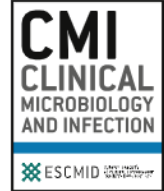




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Research note

The Sheba Medical Center healthcare workers' children's school: can we open schools safely?

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ABSTRACT

Objective: The role of school closure in mitigating coronavirus disease 2019 (COVID-19) transmission has been questioned. In our medical centre, during a 9-week national lockdown, an alternative school was opened for health-care workers' (HCW) children with a small number of children per class and strict symptom surveillance. After lockdown was lifted we screened children and their parents for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) serology.

Methods: We conducted a cross-sectional study of HCW parents and their children after one teacher contracted COVID-19 following exposure at home and 53 children were exposed, isolated and tested by RT-PCR. We compared families with children attending the alternative school with families whose children who remained at home during the 9-week lockdown. Epidemiological and medical data were collected using a short questionnaire; nasopharyngeal and oropharyngeal swabs were obtained and tested for SARS-CoV-2 by RT-PCR, and blood was collected for SARS-CoV-2 IgA and IgG titres.

Results: A total of 435 children attended the Sheba alternative school. Among the 53 children exposed to the infected teacher, none tested positive by RT-PCR. Of these, 18 children–parent pairs were tested for serology and all were negative. A total of 106/435 (24%) children and their 78 parents were recruited for the cross-sectional study; 70 attended the Sheba school and 36 did not. Approximately 16% of children in either group reported symptoms (11/70 in the school group and 6/36 in the 'stay home' group), but SARS-CoV-2 was not detected by PCR in any, and previous exposure, as determined by serological tests, was low and not significantly different between the groups.

Conclusion: In an alternative school for children of HCWs, active during COVID-19 national outbreak, we found no evidence of increased infection compared with children that stayed home. **Or Kriger, Clin Microbiol Infect 2021;27:474.e1–474.e3**

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Introduction

One of the most debated issues in coronavirus disease 2019 (COVID-19) mitigation efforts is the role of school closure. As part of a 9-week lockdown in Israel, schools were closed. To allow health-care workers (HCW) of the Sheba Medical Centre (SMC) to attend work regularly during the lockdown, the 'Sheba School' was opened for their children. Here, we compare COVID-19 exposure and

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prevalence in children who attended the Sheba School with those who stayed home during lockdown.

Materials and methods

SMC is a tertiary hospital with 1600 beds and >9000 HCW. Between 12 March and 17 May 2020, to enable HCW with young children to continue working, the 'Sheba School', an alternative educational programme, was created for children aged 3–12 years. Attendees were required to be in good health and underwent daily temperature checks. Each class consisted of up to ten children. Educational staff used face masks and were instructed to conduct frequent hand hygiene. While the school was active, one teacher developed respiratory symptoms after exposure to a COVID-19-infected family-member and tested positive for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

On 23 March 2020, following the teacher's diagnosis, all 53 children exposed to the teacher within the 7 days before first symptoms were isolated and tested twice by nasopharyngeal swabs using RT-PCR on days 7 and 14 from last potential exposure.

During the last week of the Sheba School's activity, starting 7 May 2020, children and their parents were screened by nasopharyngeal and oropharyngeal swabs for SARS-CoV-2 on RT-PCR and blood was sampled for SARS-CoV-2 IgG and IgA antibodies. RT-PCR was performed using the Seegene RT-PCR assay and expressed by cycle threshold (Ct) [1]. Antibodies were detected using an in-house ELISA with recombinant receptor-binding domain (based on the US Food and Drug Administration-approved Mount Sinai Hospital Clinical Laboratory COVID-19 ELISA Test) and expressed as positive (>index value of 1.1), intermediate (0.9–1.1) and negative (<0.9). In a few cases, where drawing blood was difficult, a commercial lateral flow kit (PharmAct, Berlin, Germany) was used. Epidemiological and clinical data were collected. Written informed consent was received from the parents, a child-suitable explanation of the studies objective ('we want to know if you and your parent were exposed to corona') was given and the study was approved by the SMC institutional review board committee (approval number 7159-20).

Statistical analysis

Student's *t* test was used for normal distribution variables; *P* values < 0.05 were considered statistically significant. Averages and standard deviations were calculated and presented.

Results

A total of 435 children attended the Sheba School during the 9-week lockdown. Of these, 53 were exposed to the SARS-CoV-2-infected teacher and were followed; 106/435 children and their 78 parents in 75 family units were recruited to the serology study. Their characteristics are given in Table 1.

None of the 53 children exposed to the teacher with COVID-19 was infected, as defined by two PCR tests. All were allowed to return to school following 14 days of isolation. Six weeks later, SARS-CoV-2 antibodies were not detected in any of the exposed children who participated in the serology sub-study (18/53).

Symptoms compatible with COVID-19 were reported equally among children who attended the school (15.7%; 11/70) and those who did not (16.6%; 6/36), as well as among their parents (15.3%; 8/52 in the school group, 23%; 6/26 in the 'stay home' group). Yet positive serology was detected in less than 2% of each group (Table 1). The three individuals who attended the Sheba School and had detectable IgG titres included one family unit of a mother and her child, who lived in a city with high SARS-CoV-2 prevalence, suggesting a community source of transmission rather than a school one (Table 1).

The characteristics of all suspected COVID-19-exposed family units are presented in Table 2.

Discussion

Our study presents a case of an alternative school for the children of HCW, where 451 students safely studied for 9 weeks, despite exposure of some to a teacher in whom COVID-19 was detected. Exposure to SARS-CoV-2, as determined by serology, was extremely low and did not differ between children and parents who stayed at home and those who attended the school.

The effectiveness of school closure as a pandemic mitigation measure derives from the idea that children are major drivers of respiratory infections, particularly influenza [2,3]. For this reason, one of the initial COVID-19 mitigation steps many countries took was massive school closures. Yet the role of school closure in COVID-19 mitigation is still largely debated. Several studies reported lower infection rates and infectivity among children [4–6], a detrimental impact on children's education, health-care workforce and national economics [7], and only modest effect on R_E [8,9].

We believe that a major factor in the success of the Sheba School in preventing COVID-19 outbreaks was the small class size of up to

Table 1
Study population characteristics

	Children attending Sheba school		Children stay at home		<i>P</i> -value	
	Children	Parents	Children	Parents		
Total participants, <i>N</i>	70	52	36	26		
Age (years)	Average	7.7	39.9	8.3	42.3	0.21
	SD	2.51	6.12	2.86	4.99	
Sex (% male)		64.1%	25%	50%	11.5%	
Average number of persons per household (SD)		4.6 (1.16)		4.5 (0.89)		0.39
SARS-CoV-2 PCR, <i>n</i> positive/ <i>n</i> tested		0/48	0/37	0/31	0/24	0.5
Exposure to a confirmed COVID-19 patient, <i>n</i> (%)		21 (30%)	18 (34%)	2 (6%)	2 (8%)	0.01
Serology	Positive IgG antibodies	1 (1.4%)	1 (1.9%)	1 (2.7%)	0 (0%)	0.31
	Equivocal IgG antibodies	1 (1.4%)	0 (0%)	0 (0%)	0 (0%)	
	Positive IgA antibodies	0 (0%)	1 (1.9%)	0 (0%)	0 (0%)	0.24
	Equivocal IgA antibodies	0 (0%)	0 (0%)	1 (2.7%)	0 (0%)	
Number of participants with any symptom		11 (15.7%)	8 (15.3%)	6 (16.6%)	6 (23%)	0.32
Number of children contacts during lock-down (outside Sheba's school)	<i>N</i> < 5	42 (60)		24 (66.6)		
	5 < <i>N</i> < 10	8 (11.4)		6 (16.6)		
	10 < <i>N</i> < 15	6 (8.5)		3 (8.3)		
	<i>N</i> > 15	14 (20)		1 (2.7)		

Table 2

Characteristics of the family units in which a child/parent had a positive (bold text)/equivocal serology test

Family unit	Child/parent	Serology status	Child attended Sheba school	Symptoms of COVID-19	Known exposure	Residency (COVID-19 N/100 00)	Date of test
6	Child	Positive IgG	Yes	No	No	582	7/5/2020
6	Parent	Positive IgG	Yes	Yes	No	582	7/5/2020
18	Child	Negative	Yes	no	No	80	10/5/2020
18	Child	Negative	Yes	No	No	80	10/5/2020
18	Parent	Positive IgA	Yes	No	No	80	10/5/2020
49	Child	Equivocal IgG	Yes	No	Yes	81	12/5/2020
49	Parent	Negative	Yes	No	No	81	12/5/2020
7	Child	Positive IgG	No	Yes	No	120	7/5/2020
7	Parent	Negative	No	Yes	No	120	7/5/2020
3	Child	Equivocal IgG	No	Yes	No	80	7/5/2020
3	Parent	Negative	No	Yes	No	80	7/5/2020
3	Child	Negative	No	No	No	80	7/5/2020
44	Child	Equivocal IgA	No	No	Yes	144	10/05/2020
44	Parent	Negative	No	No	No	144	10/5/2020

ten children, as compared to 30–40 children per class in public schools. Other probable differentiators were a more rigorous infection control policy led by the Infection Control Unit of SMC, and a daily cleaning process using 70% alcohol for surfaces and floor and toilet disinfection with sodium hypochlorite.

Our study has several limitations. First, it was conducted in a single school and enrolled the children of HCW, a population that may not be generalizable. At the time of screening, the infection rate among Sheba HCW was nearly three times higher than that in the general Israeli population (17/10 000), but this may have been due to much higher testing frequency. Although strict measures could have been the key to successful outbreak prevention, only a large-scale study involving many schools would prove this. Second, the low rates of COVID-19 infection after exposure were based on RT-PCR and serology. Both these diagnostic tests are limited; RT-PCR has an overall low clinical sensitivity [10,11]. Serology, although helpful in discerning some past asymptomatic infections, as in the case of many asymptomatic children [12,13], may not be the most sensitive indicator [14]. T-cell activity appears to play an important role, but could not be measured here [15]. Third only a minority of the exposed children (18/53) were tested for serology. Furthermore, our study was conducted when the rates of COVID-19 were low, after full lockdown that halted the transmission effectively. Repeating this study when COVID-19 infection rates in the population are higher could result in higher infection rates in schools.

Our observation supports cautious opening of primary schools and daycare centres for younger children, particularly with strict physical distancing, by allowing only small groups, obligatory masks for teachers and frequent hand hygiene.

Authors' contributions

OK contributed to study concept and design, data management, analysis and interpretation, and manuscript preparation. GRY contributed to study concept and preparation, data interpretation, and manuscript review. YL, CC, SA, AB, GB, LT, SGH and BM contributed to manuscript review and study supervision. All the authors have read and approved the final draft submitted.

Transparency declaration

All authors report no conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cmi.2020.11.030>.

References

- [1] van Kasteren PB, van der Veer B, van den Brink S, Wijsman L, de Jonge J, van den Brandt A, et al. Comparison of seven commercial RT-PCR diagnostic kits for COVID-19. *J Clin Virol* 2020;128:104412.
- [2] Bin Nafisah S, Alameery AH, Al Nafesa A, Aleid B, Brazanji NA. School closure during novel influenza: a systematic review. *J Infect Public Health* 2018;11:657–61.
- [3] Cauchemez S, Valleron A-J, Boëlle P-Y, Flahault A, Ferguson NM. Estimating the impact of school closure on influenza transmission from Sentinel data. *Nature* 2008;452:750–4.
- [4] Isaacs D, Britton P, Howard-Jones A, Kesson A, Khatami A, Marais B, et al. To what extent do children transmit SARS-CoV-2 virus? *J Paediatr Child Health* 2020;56:978–9.
- [5] Zhu Y, Bloxham CJ, Hulme KD, Sinclair JE, Tong ZWM, Steele LE, et al. Children are unlikely to have been the primary source of household SARS-CoV-2 infections. *medRxiv* 2020.
- [6] Dattner I, Goldberg Y, Katriel G, Yaari R, Gal N, Miron Y, et al. The role of children in the spread of COVID-19: using household data from Bnei Brak, Israel, to estimate the relative susceptibility and infectivity of children. *medRxiv* 2020.
- [7] Bayham J, Fenichel EP. Impact of school closures for COVID-19 on the US health-care workforce and net mortality: a modelling study. *Lancet Public Health* 2020;5:e271–8.
- [8] Viner RM, Russell SJ, Croker H, Packer J, Ward J, Stansfield C, et al. School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review. *Lancet Child Adolesc Health* 2020;4:397–404.
- [9] Otte Im Kampe E, Lehfeld A-S, Buda S, Buchholz U, Haas W. Surveillance of COVID-19 school outbreaks, Germany, March to August 2020. *Euro Surveill* 2020;25.
- [10] Chan JF-W, Yip CC-Y, To KK-W, Tang TH-C, Wong SC-Y, Leung K-H, et al. Improved molecular diagnosis of COVID-19 by the novel, highly sensitive and specific COVID-19-RdRp/Hel real-time reverse transcription-PCR assay validated in vitro and with clinical specimens. *J Clin Microbiol* 2020:58.
- [11] Fang Y, Zhang H, Xie J, Lin M, Ying L, Pang P, et al. Sensitivity of chest CT for COVID-19: comparison to RT-PCR. *Radiology* 2020;296:E115–7.
- [12] Cohen R, Jung C, Ouldali N, Sellam A, Batard C, Cahn-Sellem F, et al. Assessment of spread of SARS-CoV-2 by RT-PCR and concomitant serology in children in a region heavily affected by COVID-19 pandemic. *medRxiv* 2020.
- [13] Ludvigsson JF. Systematic review of COVID-19 in children shows milder cases and a better prognosis than adults. *Acta Paediatr* 2020;109:1088–95.
- [14] Lisboa Bastos M, Tavaziva G, Abidi SK, Campbell JR, Haraoui L-P, Johnston JC, et al. Diagnostic accuracy of serological tests for COVID-19: systematic review and meta-analysis. *BMJ* 2020;370:m2516.
- [15] Grifoni A, Weiskopf D, Ramirez SI, Mateus J, Dan JM, Moderbacher CR, et al. Targets of T cell responses to SARS-CoV-2 coronavirus in humans with COVID-19 disease and unexposed individuals. *Cell* 2020;181:1489–501. e15.