BMJ Open

SARS-CoV-2 seroprevalence and mental health of school staff: a cross-sectional study of schools from four areas of Montreal, Quebec in 2021

Katia Charland,[1,2] Matteo Pannunzio,[3] Eleanor Greenspan-Ardman,[3] Adrien Saucier,[1,2] Laura Pierce,[1,2] Marie-Eve Hamelin,[4] Margot Barbosa Da Torre,[1,2] Julie Carbonneau,[4] Cat Tuong Nguyen,[5] Gaston De Serres,[6] Jesse Papenburg,[7] Guy Boivin,[4] Caroline Quach,[1,8] Kate Zinszer [1,2]

To cite: Charland K, Pannunzio M, Greenspan-Ardman E, *et al*. SARS-CoV-2 seroprevalence and mental health of school staff: a cross-sectional study of schools from four areas of Montreal, Quebec in 2021. *BMJ Open* 2024;**14**:e081838. doi:10.1136/bmjopen-2023-081838

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2023-081838).

Received 07 November 2023
Accepted 02 August 2024

For numbered affiliations see end of article.

Correspondence to
Dr Kate Zinszer;
kate.zinszer@umontreal.ca

ABSTRACT

Objectives To assess the seroprevalence of infection-acquired SARS-CoV-2 and the mental health of school/daycare staff in the months after reopening of schools in Montreal, Quebec (Canada) in the Fall of 2020 and whether these varied by school and participant characteristics.

Design A cross-sectional design based on a convenience sample of schools/daycares and staff was used as the originally planned longitudinal design was no longer feasible due to obstacles in recruitment, for example, teacher's strike.

Setting Forty-nine schools/daycares in four Montreal neighbourhoods from March to October 2021.

Participants Three-hundred and sixty-two participants completed both questionnaires and serology tests.

Primary and secondary outcome measures SARS-CoV-2 seroprevalence and prevalence of anxiety, depression, resilience and burnout/emotional exhaustion.

Results The seroprevalence estimate made representative to the Quebec population of educators was 8.6% (95% CI 5.2 to 13.0). The adjusted seroprevalence in high school was 20% that of elementary school (aRR=0.20, 95% CI 0.07 to 0.58). Thirty per cent of seropositive staff were exposed to a household member with confirmed COVID-19. Prevalence of high emotional exhaustion/burnout was 35%, 44% and 53% in daycare, elementary school and high school staff, respectively. However, moderate/severe anxiety and depression and low resilience did not exceed 18%. After adjusting for confounders, being very afraid of catching COVID-19 at school was associated with moderate–severe anxiety, moderate–severe depression and high emotional exhaustion (aRR=4.4, 95% CI 2.2 to 8.9; aRR=2.8, 95% CI 1.5 to 5.4; aRR=2.2, 95% CI 1.6 to 3.0, respectively).

Conclusion The seroprevalence, anxiety and depression among school/daycare staff were comparable to the reported levels in the adult population of Quebec. The prevalence of emotional exhaustion/burnout was high across all school levels and exceeding the average across all occupations in the USA and in teachers in Germany.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The parallel study of seroprevalence among children attending the daycares and schools allowed us to compare the geographical patterns in seroprevalence in the student and staff samples.
⇒ We were able to assess any benefit to mental health provided by student compliance to non-pharmaceutical interventions and vaccination status.
⇒ The cross-sectional nature of the study prevented us from comparing mental health during the pandemic to prepandemic levels, though we were able to compare mental health outcomes to other studies from Quebec, and other countries.
⇒ Schools and daycares were selected in collaboration with school boards and administrators and though all staff were invited to participate, only a small percentage (roughly 16%–22%) enrolled.
⇒ The study used convenience sampling and our sample differed from our study population across important demographic factors such as ethnic/racial minority status; while raking was used to generate a more representative estimate for our target population of school staff in Montreal, this does not take care of the non-response bias introduced by this method of sampling.

INTRODUCTION

In the early days of the COVID-19 pandemic, one of the first non-pharmaceutical interventions (NPI) to reduce COVID transmission was school closures, closing daycares and sending school children home to learn in either a fully online or hybrid form of education. In time, concerns were raised over the effectiveness of online teaching and the impact of the school closures on the mental health and development of children.[1] The effect of the pandemic and preventive measures on mental health has been widely discussed and researched, with

students worldwide experiencing higher levels of depression, anxiety and other deleterious mental health effects during the pandemic.[2–5] In Quebec, Canada, the government announced its plan to reopen schools in the Fall of 2020 to preserve children and adolescents' mental health and improve learning and development. However, many teachers expressed concern that COVID-19 would spread rapidly within schools among both educators and students. Adding to the debate, teachers were thought to experience increased negative mental health impacts stemming from various sources, including sudden shifts in mode of teaching, competing home and work responsibilities, a lack of effectiveness of online teaching and new responsibilities related to implementing and enforcing COVID-19 preventive measures during in-person learning.[6–8]

Studies of the effect of school reopening on teachers found that schools were not a key driver of COVID-19 transmission with a risk of infection for teachers comparable to the general community's risk.[9–12] Studies also demonstrated pandemic-related mental health detriments in school staff[13–16] but further research in different settings is needed, in light of the regional and school-level differences in public health measures implementation (timing, stringency and compliance as well as regional/school variation in professional, technical and administrative support for school employees) (eg, McCoy *et al*). In this cross-sectional study, we assessed potential determinants of COVID-19 seropositivity and poor mental health in a cohort of school staff from four Montreal neighbourhoods after the reopening of schools in the Fall of 2020. We assessed differences in seropositivity, anxiety, depression, resilience and emotional exhaustion (EE)/burnout by school level (daycare, elementary school and high school) and employee and school characteristics.

METHODS

Study design

This study was part of the larger EnCORE seroprevalence study in children, adolescents and school staff that collects participant data from questionnaires and establishes participants' serostatus from mailed in dried blood spot (DBS) collection kits.[17 18] This is a cross-sectional study of SARS-CoV-2 seroprevalence and mental health of daycare, elementary and high school staff in public schools from four regions of Montreal, Quebec, from March to October 2021. The originally planned longitudinal design for school staff, with two serology assessments, was no longer feasible due to obstacles in recruitment, including a teacher's strike and the staff's limited capacity to be involved in research.[18] Regions of participating schools, the Plateau, Hochelaga-Maisonneuve, the West Island and Montreal North, are distinct with respect to sociodemographic profiles Convenience sampling was carried out. Schools were selected in collaboration with school boards. Daycares were selected based on their administrator agreeing that their staff participate. All staff working within the selected institutions and organisations were offered the opportunity to participate in the study and eligible volunteers were accepted into the study. Occupations of invited personnel included teachers, administrators, maintenance employees and technicians. Participating staff were then asked to complete the online questionnaire. The questionnaire collected information regarding their occupation, sociodemographics, health history, COVID-19 preventive behaviours and mental health. This included school-level taught, and the number of classes taught for at least 25% of the time (where applicable). School levels were daycare, elementary school and high school, where students are approximately 2–4, 5–11 and 12–17 years old, respectively. Sociodemographic and household-related questions provided information on age of the respondent, sex at birth, number of household members and number of bedrooms in the home. Questions on health and COVID-19 included health history, all COVID-19 tests, results and dates, their adherence to COVID-19 NPIs, their students' NPI compliance such as wearing masks and physically distancing (where applicable), their level of fear of getting COVID-19 at school and other mental health questions. In the weeks after questionnaire completion, the DBS was collected by the participant and sent to the lab where IgG seropositivity was assessed via ELISA. The ELISA was developed and validated to detect the receptor binding domain (RBD) from the spike protein and the nucleocapsid protein (N) as antigens.[19] Vaccinated participants with first dose at least 10 days before DBS collection, that tested positive for RBD and N, and unvaccinated participants or those vaccinated within 10 days of their DBS, that tested positive for RBD, were classified as infection-acquired seropositive.[17] Sample size calculations, assuming a seroprevalence of 5%, indicated that 457 participants would need to provide serology samples to estimate the seroprevalence with 2% precision at the 95% confidence level.[18]

Patient and public involvement

Participants in this study were not involved in developing the study design, conduct, reporting or dissemination plans. The study design and objectives were developed by the investigators of the study and reviewed by the funding committee and the relevant research ethics committees. Study partners (daycares, schools, school boards, Montreal Public Health Department) provided advice on participant recruitment and feedback on general aspects of study participation for improvement (eg, DBS collection, questionnaire).

Statistical analyses

Seroprevalence

The outcome was the infection-acquired serological status of the participant (positive or negative). Analyses were restricted to participants who had complete serological data of sufficient quality, for example, DBS with adequate blood volume and no layering of blood drops.

Crude seroprevalence was calculated as the percentage of participants having positive serology for

infection-acquired SARS-CoV-2. Overall crude seroprevalence is presented with and without adjustment for assay sensitivity (≥95%) and specificity (100%) by the method of Blaker.[20] Raking was used to adjust the seroprevalence estimate to better represent the demographic distributions of educators in Montreal. The demographic summaries for the Quebec province were used in the raking procedure and came from the 2021 Canadian Census.[21] Montreal makes up approximately 45% of Quebec's population. To assess the unconfounded association between SARS-CoV-2 seropositivity and each variable of interest, multivariable regression was used, adjusting for potential confounders. Since ORs from logistic regression tend to exaggerate effect sizes when the outcome is common, the relative risk of seropositivity was estimated directly using Zou's modified Poisson regression.[22] Model selection for each variable was based on a directed acyclic graph (DAG) including the relevant correlates of seropositivity found in the literature (online supplemental table 1 and figure 1). The correlates were age, sex, race/ethnicity, school neighbourhood, number of interactions with different classes, household crowding, household income, vaccination status, compliance to NPI and educational attainment.[23–26] Bedroom density, defined as the number of people in the household divided by the number of bedrooms, was used as a marker of household crowding. Nearly all participants reported always or often wearing a mask in indoor public places and staff were required to wear masks if a 2-m distance from others could not be maintained, therefore this variable was not included in the DAG. Missing covariate data were imputed via the MICE statistical package[27] with 20 copies, and imputed data were used in all regression models.[27]

Mental health

For the mental health analysis, depression, anxiety, burnout and resilience were scored. Depression was assessed using the Patient Health Questionnaire-9, anxiety via the 7-item General Anxiety Disorder assessment, burnout via four items from the EE portion of the Maslach Burnout Inventory-Human Services Survey and resilience via the Brief Resilience Scale. Only study participants who answered all questions within a scale were included to avoid incomplete scoring. Scoring was determined using each assessment tool's respective protocol. In the case of EE assessment, scoring was calculated via the method outlined by Leiter and Maslach, for four items.[28] The responses to the question, 'Are you afraid that you will contract the COVID-19 virus at work?' was also analysed. The distribution of scores for each mental health outcome across school levels is presented. Using multivariable regression, we then assessed the adjusted risk of having a score in the worst mental health categories (vs other) in relation to explanatory variables such as school-level taught and level of fear of catching COVID at school. For this analysis, the multicategory outcomes for anxiety and depression were dichotomised as severe/moderate versus other for anxiety and severe/moderately severe/moderate versus other for depression. We adjusted for minimally sufficient adjustment sets identified in DAGs (online supplemental table 2 and figure 2).

All data manipulation and analyses were carried out using R V.4.2.1.

RESULTS

Roughly 1760–2440 staff were invited to participate. Three hundred and eighty-nine completed the full questionnaire, giving a response rate of approximately 16%–22%. Of these, 362 participants also provided a serological sample. Staff were from 20 daycares, 19 elementary schools and 10 high schools. Demographic characteristics of the study participants are summarised in table 1.

Infection-induced seroprevalence

Out of the 362 participants that provided a serological sample, 30 were seropositive, resulting in a crude infection-acquired seroprevalence of 8.3% (95% CI 5.8 to 11.6). The study sample differed to that of the census of Quebec educators in 2021 across distributions of age, ethnic/racial minority, school level and sex (online supplemental table 3). A representative estimate of the infection-acquired seroprevalence is 8.6% (95% CI 5.2 to 13.0). Adjusting for the assay sensitivity of 95% and specificity of 100%, the seroprevalence was 8.7% (95% CI 6.0 to 12.1). DBS dates ranged from 9 April 2021 to 3 October 2021 with a median date of 23 May 2021. The seroprevalence for DBS collected before 23 May 2021 was 7.8% and the seroprevalence after was 8.7% (table 2). According to participant responses to questions on students' NPI compliance (where applicable), in daycares, elementary schools and high schools, 69%, 27% and 11% of children were not usually wearing a mask and 82%, 81% and 63% were not usually physically distancing, respectively. Over 96% of participants reported often or always wearing a mask in indoor public places. More than 70% of participants had been vaccinated and at least three-quarters had their last dose within 60 days of their DBS collection date. The risk of infection was lowest among high school staff at 3.3%, followed by daycare at 9.2%. The highest crude seroprevalence was among elementary school staff at 12.3% (table 2). In adjusted analyses, the risk of infection in high school staff was approximately 20% that of elementary school staff, after controlling for confounders identified in the DAG, that is, vaccination with at least one dose, household income, household crowding (bedroom density), education, sex, number of classes taught and identifying as an ethnic minority (aRR=0.20, 95% CI 0.067 to 0.58) (table 3). There was little evidence of an association between number of classes taught (for at least 25% of the time) and risk of infection after adjusting for confounders (1 to 2 classes: aRR 0.76; 3 to 4 classes: aRR 1.19; where 'not applicable < to their job function >' was the reference) (table 3). Being exposed to students who did not usually or always physically distance was associated with an increased risk of seropositivity, though not

Table 1 Characteristics of school and daycare staff participants, March–October 2021

		Seroprevalence sample n (%)	Mental health sample n (%)
Dates of assessments		April–October, 2021	March–July, 2021
Total		362	389
School level	Daycare	109 (30.1)	113 (29.0)
	Elementary school	130 (35.9)	142 (36.5)
	High school	123 (34.0)	134 (34.4)
Age group	<40 years	130 (35.9)	142 (36.5)
	40–50 years	105 (29.0)	116 (29.8)
	50+ years	126 (34.5)	128 (32.9)
	Missing	2 (0.55)	3 (0.77)
Sex at birth	Male	40 (11.0)	41 (10.5)
	Female	322 (89.0)	348 (89.5)
Ethnic or racial minority	White	346 (95.6)	371 (95.4)
	Other	14 (3.9)	16 (4.1)
	Missing	2 (0.55)	2 (0.51)
Number classes taught	1–2	126 (34.8)	128 (32.9)
	3–4	120 (33.1)	127 (32.6)
	Not applicable	116 (32.0)	134 (34.4)
Bedroom density*	<1 persons per bedroom	110 (30.4)	117 (30.1)
	≥1 persons per bedroom	252 (69.6)	272 (69.9)
Household income	<100 000$ CAD	158 (43.6)	168 (43.2)
	≥100 000$ CAD	161 (44.5)	173 (44.5)
	Missing	43 (11.9)	48 (12.3)
Education level	No university	112 (30.9)	122 (31.4)
	University degree	248 (68.5)	265 (68.1)
	Missing	2 (0.55)	2 (0.51)
Vaccinated with at least one dose	No	105 (29.0)	167 (42.3)
	Yes	257 (71.0)	222 (57.1)
School area	HOMA	38 (10.5)	43 (11.1)
	Montreal North	176 (48.6)	194 (49.9)
	Plateau Mont Royal	53 (14.6)	55 (14.1)
	West Island	95 (26.2)	97 (24.9)
Contact with students that do not usually physically distance	No	91 (25.1)	101 (26.0)
	Yes	271 (74.9)	282 (72.5)
	Not applicable	0 (0.00)	6 (1.54)
Contact with students that do not usually wear a mask	No	238 (65.7)	254 (65.3)
	Yes	124 (34.3)	129 (33.2)
	Not applicable	0 (0.00)	6 (1.54)

*Number of people in the household divided by number of bedrooms in the home.
$ CAD, Canadian dollars.

significantly (aRR 3.76, 95% CI 0.95 to 14.8). No other educator or school characteristics, including school neighbourhood, were associated with risk of seropositivity. However, wide CIs were observed for most variables, suggesting low power to detect meaningful differences in seroprevalence. Given that few participants identified as an ethnic/racial minority, there was insufficient representation in some strata of covariates. We ran analyses

Table 2 Seroprevalence among school staff in the EnCORE Study in March–October 2021, by participant characteristics

		Number seropositive per group	Seroprevalence 95% CI (%)
Overall		30/362	8.3 (5.8 to 11.6)
School level	Daycare	10/109	9.2 (4.9 to 16.2)
	Elementary school	16/130	12.3 (7.6 to 19.2)
	High school	4/123	3.3 (1.0 to 8.3)
Age group	<40 years	9/130	6.9 (3.5 to 12.8)
	40–50 years	9/105	8.6 (4.4 to 15.7)
	50+years	12/125	9.6 (5.4 to 16.2)
Sex at birth	Male	3/40	7.5 (1.9 to 20.6)
	Female	27/322	8.4 (5.8 to 12.0)
Ethnic or racial minority	White	27/346	7.8 (5.4 to 11.2)
	Other	3/14	21.4 (6.8 to 48.3)
Number classes taught	1–2	11/126	8.7 (4.8 to 15.1)
	3–4	10/120	8.3 (4.4 to 14.8)
	Not applicable	9/116	7.8 (4.0,14.3)
Bedroom density	<1 persons per bedroom	11/110	10.0 (5.5 to 17.2)
	≥1 persons per bedroom	19/252	7.5 (4.8 to 11.5)
Household income	<100 000$ CAD*	16/158	10.1 (6.2 to 15.9)
	≥100 000$ CAD	9/161	5.6 (2.8 to 10.4)
Education level	No university	10/112	8.9 (4.8 to 15.8)
	University degree	20/248	8.1 (5.2 to 12.2)
Vaccinated with at least one dose	No	10/105	9.5 (5.1 to 16.8)
	Yes	20/257	7.8 (5.0 to 11.8)
School area	HOMA	2/38	5.3 (0.5 to 18.2)
	Montreal North	14/176	8.0 (4.7 to 13.0)
	Plateau Mont Royal	7/53	13.2 (6.2 to 25.2)
	West Island	7/95	7.4 (3.4 to 14.7)
Contact with students that do not usually physically distance	Yes	28/271	10.3 (7.2 to 14.6)
	No	2/91	2.2 (0.1 to 8.1)
Contact with students that do not usually wear a mask	Yes	10/124	8.1 (4.3 to 14.4)
	No	20/238	8.4 (5.4 to 12.7)
DBS collected before 23 May 2021	Yes	14/179	7.8 (4.6 to 12.8)
	No	16/183	8.7 (5.4 to 13.8)

*$ CAD: Canadian dollars
DBS, dried blood spot.

with and without the variable, ethnic/racial minority, to determine the sensitivity of results to its inclusion. The conclusions from these analyses were similar to the original model, for example, high school versus elementary school, aRR=0.194, 95% CI 0.067 to 0.57.

Mental health outcomes

The prevalence of moderate to severe anxiety and depression in our sample ranged between 9% and 16% (table 4). Over 44% of staff felt a high level of EE/burnout and approximately 15% reported low resilience (table 4). There was little difference in the distribution of mental health scores across school levels, except for EE/burnout (table 4). High school staff were at higher risk of burnout than daycare and elementary school staff even after adjusting for confounders (high school 53% vs daycare 35% and elementary school 44%; aRR=1.52, 95% CI 1.14 to 2.04, ref=daycare) (table 4). A large percentage of staff, approximately 60% in daycare and

Table 3 Adjusted relative risk of seropositivity in EnCORE study school staff, March–October 2021, by participant characteristics, where each variable is adjusted by confounders identified by their DAG

		Relative risk*	95% CI	P value
School level	Daycare	0.58	0.22 to 1.5	0.27
	Elementary school	ref	---	---
	High school	0.20	0.066 to 0.58	0.003
Number classes taught	Not applicable	ref	---	---
	1–2	0.76	0.33 to 1.8	0.52
	3–4	1.19	0.52 to 2.7	0.68
Age group	<40 years	ref	---	---
	40–50 years	1.25	0.51 to 3.0	0.62
	50+years	1.40	0.61 to 3.2	0.43
Sex at birth	Female	ref	---	---
	Male	0.89	0.28 to 2.8	0.85
Ethnic or racial minority	No	ref	---	---
	Yes	2.73	0.94 to 7.96	0.066
Bedroom density	<1 persons per bedroom	ref	---	---
	≥1 persons per bedroom	0.83	0.38 to 1.80	0.63
Household income	<100 000$ CAD	ref	---	---
	≥100 000$ CAD	0.61	0.28 to 1.3	0.22
Education level	No university	ref	---	---
	University degree	0.92	0.44 to 1.89	0.81
Vaccinated with at least one dose	No	ref	---	---
	Yes	0.82	0.39 to 1.73	0.61
Contact with students that do not usually physically distance	No	ref	---	---
	Yes	3.76	0.95 to 14.8	0.059
Contact with students that do not usually wear a mask	No	ref	---	---
	Yes	0.74	0.32 to 1.68	0.47

*Minimally sufficient adjustment sets: age, sex ethnic/racial minority, region, level of education—no adjustment. Student NPI compliance—school level, region. School level—education, household crowding, household income, ethnic/racial minority, sex, vaccination status, number of classes taught. Number of classes taught—education, household crowding, household income, ethnic/racial minority, sex, vaccination, school level. Household crowding—age, household income, ethnic/racial minority. Vaccination status (at least one dose)—age, education, household income, ethnic/racial minority.
DAG, directed acyclic graph.

elementary and nearly 75% in high school, felt fear of becoming infected at school (table 4). After adjusting for age, vaccination and reporting contact with students who did not usually wear a mask or physically distance, feeling very afraid of catching COVID-19 at school was associated with a twofold to fourfold increase in risk of severe anxiety, moderate to severe depression and EE/burnout (aRR=4.4, 2.8 and 2.2, respectively, table 5). There was little evidence that poor mental health scores were associated with students not physically distancing and mask wearing (table 5). There was also little evidence that having received at least one vaccine dose alleviated fears of becoming infected: 61% of unvaccinated participants and 68% of vaccinated participants were somewhat or very afraid of becoming infected. Sex was not associated with any mental health outcome though 11% of our sample were men (eg, moderate to severe anxiety: women aRR=1.44, 95% CI 0.55 to 3.8). Note that only 14% of educators in Quebec are men. Age differences were evident with older age groups generally having lower risk of severe anxiety, moderate–severe depression and low resilience (moderate or severe anxiety, 40–50 years vs <40 years, RR=0.41, 95% CI 0.20 to 0.83; moderate–severe depression, 50+ years vs <40 years, RR=0.47, 95% CI 0.24 to 0.91; low resilience, 0.48, 95% CI 0.25 to 0.90). For those 362 participants providing a serological sample, there was little difference in the dichotomised mental health scores of the seropositive and seronegative participants, with the exception of low resilience (seronegative vs seropositive: moderate/severe anxiety 13% vs 17%,

Table 4 EnCORE study school staff, March–October 2021 mental health scores by school level

Mental health assessment tool	Daycare staff N (%)	Elementary school staff N (%)	High school staff N (%)
Burnout level (EE) (N=379)			
Low	73/113 (64.6%)	74/133 (55.6%)	63/133 (47.4%)
High	40/113 (35.4%)	59/133 (44.4%)	70/133 (52.6%)
Anxiety (GAD-7) (N=389)			
None—minimal	72/113 (63.7%)	82/142 (57.7%)	72/134 (53.7%)
Mild	25/113 (22.1%)	40/142 (28.2%)	45/134 (33.6%)
Moderate	10/113 (8.8%)	13/142 (9.2%)	9/134 (6.7%)
Severe	6/113 (5.3%)	7/142 (4.9%)	8/134 (6.0%)
Depression (PHQ-9) (N=389)			
None—minimal	69/113 (61.1%)	78/142 (54.9%)	78/134 (58.2%)
Mild	26/113 (23.0%)	51/142 (35.9%)	37/134 (27.6%)
Moderate	14/113 (12.4%)	7/142 (4.9%)	12/134 (9.0%)
Moderately–severe	3/113 (2.7%)	3/142 (2.1%)	5/134 (3.7%)
Severe	1/113 (0.9%)	3/142 (1.5%)	2/134 (1.5%)
Resilience (BRS) (N=389)			
High resilience	16/113 (14.2%)	28/142 (19.7%)	27/134 (20.1%)
Normal resilience	77/113 (68.1%)	92/142 (64.8%)	91/134 (67.9%)
Low resilience	20/113 (17.7%)	22/142 (15.5%)	16/134 (11.9%)
Afraid of catching COVID from work			
Not/little/not applicable	47/113 (41.6%)	54/137 (39.4%)	34/133 (25.6%)
Somewhat/very	66/113 (58.4%)	83/137 (60.6%)	99/133 (74.4%)

BRS, Brief Resilience Scale; EE, emotional exhaustion; GAD-7, 7-item General Anxiety Disorder assessment; NPI, non-pharmaceutical interventions; PHQ-9, Patient Health Questionnaire-9.

moderate/severe depression 4% vs 3%, high EE 44.3% vs 43.3%, low resilience 14% vs 27%).

DISCUSSION

We estimated that the infection-acquired seroprevalence in our school staff cohort between March and October 2021 was 8.6% (95% CI 5.2 to 13.0) (representative), which is slightly lower than the age-weighted and sex-weighted seroprevalence of 10.52% (95% CI 9.71 to 11.33) among unvaccinated blood donors during the period of January to March 2021.[29] We found the highest seroprevalence in elementary school followed by daycares, with high schools having one-fifth the adjusted risk of seropositivity. There was little evidence that students usually wearing a mask was protective to staff, however over 96% of staff reported usually wearing a mask themselves. Even though staff wore masks, there was some suggestion that students physically distancing was protective. Regarding mental health, fear of acquiring COVID-19 at school was associated with increased risk of severe anxiety, moderate–severe depression and high levels of EE/burnout. Feeling very afraid was not strongly associated with the students' compliance to wearing a mask and distancing. EE/burnout was high across school levels but was most common in high school staff where over half of participants scored high levels of EE.

Like other studies, we found that risk of seroprevalence in school staff was comparable to that of the general population.[9 10 12] Interestingly, the geographical areas where the seroprevalence was highest and lowest in the EnCORE staff sample were not the areas with highest and lowest prevalence in the EnCORE student sample in 2021.[17] In Montreal, students typically reside close to their school, but teachers often do not. In 2021, the student study participants attending schools in the West Island had the lowest seroprevalence, but the seroprevalence among West Island school staff was the second highest. The students in the Plateau schools had the second lowest seroprevalence, while the school staff working in the Plateau had the highest seroprevalence. Furthermore, 30% of seropositive staff had been exposed to a household contact with COVID-19 prior to completing the questionnaire, further supporting assertions that infection exposure was not likely from contact with students.[30]

Hutchison *et al* found poorer mental health outcomes in their sample of school staff in Vancouver, Canada in 2021, compared with a Canadian survey of adults during a similar time period.[31] Though the prevalences of

Table 5 Adjusted risk of severe anxiety, moderate to severe depression, low resilience and high emotional exhaustion/burnout among EnCORE study school staff, March–October 2021, in relation to participants socio-demographic characteristics and to the level of the respondents fear of catching COVID at school

		Relative risk*	95% CI	P value
Anxiety				
Contact with students that do not usually physically distance	No	ref	---	---
	Yes	1.5	0.79 to 2.8	0.22
Contact with students that do not usually wear a mask	No	ref	---	---
	Yes	1.11	0.62 to 2.0	0.72
Fear of COVID infection from school	None, little or not applicable	ref	---	---
	Somewhat afraid	1.8	0.88 to 3.6	0.11
	Very afraid	4.4	2.2 to 8.9	<0.0001
Depression				
Contact with students that do not usually physically distance	No	ref	---	---
	Yes	1.47	0.76 to 2.8	0.25
Contact with students that do not usually wear a mask	No	ref	---	---
	Yes	0.93	0.49 to 1.7	0.81
Fear of COVID infection from school	None, little or not applicable	ref	---	---
	Somewhat afraid	0.98	0.52 to 1.9	0.
	Very afraid	2.8	1.5 to 5.4	0.002
Low resilience				
Contact with students that do not usually physically distance	No	ref	---	---
	Yes	1.45	0.78 to 2.7	0.24
Contact with students that do not usually wear a mask	No	ref	---	---
	Yes	0.96	0.55 to 1.65	0.88
Fear of COVID infection from school	None, little or not applicable	ref	---	---
	Somewhat afraid	1.03	0.60 to 1.8	0.91
	Very afraid	1.62	0.85 to 3.1	0.14
Emotional exhaustion/burnout				
Contact with students that do not usually physically distance	No	ref	---	---
	Yes	1.16	0.89 to 1.5	0.27
Contact with students that do not usually wear a mask	No	ref	---	---
	Yes	1.05	0.79 to 1.4	0.75
Fear of COVID infection from school	None, little or not applicable	ref	---	---
	Somewhat afraid	1.45	1.1 to 1.9	0.01
	Very afraid	2.19	1.6 to 3.0	<0.0001

*Minimally sufficient adjustment sets: School level—sex. Student NPI compliance—school level. Fear of catching COVID from school—vaccination status, age, student NPI compliance.
NPI, non-pharmaceutical interventions.

moderate to severe anxiety and depression in our school staff cohort in 2021 were under 16% and similar to the prevalence of 13% and 17%, respectively, in the general Quebec adult population, surveyed from May to June 2021,[32] the prevalences of high EE/burnout were over 40% in the elementary and high school levels, compared

with 32% from all occupations in the USA,[33] and 20% in school staff in Germany.[34] For the determinants of mental health, Santiago *et al*, in their systematic review, reported a considerable proportion of studies of teachers during the pandemic found that generalised anxiety, depression and burnout syndrome were prevalent and were more common in female teachers, 50 years or older, and in those with a pre-existing mental illness.[15] Hossain *et al* found that teachers in Bangladesh that expressed fear of COVID-19 experienced greater anxiety and depression.[14] Though we had limited statistical power and only 11% of our sample were men (compared with 14% in the Quebec population of educators), we did not find sex related to the risk of severe anxiety, depression or burnout. However, older age groups were found to have lower risk of severe anxiety, depression and also had a decreased risk of low resilience. This may be explained by greater resilience developed through the life course and that experienced teachers did not self-select out of the profession earlier in their career, due to poor mental health.[35] Also in Quebec, seniority usually decides the order in which elementary and high school teachers choose the classes they will teach, from the available classes. This means that teachers with less experience may be left to teach more challenging classes in more difficult schools. Like Hutchison *et al*, we found strong associations between poor mental health outcomes and the fear of acquiring COVID-19 at work.[36] Factors known to protect against infection, like vaccination, distancing and wearing masks, were not strongly associated with the fear of becoming infected.

Our study comes with several limitations. The wide CIs, particularly for the less common outcomes like seropositivity and for explanatory variables with less variation (eg, ethnic or racial minority), suggested low power to detect meaningful differences in risk. Despite low power, we did find some interesting and significant associations. We were also limited by the cross-sectional nature of the study, which did not allow us to examine changes in mental health before and after the start of the pandemic. Nevertheless, we could examine the differences between these occupational subgroups and the general population during the same time period. Another limitation is the convenience sampling of participants made it less likely that our seroprevalence estimate would be representative of our study population. Although we generated a more representative seroprevalence estimate for the study population using the method of raking, this does not take care of the non-response bias introduced by this method of sampling.

CONCLUSIONS

With the preventive measures in place, and the recent availability of the vaccine in 2021, the seroprevalence of infection-acquired SARS-CoV-2 among school staff was comparable to the general population of Quebec. The risk of anxiety and depression were also similar to those reported in a study of adults in Quebec. However, there was a high risk of burnout, particularly among high school staff. Fear of becoming infected at school was also common and greater levels of fear were associated with poorer mental health outcomes. Given the ongoing challenges in recruiting and retaining teachers in Quebec, and our findings of a high risk of burnout during the pandemic, continued monitoring of the emotional health of school staff and potential avenues for improvement are needed.[37]

Author affiliations
[1]Université de Montréal, Montréal, Québec, Canada
[2]Centre de recherche en santé publique, Montréal, Québec, Canada
[3]McGill University, Montréal, Québec, Canada
[4]CHU de Québec-Université Laval, Québec, Québec, Canada
[5]Faculty of Medicine, Université de Montréal, Montréal, Québec, Canada
[6]Institut national de santé publique du Québec, Québec, Québec, Canada
[7]McGill University Health Centre, Montréal, Québec, Canada
[8]Sainte-Justine University Hospital Research Centre, Montréal, Québec, Canada

Acknowledgements We sincerely thank all the participants for their valuable contribution to our study. We also thank all of the daycares, schools and school boards for their help with recruitment. We express our sincere gratitude for the invaluable help provided by educators, J Horlador and L Baldock, who shared information about the education system that helped shape our assumptions and guide our analysis. We are grateful for the support and guidance of our partners: Direction régionale de santé publique de Montréal, COVID-19 Immunity Task Force, Institut national de santé publique du Québec and Observatoire pour l'éducation et la santé des enfants.

Contributors Conceptualisation: KZ, JP, GDS and CQ. Data curation: KZ, KC, LP, AS, MBDT, JP, M-ÈH, JC, CTN, GB and GDS. Investigations: MP, KC, EG-A. Formal analysis: KC. Funding acquisition: KZ, GDS and CQ. Project administration: KZ and LP. Supervision: KZ, KC, LP, GB and GDS. Writing—original draft: KC. Writing—review and editing: KC, KZ, MP, EG-A, LP, AS, MBDT, JP, M-ÈH, JC, CTN, GB, GDS and CQ. KZ is the guarantor.

Funding This study was funded by the Public Health Agency of Canada (2021-HQ-000097).

Competing interests JP reports grants from MedImmune, grants and personal fees from Merck and AbbVie, and personal fees from AstraZeneca, all outside the submitted work. All other authors have no competing interests to declare.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The research ethic board (comité d'éthique de la recherche en sciences et en santé - CERSES) of the Univesité de Montréal (#2020-965) and the research ethic board of the Centre Hospitalier Universitaire Sainte-Justine (MP-21-2021-3105) approved this study in accordance with the laws of the Government of Quebec. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer-reviewed.

Data availability statement Data are available upon reasonable request.

ORCID iD
Kate Zinszer http://orcid.org/0000-0003-1388-1145

REFERENCES

1 Engzell P, Frey A, Verhagen MD. Learning loss due to school closures during the COVID-19 pandemic. *Proc Natl Acad Sci USA* 2021;118.
2 Duan L, Shao X, Wang Y, *et al*. An investigation of mental health status of children and adolescents in China during the outbreak of COVID-19. *J Affect Disord* 2020;275:112–8.
3 Gazmararian J, Weingart R, Campbell K, *et al*. Impact of COVID-19 Pandemic on the Mental Health of Students From 2 Semi-Rural High Schools in Georgia. *J Sch Health* 2021;91:356–69.
4 Rao ME, Rao DM. The Mental Health of High School Students During the COVID-19 Pandemic. *Front Educ* 2021;6.
5 Tang S, Xiang M, Cheung T, *et al*. Mental health and its correlates among children and adolescents during COVID-19 school closure: The importance of parent-child discussion. *J Affect Disord* 2021;279:353–60.
6 Jakubowski TD, Sitko-Dominik MM. Teachers' mental health during the first two waves of the COVID-19 pandemic in Poland. *PLoS One* 2021;16:e0257252.
7 Kim LE, Asbury K. 'Like a rug had been pulled from under you': The impact of COVID-19 on teachers in England during the first six weeks of the UK lockdown. *Br J Educ Psychol* 2020;90:1062–83.
8 MacIntyre PD, Gregersen T, Mercer S. Language teachers' coping strategies during the Covid-19 conversion to online teaching: Correlations with stress, wellbeing and negative emotions. *Syst* 2020;94:102352.
9 Campeau L, Thistlethwaite F, Yao JA, *et al*. Transmission dynamics of SARS-CoV-2 in British Columbia's largest school district during the second half of the 2020-2021 school year. *Can J Public Health* 2022;113:653–64.
10 Coleman BL, Fischer K, Maunder R, *et al*. Study of the epidemiology of COVID-19 in Ontario elementary and secondary school education workers: an interim analysis following the first school year. *Can J Public Health* 2022;113:185–95.
11 Fitzpatrick T, Wilton A, Cohen E, *et al*. School Reopening And COVID-19 In The Community: Evidence From A Natural Experiment In Ontario, Canada. *Health Aff (Millwood)* 2022;41:864–72.
12 Vardavas C, Nikitara K, Mathioudakis AG, *et al*. Transmission of SARS-CoV-2 in educational settings in 2020: a review. *BMJ Open* 2022;12:e058308.
13 Hesham Abdou Ahmed G. Special education teachers' mental health after reopening schools during Covid-19. *PLoS One* 2023;18:e0284870.
14 Hossain MdT, Islam MdA, Jahan N, *et al*. Mental Health Status of Teachers During the Second Wave of the COVID-19 Pandemic: A Web-Based Study in Bangladesh. *Front Psychiatry* 2022;13.
15 Santiago ISD, Dos Santos EP, da Silva JA, *et al*. The Impact of the COVID-19 Pandemic on the Mental Health of Teachers and Its Possible Risk Factors: A Systematic Review. *Int J Environ Res Public Health* 2023;20:1747.
16 Woltran F, Lindner KT, Schwab S. Pandemic Education-Insights into Teachers' Perceptions of Hygiene Measures in Schools Due to COVID-19. *Int J Environ Res Public Health* 2023;20:5207.
17 Zinszer K, Charland K, Pierce L, *et al*. Pre-Omicron seroprevalence, seroconversion, and seroreversion of infection-induced SARS-CoV-2 antibodies among a cohort of children and teenagers in Montréal, Canada. *Int J Infect Dis* 2023;131:119–26.
18 Zinszer K, McKinnon B, Bourque N, *et al*. Seroprevalence of anti-SARS-CoV-2 antibodies among school and daycare children and personnel: protocol for a cohort study in Montreal, Canada. *BMJ Open* 2021;11:e053245.
19 Dibernardo A, Toledo NP, Robinson A, *et al*. Evaluation of the performance of multiple immunoassay diagnostic platforms on the National Microbiology Laboratory SARS-CoV-2 National Serology Panel. *Off J Assoc Med Microbiol Infect Dis Can* 2022;7:186–95.
20 Blaker H. Confidence curves and improved exact confidence intervals for discrete distributions. *Can J Statistics* 2000;28:783–98.
21 Statistics Canada. Table 98-10-0330-01. Visible minority by occupation, highest level of education and generation status: Canada, provinces and territories. 2023.
22 Gallis JA, Turner EL. Relative Measures of Association for Binary Outcomes: Challenges and Recommendations for the Global Health Researcher. *Ann Glob Health* 2019;85:137.
23 Ladhani SN, Ireland G, Baawuah F, *et al*. SARS-CoV-2 infection, antibody positivity and seroconversion rates in staff and students following full reopening of secondary schools in England: A prospective cohort study, September-December 2020. *EClinMed* 2021;37:100948.
24 Reyes-Vega MF, Soto-Cabezas MG, Cárdenas F, *et al*. SARS-CoV-2 prevalence associated to low socioeconomic status and overcrowding in an LMIC megacity: a population-based seroepidemiological survey in Lima, Peru. *EClinMed* 2021;34:100801.
25 van Ingen T, Brown KA, Buchan SA, *et al*. Neighbourhood-level socio-demographic characteristics and risk of COVID-19 incidence and mortality in Ontario, Canada: a population-based study. *PLoS One* 2022;17:e0276507.
26 Yoshikawa M, Asaba K. Educational Attainment Decreases the Risk of COVID-19 Severity in the European Population: A Two-Sample Mendelian Randomization Study. *Front Public Health* 2021;9:673451.
27 van Buuren S, Groothuis-Oudshoorn K. mice: Multivariate Imputation by Chained Equations in R. *J Stat Softw* 2011;45.
28 Maslach C, Jackson S, Leiter M. *Maslach Burnout Inventory: Manual*. 4th edn. Menlo Park, Calif: MindGarden, 2018.
29 Héma-Québec. Phase 2 de l'étude sur la séroprévalence des anticorps dirigés contre le SRAS-CoV-2 au Québec 2021.
30 Lee B, Raszka WV Jr. COVID-19 Transmission and Children: The Child Is Not to Blame. *Pediatrics* 2020;146:e2020004879.
31 Hutchison SM, Watts A, Gadermann A, *et al*. School staff and teachers during the second year of COVID-19: Higher anxiety symptoms, higher psychological distress, and poorer mental health compared to the general population. *J Affect Disord Rep* 2022;8:100335.
32 Généreux M, Landaverde E. Psychosocial impacts of the covid-19 pandemic: results of a broad survey in Québec Phase 4 2021.
33 Abramson A. Burnout and stress are everywhere. *Mon Psychol* 2022;53. Available: https://www.apa.org/monitor/2022/01/special-burnout-stress
34 Klusmann U, Aldrup K, Roloff-Bruchmann J, *et al*. Teachers' emotional exhaustion during the COVID-19 pandemic: Levels, changes, and relations to pandemic-specific demands. *Teach Teach Educ* 2023;121:103908.
35 Czeisler MÉ, Lane RI, Petrosky E, *et al*. Mental Health, Substance Use, and Suicidal Ideation During the COVID-19 Pandemic - United States, June 24-30, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:1049–57.
36 Hutchison SM, González OD-J, Watts A, *et al*. Anxiety symptoms, psychological distress, and optimism in school staff: Testing associations with stressors and coping during the second year of the COVID-19 pandemic. *J Affect Disord Rep* 2023;14:100662.
37 Fortin A, Côté É, Boily M-H, *et al*. Rapport du Vérificateur général du québec à l'Assemblée nationale pour l'année 2022-2023. Cahpitre 3; 2023. Available: https://www.vgq.qc.ca/Fichiers/Publications/rapport-annuel/203/03_vgq_ch3_mai2023_web_vf.pdf [Accessed 24 Aug 2023].