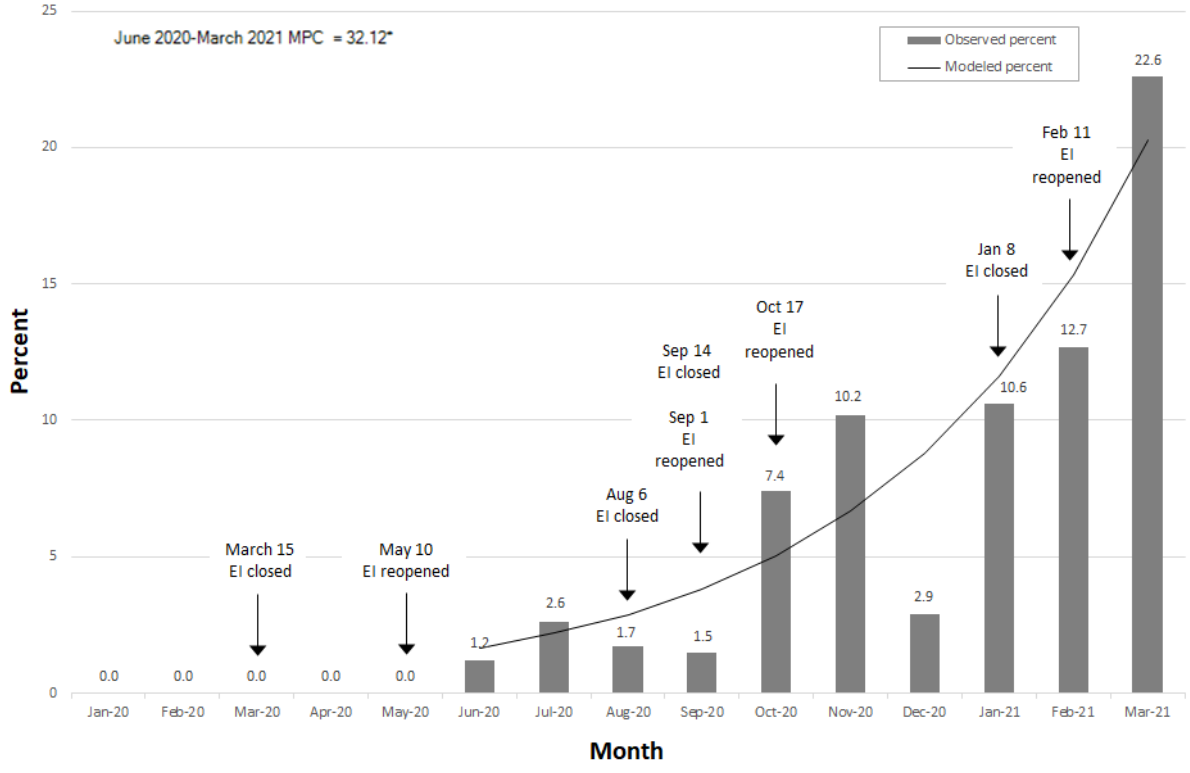
Ethical statement

The sera collection and analysis in the Israeli National Sera Bank is part of the regulatory capacity of the Israel Ministry of Health and approved by its legal department. Additionally, the sera bank samples are completely unidentified.

3. Results

The characteristics of the study population were described previously. [8] Figure 1 presents the seropositivity rate for SARS-CoV-2 and MPC in the age group 0-<6 years by month. Seropositivity rate was 0.0% between January and May 2020, increased to 2.6% in July, remained stable until September and increased to 7.4% in October and 10.2% in November, decreased to 2.9% in December, increased to 10.6% in January 2021 and reached 22.6% in March (Figure 1). In this age group, using the model produced by Joinpoint, we observed a statistically significant increase in seropositivity rate between June 2020 and March 2021 (MPC=32.1%; p-value=0.000571). Figure 1 also describes time points in the activity of educational institutions relevant to the 0-<6 years age group. Correspondingly, the increase in seropositivity rates between September and November 2020 and between December 2020 and March 2021 were parallel to preschools' activity (Figure 1).

Figure 1: Seropositivity rate for SARS-CoV-2 and Monthly Percent Change in the age group 0-<6 years, by month (January 2020 - March 2021)

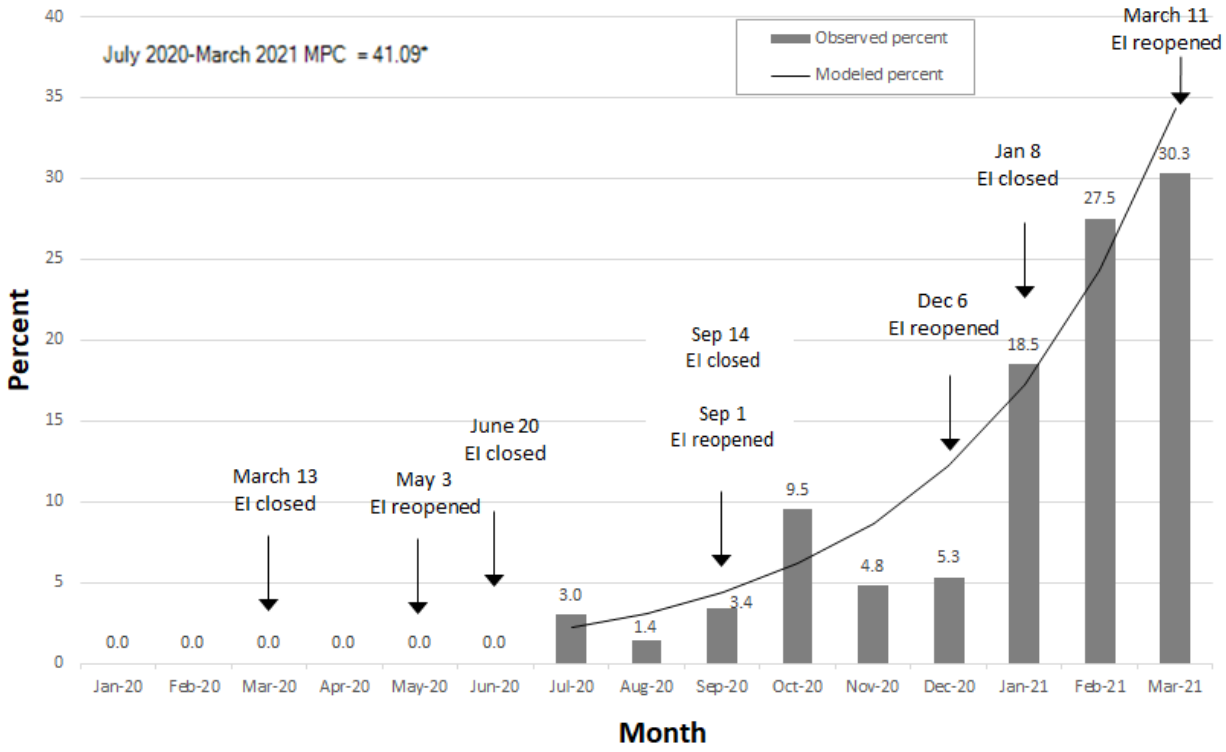


EI – Educational Institutions
* - Statistically significant

In the 12-<16 years age group, seropositivity rate remained 0.0% between January 2020 and June 2020, increased to 3.0% in July 2020, remained stable until September 2020, increased to 9.5% in October 2020, remained low until December 2020 (5.3%), increased to 18.5% in January 2021 and reached 30.3% in March 2021 (Figure 2). The increase observed between July 2020 and March 2021 was statistically significant (MPC=41.1%; p-value=0.000435) (Figure 2). The steepest increases in this age group were observed between August and October 2020, during the second wave of COVID-19, and between December 2020 and March 2021, during the third wave of COVID-19 (Figure 2). Educational institutions activity in the 12-<16 years age group is also described in Figure 2. The increase observed in seropositivity rate between August 2020 and October 2020 was parallel to schools activity. However, during the increase in seropositivity between January 2021 and March 2021, schools were mostly closed, and yet, SARS-CoV-2 transmission was still observed.

Non-significant increase in seropositivity rates were observed in the age groups 6-<10 years between September 2020 and March 2021 (MPC=6.2%; p-value=0.32314) (Figure 3) and 10-<12 years between August 2020 and March 2021 (MPC=14.5%; p-value=0.157891) (Figure 4).

Figure 2: Seropositivity rate for SARS-CoV-2 and Monthly Percent Change in the age group 12-<16 years, by month (January 2020 - March 2021)



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* - Statistically significant

Figure 3: Seropositivity rate for SARS-CoV-2 and Monthly Percent Change in the age group 6-<10 years, by month (January 2020 - March 2021)

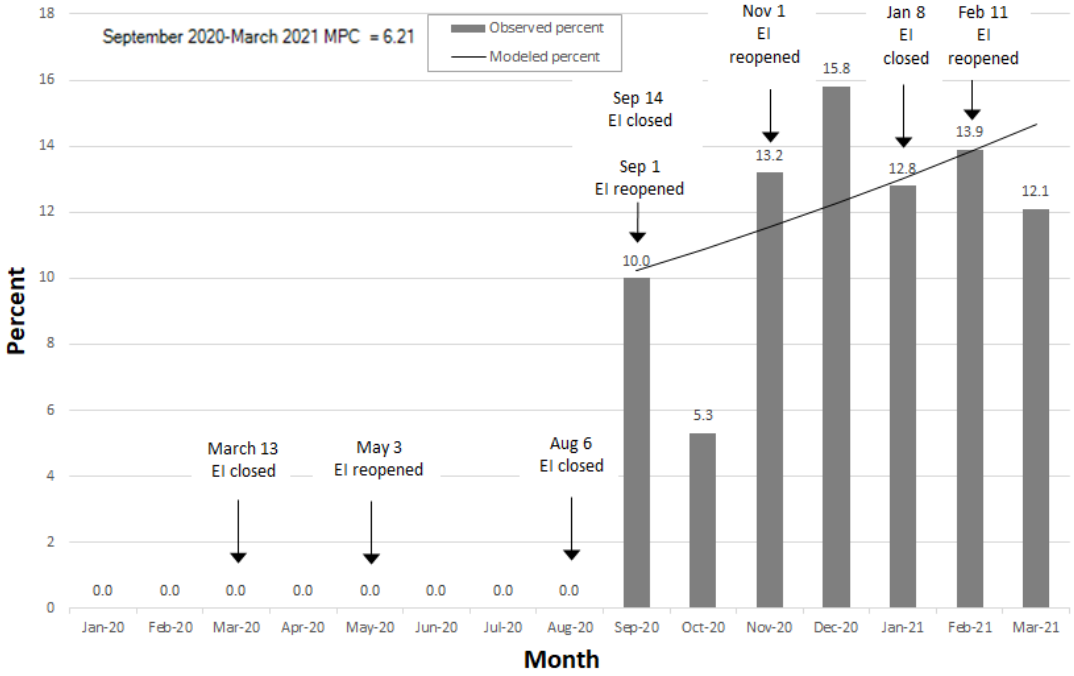

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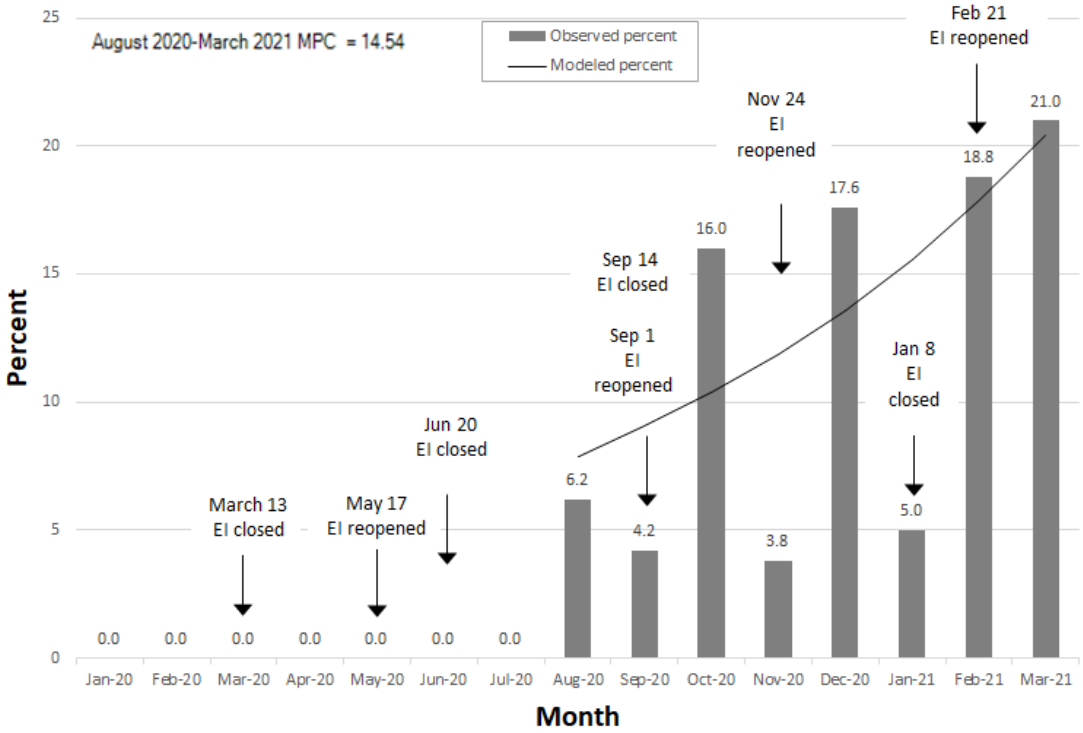
Figure 4: Seropositivity rate for SARS-CoV-2 and Monthly Percent Change in the age group 10-<12 years, by month (January 2020 - March 2021)



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4. Discussion

We hereby report that seropositivty rates in Israel increased significantly in the 0-<6 and 12-<16 years age groups during first three COVID-19 pandemic waves in Israel (February 2020-March 2021).

For the 0-<6 years age group, the steepest increases were observed between September and November 2020, during the second COVID-19 wave in Israel, and between December 2020 towards March 2021, representing the third COVID-19 wave in Israel.

The increases in seropositivity rates were parallel to preschools' activity. The relatively small social circle and the low engagement of the 0-<6 years age group in social activity, especially during the pandemic, may explain this correlation.

In the 12-<16 years age group, the increase in seropositivity rate was substantial between August 2020 and October 2020 (the 2nd COVID-19 wave) and between December 2020 and March 2021 (the 3rd COVID-19 wave). The steepest increase in seropositivity rate in this age group was also reported by others. [13, 14] In Missouri, the 10-17 age group demonstrated the steepest increase in seropositivity rate, spanning 6 months (July 2020 to January 2021) from 7.9% to 26.0% in comparison to an increase from 5.6% to 16.5% in the 5-9 years age group and from 3.5% to 18.0% in the <5 years age group. [13] In Denmark, an increase in seropositivity rates in the 12-17 years age group was also reported between August 2020 (1.0%) and December 2020 (6.5%). [14] The explanation for the significant increase among adolescents may be the expanded social circle and the tendency to meet other children, even out of school time, in comparison to the younger age groups. This potential explanation is further supported by the partial correlation between seropositivity rates and educational institutions activity.

For the 6-<10 and 10-<12 years age groups, schools were mostly closed and children stayed at home during most of the epidemic. Due to the dependency in adults, parents' fear of infection and the narrow social circle in these age groups, their exposure to other children was presumably low. The non-significant increase in seroprevalence rates observed in these age groups probably reflects the exposure to the virus in the total population.

The trends demonstrated in seropositivity rates were quite consistent with school activities in the 0-<6 but only partially associated with them in the 12-<16 years age group, thus most probably reflected SARS-CoV-2 overall transmission in Israel and not necessarily transmission within educational institutions. Notwithstanding, educational institutions closures occurred concurrently with the application of other preventive measures, such as lockdowns, social distancing and public gathering bans, thus the ability to measure the direct impact of school closure on SARS-CoV-2 circulation is confined.

Studies performed in Japan and Ireland have also demonstrated that schools were not necessarily a high risk setting for the transmission of COVID-19 between students or between staff and students [15] and there is no evidence that school closures reduced the spread of COVID-19. [16] In Milan, Italy, in September 2020, before school reopening, the seroprevalence among 3-18 years old was 2.8%, while in January 2021, the seroprevalence was 12.5%, reflecting an increase in the rate of infection. [17] However, the researchers also reported that no difference in seropositivity rates was observed between those who attended schools compared to those who switched to remote learning, leading to the conclusion

that schools did not amplify SARS-CoV-2 transmission, but rather reflected the overall transmission of the virus in the community. [17]

In conclusion, our study results suggest that seropositivity rate increased over time, but the trends were age-dependent and only partially parallel to educational institutions activities. Thus, seropositivity rates were not only associated with educational activities but also with other factors, including the circulation of the virus in the general population.

Conflict of interest: None declared.

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