Seroprevalence and factors associated with SARS-CoV-2 infection among education workers after the first wave: the first cross-sectional study in Brazil

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ABSTRACT

Background: The school community was heavily impacted by the Covid-19 pandemic, especially with the long time of school closures. This study aimed to analyze the seroprevalence of SARS-CoV-2 antibodies and possible factors associated with seropositivity for COVID-19 in teachers and other school staff, and to estimate the fraction of asymptomatic individuals by sex and age group.

Methods: We conducted a serological survey of SARS-CoV-2 infections. An analytical cross-sectional study was conducted in Fortaleza, Brazil. Teachers and other staff members from pre-schools to universities of higher education to were investigated.

Results: A total of 1,901 professionals participated in the study, of which 1,021 were staff and 880 were teachers. The seroprevalence of SARS-CoV-2 was 8.0% (152/1901). In the seropositive group, 48.3% were asymptomatic. There was a predominance of women (68.4%); and, 47.1% of the participants were between 31 and 45 years old. There was an increase in prevalence with increasing age. An inverse relationship was found for education level: more professionals with less education tested positive for COVID-19. The presence of an infected person living in the same household was significantly associated with positive results for COVID-19 among the professionals.

Conclusions: This is the first study to report the seroprevalence of IgG against SARS-CoV-2 in Brazilian educational staff after the first wave of the disease. In this study, the seroprevalence was much lower than that in the general population. During school reopening, a small fraction of school workers showed serologically detectable signs of SARS-CoV-2 exposure.

Keyword: Covid-19. Survey. School. SARS-CoV-2.
INTRODUCTION

The detection and spread of an emerging respiratory disease is associated with a huge amount of uncertainty regarding its epidemiological and serological characteristics. The novel coronavirus, SARS-CoV-2, emerged in Wuhan, China, in December 2019 and rapidly spread to other countries. On March 11, 2020, the World Health Organization (WHO) declared the coronavirus disease (COVID-19) a pandemic.

To reduce transmission speed, control measures were launched worldwide; thus, pubs, shopping malls, parks, and schools were closed to avoid social contact. Despite the reopening of several sectors of the economy, more than 100 countries did not schedule dates for the reopening of schools until May 2020.

The state of Ceará in northeast Brazil was one of the first to confirm sustained SARS-CoV-2 transmission, and schools were closed on March 20, 2020. The state government of Ceará issued early guidance for safe operation through prevention, early detection, and control of COVID-19 in schools and other educational facilities. Sectoral protocol N.18 mentions, among other requirements, that alcohol gel must be available in all rooms; a minimum of 1.5 meters of space should be kept between school desks; classes should be filled up to 35% capacity; and, students, teachers, and staff should mandatorily use masks. In addition, all teachers and staff were tested for COVID-19 by RT-PCR until one week before classroom return.

Available evidence suggests that children and adolescents may be less susceptible and present less severe disease than adults. However, there are reports in the northeast of the systemic inflammatory syndrome in children during the COVID-19 pandemic.

As SARS-CoV-2 is a new virus, its initial seroprevalence in the population is assumed to be negligible. Therefore, the surveillance of antibody seropositivity in specific populations can allow inferences regarding the extent of infection in this population and subsequent control measures. By the end of November 2020, the state of Ceará had reported 293,237 cases and 9,563 deaths.

The main objective of this study was to measure the seroprevalence of antibodies against anti-SARS-CoV-2 IgG antibodies, to identify factors associated with infection in teachers and other school staff to ascertain the cumulative population immunity, and to estimate the prevalence of asymptomatic infection by sex and age group after the first wave of the disease in Brazil. This is particularly important in the context of novel respiratory pathogens, such as SARS-CoV-2, and in the context of education.

METHODS

We conducted a serological survey using chemiluminescence immunoassay for anti-SARS-CoV-2 immunoglobulin G (IgG) antibodies in 2,341 private school teachers and staff in Fortaleza, Brazil. In 2020, only private schools returned to classroom lessons five months after the first pandemic peak and two months after the schools reopened.

In this section, we describe the study location, sampling and recruitment approaches, specimen collection methods, antibody testing procedures, statistical methods, and ethical aspects.
Table 1

| Characteristics of positive cases of COVID-19 |
|-----------------------------------------------|
| IgG antibodies were detected in 152 of the 1,901 samples, with a positive seroprevalence of 8.0% (95% CI: 6.8–9.3). Among the seropositive participants, 48.3% did not report prior COVID-19-like illnesses. |
| An increase in the seroprevalence was observed with increasing age. Individuals older than 45 years showed 12.0% positivity (PR=1.63; 95%CI: 1.11–2.41). The seroprevalence in the brown and black races was 9.6% (PR=1.97; 95%CI:1.35–2.88) and 11.7% (PR=2.18; 95%CI: 1.25–3.80), respectively, and it was significantly higher in them than those who declared themselves white (5.4%). |
| The seropositivity among the staff was slightly higher (8.5%; 95%CI: 7.0–10.2) as compared to that in teachers (7.4%;95%CI:5.9–9.4), but without a significant difference (p=0.363). |
| Contrasting, for teachers, positivity for COVID-19 IgG antibodies was higher among those with more than 20 years of classroom teaching experience (11.5%; 95%CI: 7.6–17.6). Teachers working in preschool classes and elementary I showed 8.8% (95%CI: 5.6–13.6) and 9.0% (95%CI 6.2–12.8) positivity, respectively, which was higher than the average positivity of the other classes (5.9%; 95%CI: 4.3–7.9). |

It was also observed that teachers excluded from the present classroom activities showed no significant difference in positivity for COVID-19 (p=0.214) (Table 1). The presence of infected persons at home was significantly associated with positivity for COVID-19 among professionals (PR=3.76; 95%CI: 2.65–5.35).

Social isolation was declared as intense by 312 professionals, and this group had a mean prevalence of positivity of 6.1% (95%CI: 3.9–9.4), lower than that in professionals who did not maintain isolation at the same intensity (8.4%; 95%CI: 7.1–9.9). This was also observed in the social isolation routine, in which those who went out (8.5%; 95%CI:7.2–9.9) and those who received more visitors (9.0%) (95%CI: 7.4–11.7) had higher positivity rates than those who stayed at home all the time (5.4%; 95%CI: 3.3–8.7).

The most prevalent symptoms among participants with positive tests who reported prior COVID-19-like illnesses were loss of smell, loss of taste, fever, body pain, and cough, with percentages higher than 25%, with a statistically significant difference from those professionals with the same symptoms but showing negative tests. The only symptom that was not statistically significant was headache, with only seven reports (p=0.078). Among the symptomatic patients, six different groups of medications were prescribed, and azithromycin (40.3%), dipyrone (35.1%), ivermectin (27.7%), and paracetamol (25.5%) were notable. However, none of the medications used was associated with COVID-19 symptoms (Table 4).

In an adjusted analysis, the chance of positivity among those aged >45 years was 2.39 times higher (95%CI: 1.12–5.13; p=0.025), and seroconversion was 2.00 times lower in those who did not perform physical activity (95%CI: 1.09–3.57; p=0.025). For those who had patients with COVID-19 at home, the chance of positivity was 5.58 times higher (95%CI: 3.03–10.3; p<0.001). Regarding symptoms, difficulty in breathing and loss of smell were notable, which were 4.04 and 4.12 times higher among those who showed positive results (p<0.001), respectively.

Employees who used public transportation to attend school showed higher positivity rates. On the other hand, lower positivity rates were observed in teachers who worked only one shift, commuted alone in their cars, and had health insurance (Table 5).

DISCUSSION

This study was the first large-scale prevalence study conducted among educational workers in Brazil immediately after the first wave of the disease. This study was the first to measure the IgG antibody response to SARS-CoV-2 in a school community exposed to the virus. In our study, the immune response related to previous SARS-CoV-2 infections was < 10.0%. The seropositivity was lower than that of the general population (15.53%) when tested during the same period in the city of Fortaleza13.

Seroprevalence studies help understand the likelihood of asymptomatic infections. Among our participants who tested seropositive, 48.3% reported no prior COVID-19-like illnesses. This finding suggests that a significant proportion of patients with COVID-19 were asymptomatic. It is likely that these individuals did not self-isolate when infected, and they continued to spread the disease to other people.

A population-based survey conducted in another state in the northeast region of Brazil showed that the seroprevalence of total antibodies against SARS-CoV-2 was 40.4%14, much higher than that...
TABLE 1: Influence of socioeconomic factors on seroconversion in teachers and school employees during the first wave of the COVID-19 pandemic in the city of Fortaleza, Brazil.

| Sociodemographic variables | Univariable Analysis | Multivariable logistic regression |
|----------------------------|----------------------|----------------------------------|
|                            | Total                | COVID–19 IgG | p–value | Adjusted OR (95%CI) | p–value |
|                            |                      | Negative | Positive |                      |         |
| Gender                     |                      |          |          |                      |         |
| Female                     | 1300 (68.4%)         | 1197 (68.5%) | 103 (67.8%) | 0.856 | – | – |
| Male                       | 600 (31.6%)          | 551 (31.5%) | 49 (32.2%) | RC | – | – |
| Age                        |                      |          |          |                      |         |
| Up to 30 years old         | 563 (29.6%)          | 522 (29.8%) | 41 (27.0%) | 0.002 | RC | – |
| 31 to 45 years old         | 896 (47.1%)          | 838 (47.9%) | 58 (38.2%) | – | – | – |
| >45 years old              | 442 (23.3%)          | 389 (22.2%) | 53 (34.9%) | 2.39 (1.12–5.13) | 0.025 |
| Race                       |                      |          |          |                      |         |
| White                      | 634 (34.0%)          | 600 (35.0%) | 34 (22.8%) | 0.001 | 0.80 (0.44–1.46) | 0.467 |
| Brown                      | 1024 (54.9%)         | 926 (54.0%) | 98 (65.8%) | RC | – | – |
| Black                      | 145 (7.8%)           | 128 (7.5%) | 17 (11.4%) | – | – | – |
| Yellow                     | 62 (3.3%)            | 62 (3.6%) | 0 (0.0%) | – | – | – |
| Education level            |                      |          |          |                      |         |
| Up to elementary school/High school | 496 (26.1%) | 445 (25.4%) | 51 (33.6%) | 0.078 | RC | – |
| University                 | 753 (39.6%)          | 696 (39.8%) | 57 (37.5%) | – | – | – |
| Postgraduate               | 652 (34.3%)          | 608 (34.8%) | 44 (28.9%) | – | – | – |
| Marital status             |                      |          |          |                      |         |
| Married                    | 887 (46.7%)          | 813 (46.5%) | 74 (48.7%) | 0.022 | 1.44 (0.73–2.84) | 0.290 |
| Single                     | 751 (39.5%)          | 696 (39.8%) | 55 (36.2%) | RC | – | – |
| Divorced                   | 124 (6.5%)           | 118 (6.7%) | 6 (3.9%) | – | – | – |
| Stable union               | 114 (6.0%)           | 103 (5.9%) | 11 (7.2%) | – | – | – |
| Widower                    | 25 (1.3%)            | 19 (1.1%) | 6 (3.9%) | – | – | – |
| Housing Type               |                      |          |          |                      |         |
| House                      | 1198 (63.1%)         | 1089 (62.3%) | 109 (71.7%) | 0.021 | – | – |
| Apartment                  | 702 (36.9%)          | 659 (37.7%) | 43 (28.3%) | RC | – | – |
| People living in the house |                      |          |          |                      |         |
| Up to 3                    | 1060 (56.9%)         | 987 (57.6%) | 73 (48.3%) | 0.027 | 0.86 (0.47–1.57) | 0.620 |
| >3                         | 804 (43.1%)          | 726 (42.4%) | 78 (51.7%) | RC | – | – |
| Housing Conditions         |                      |          |          |                      |         |
| It has basic sanitation    | 1700 (89.5%)         | 1566 (89.6%) | 134 (88.2%) | 0.582 | RC | – |
| It has garbage collection  | 1890 (99.5%)         | 1740 (99.5%) | 150 (98.7%) | 0.161 | 0.98 (0.50–10.51) | 1.000 |
| It has piped water         | 1895 (99.7%)         | 1745 (99.8%) | 150 (98.7%) | 0.008 | 3.00 (0.30–13.13) | 1.000 |

Subtitle: *p<0.05, Fisher exact test or Pearson chi-square test; ¥Not everyone filled in this information; OR: odds ratio; 95% CI: 95% confidence interval of adjusted OR; RC: reference category in the multivariate analysis.
TABLE 2: Influence of professional profile on seroconversion in school teachers and employees during the first wave of the COVID-19 pandemic in the city of Fortaleza, Brazil.

| Professional profile                      | Univariable Analysis | Multivariable logistic regression |
|-------------------------------------------|----------------------|-----------------------------------|
|                                           | Total                | COVID–19 IgG                       | p-value | Adjusted OR (95%CI) | p-value |
|                                           |                      | Negative                          | Positive |                      |         |
| Function                                  |                      | 880 (46.3%)                       | 815 (46.6%) | 65 (42.8%)             | 0.363   | –        | –        |
| Teacher                                   |                      | 1021 (53.7%)                      | 934 (53.4%) | 87 (57.2%)             | RC      | –        | –        |
| Collaborator                               |                      |                                   |           |                       |         |         |         |
| Shift work                                |                      | 1615 (85.0%)                      | 1494 (85.4%) | 121 (79.6%)            | 0.054   | 0.66 (0.31–1.38) | 0.268   |
| Morning                                   |                      |                                   |           |                       |         |         |         |
| Afternoon                                  |                      | 1358 (71.4%)                      | 1252 (71.6%) | 106 (69.7%)           | 0.629   | –        | –        |
| Night                                     |                      | 351 (18.5%)                       | 323 (18.5%) | 28 (18.4%)             | 0.989   | –        | –        |
| Works quantity shifts                      |                      |                                   |           |                       | RC      | –        | –        |
| < 1                                       |                      | 2 (0.1%)                          | 2 (0.1%) | 0 (0.0%)              | 0.311   | –        | –        |
| 1                                         |                      | 610 (32.1%)                       | 551 (31.5%) | 59 (38.8%)           | –       | –        | –        |
| 2                                         |                      | 1153 (60.7%)                      | 1070 (61.2%) | 83 (54.6%)           | –       | –        | –        |
| 3                                         |                      | 136 (7.2%)                        | 126 (7.2%) | 10 (6.6%)             | RC      | –        | –        |
| Time spent teaching in the classroom       |                      |                                   |           |                       |         |         |         |
| < 6                                        | 199 (23.0%)          | 186 (23.2%)                       | 13 (20.3%) | 0.092 | RC      | –        |
| 6–10                                       | 238 (27.5%)          | 221 (27.6%)                       | 17 (26.6%) | –       | –        | –        |
| 11–20                                      | 247 (28.5%)          | 234 (29.2%)                       | 13 (20.3%) | –       | –        | –        |
| >20                                        | 182 (21.0%)          | 161 (20.1%)                       | 21 (32.8%) | 0.99   | (0.44–2.22) | 0.974   |
| Transportation used for work               |                      |                                   |           |                       | RC      | –        | –        |
| Bicycle                                    | 52 (2.7%)            | 46 (2.6%)                         | 6 (3.9%)  | 0.235   | –        | –        |
| Hitchhiking with co-workers                | 87 (4.6%)            | 81 (4.6%)                         | 6 (3.9%)  | –       | –        | –        |
| Car alone                                  | 873 (45.9%)          | 814 (46.6%)                       | 59 (38.8%) | RC      | –        | –        |
| Motorcycle with co–worker                  | 26 (1.4%)            | 24 (1.4%)                         | 2 (1.3%)  | –       | –        | –        |
| Motorcycle alone                           | 101 (5.3%)           | 87 (5.0%)                         | 14 (9.2%) | –       | –        | –        |
| Collective Transportation                  | 606 (31.9%)          | 553 (31.6%)                       | 53 (34.9%) | –       | –        | –        |
| Other                                      | 155 (8.2%)           | 143 (8.2%)                        | 12 (7.9%) | –       | –        | –        |
| Professional performance                   |                      |                                   |           |                       | RC      | –        | –        |
| Preschool                                  | 204 (23.2%)          | 186 (22.8%)                       | 18 (27.7%) | 0.371   | RC      | –        |
| Elementary I                               | 301 (34.2%)          | 274 (33.6%)                       | 27 (41.5%) | 0.195   | 1.23   | (0.65–2.30) | 0.523   |
| Fundamental II                             | 211 (24.0%)          | 200 (24.5%)                       | 11 (16.9%) | 0.166   | 0.89   | (0.40–1.98) | 0.767   |
| High School                                | 188 (21.4%)          | 176 (21.6%)                       | 12 (18.5%) | 0.553   | –       | –        |
| Higher Education                           | 209 (23.8%)          | 197 (24.2%)                       | 12 (18.5%) | 0.296   | –       | –        |
| Post–graduation                            | 72 (8.2%)            | 67 (8.2%)                         | 5 (7.7%)  | 0.881   | –       | –        |
| Technical courses                          | 19 (2.2%)            | 18 (2.2%)                         | 1 (1.5%)  | 0.721   | –       | –        |
| Was excluded from face–to–face activities in the pandemic | | | | | | |
| No                                        | 493 (25.9%)          | 460 (26.3%)                       | 33 (21.7%) | 0.214   | RC      | –        |
| Yes                                       | 1407 (74.1%)         | 1288 (73.7%)                      | 119 (78.3%) | –       | –        | –        |
| Has health insurance                       | 1462 (76.9%)         | 1356 (77.6%)                      | 106 (69.7%) | 0.028   | 0.45   | (0.18–1.17) | 0.102   |
| Practices physical activity                |                      |                                   |           |                       | RC      | –        | –        |
| No                                        | 930 (49.0%)          | 843 (48.3%)                       | 87 (57.2%) | 0.034   | 0.50   | (0.28–0.92) | 0.025   |
| Yes                                       | 969 (51.0%)          | 904 (51.7%)                       | 65 (42.8%) | RC      | –       | –        |

Subtitle: *p<0.05, Fisher exact test or Pearson chi-square test; † Not everyone provided this information; OR: odds ratio; 95% CI: 95% confidence interval of adjusted OR; RC: reference category of multivariable analysis.
TABLE 3: Influence of daily routine on seroconversion in school teachers and employees during the first wave of the COVID-19 pandemic in the city of Fortaleza, Brazil.

| Daily Routine | Univariable Analysis | Multivariable logistic regression |
|---------------|----------------------|-----------------------------------|
|               | Total | COVID–19 IgG | Negative | Positive | p-value | Adjusted OR (95%CI) | p-value |
| In your home, someone had COVID19 | | | | | | | |
| No | 1095 (57.6%) | 1044 (59.7%) | 51 (33.6%) | | <0.001 | 5.58 (3.02–10.30) | <0.001* |
| I don’t know | 458 (24.1%) | 418 (23.9%) | 40 (26.3%) | | | | |
| Yes | 348 (18.3%) | 287 (16.4%) | 61 (40.1%) | | | | |
| Do you know someone who had COVID–19? | | | | | | | |
| No | 194 (10.2%) | 176 (10.1%) | 18 (11.8%) | | 0.487 | – | – |
| Yes | 1707 (89.8%) | 1573 (89.9%) | 134 (88.2%) | | | | |
| Do you know anyone who died from COVID–19? | | | | | | | |
| No | 600 (31.6%) | 556 (31.8%) | 44 (28.9%) | | 0.470 | – | – |
| Yes | 1301 (68.4%) | 1193 (68.2%) | 108 (71.1%) | | | | |
| Did you succeed in social isolation? | | | | | | | |
| Practically isolated from the world | 312 (16.5%) | 293 (16.8%) | 19 (12.5%) | | 0.266 | – | – |
| Very little | 67 (3.5%) | 61 (3.5%) | 6 (3.9%) | | – | – | – |
| Not much | 35 (1.8%) | 30 (1.7%) | 5 (3.3%) | | – | – | – |
| More or less | 345 (18.2%) | 311 (17.8%) | 34 (22.4%) | | – | – | – |
| Quite | 1137 (60.0%) | 1049 (60.1%) | 88 (57.9%) | | – | – | – |
| How was your routine during social isolation? | | | | | | | |
| Staying at home all the time | 295 (15.6%) | 279 (16.1%) | 16 (10.6%) | | 0.461 | – | – |
| Going out only for essential things, like buying food or a pharmacy | 1265 (67.1%) | 1160 (66.9%) | 105 (69.5%) | | – | – | – |
| Going out once in a while to buy food and stretching legs | 114 (6.0%) | 103 (5.9%) | 11 (7.3%) | | – | – | – |
| Going out every day for some activity | 39 (2.1%) | 35 (2.0%) | 4 (2.6%) | | – | – | – |
| Going out every day, all day, to work or for other regular activities | 173 (9.2%) | 158 (9.1%) | 15 (9.9%) | | RC | – | – |
| Visiting routine in your home | | | | | | | |
| Only who lives in the house and nobody else | 911 (49.2%) | 845 (49.7%) | 66 (43.7%) | | 0.433 | – | – |
| Some close relatives visit once or twice a week | 757 (40.9%) | 689 (40.6%) | 68 (45.0%) | | – | – | – |
| Friends, distant relatives, or others who visit once or twice a week | 89 (4.8%) | 80 (4.7%) | 9 (6.0%) | | – | – | – |
| Some close relatives visit almost every day | 79 (4.3%) | 71 (4.2%) | 8 (5.3%) | | – | – | – |
| Friends, distant relatives, or others who visit every day | 14 (0.8%) | 14 (0.8%) | 0 (0.0%) | | RC | – | – |
| Do you consider that the following protect you against COVID–19? | | | | | | | |
| Wearing a mask every time you leave the house | 1796 (94.5%) | 1651 (94.4%) | 145 (95.4%) | | 0.605 | RC** | – |
| Staying at home and avoiding contact with other people | 1207 (63.5%) | 1110 (63.5%) | 97 (63.8%) | | 0.931 | RC** | – |
| Cleaning your hands with alcohol gel | 1557 (81.9%) | 1427 (81.6%) | 130 (85.5%) | | 0.227 | RC** | – |
| Avoiding people while outside the home | 1335 (70.2%) | 1234 (70.6%) | 101 (66.4%) | | 0.288 | RC** | – |
| Washing your hands frequently | 1818 (95.6%) | 1672 (95.6%) | 146 (96.1%) | | 0.792 | RC** | – |
| Not putting your hands in your mouth, nose, or eyes | 1604 (84.4%) | 1475 (84.3%) | 129 (84.9%) | | 0.862 | RC** | – |
| Taking chloroquine | 45 (2.4%) | 42 (2.4%) | 3 (2.0%) | | 0.739 | RC** | – |
| Being young | 30 (1.6%) | 26 (1.5%) | 4 (2.6%) | | 0.277 | RC** | – |

Subtitle: *p<0.05: Fisher exact test or Pearson chi-square test; **Considering only those who declared yes or no; RC: reference category of multivariable analysis; RC**: reference category of multivariable analysis is professionals who do not respond to this item.
TABLE 4: Perceptions of people who had symptoms regarding seroconversion in teachers and school employees during the first wave of the COVID-19 pandemic in the city of Fortaleza, Brazil.

| Perception of the symptomatic | Total | IgG COVID-19 | p-Value |
|-------------------------------|-------|--------------|---------|
|                               |       | Negative     | Positive|         |
| Symptoms                      |       |              |         |
| Chills                         | 115 (6.1%) | 90 (5.1%) | 25 (16.4%) | <0.001 |
| Diarrhea                      | 79 (4.2%) | 65 (3.7%) | 14 (9.2%) | 0.001  |
| Difficulty breathing          | 104 (5.5%) | 77 (4.4%) | 27 (17.8%) | <0.001 |
| Headache                      | 47 (2.5%) | 40 (2.3%) | 7 (4.6%) | 0.078  |
| Sore throat                   | 62 (4.0%) | 56 (3.9%) | 6 (4.9%) | <0.001 |
| Pain in the body              | 189 (9.9%) | 145 (8.3%) | 44 (28.9%) | <0.001 |
| Fever                         | 209 (11.0%) | 159 (9.1%) | 50 (32.9%) | <0.001 |
| Loss of sense of smell        | 223 (11.7%) | 164 (9.4%) | 59 (38.8%) | <0.001 |
| Loss of taste                 | 233 (12.3%) | 176 (10.1%) | 57 (37.5%) | <0.001 |
| Cough                         | 173 (9.1%) | 134 (7.7%) | 39 (25.7%) | <0.001 |
| If you have had symptoms, have taken any medication |       |              |         |
| No                            | 73 (17.4%) | 63 (18.6%) | 10 (12.3%) | 0.180  |
| Paracetamol                   | 107 (25.5%) | 83 (24.6%) | 24 (29.6%) | 0.347  |
| Azithromycin                  | 169 (40.3%) | 129 (38.2%) | 40 (49.4%) | 0.065  |
| Hydroxychloroquine/chloroquine| 26 (6.2%) | 18 (5.3%) | 8 (9.9%) | 0.127  |
| Dipyrone                      | 147 (35.1%) | 116 (34.3%) | 31 (38.3%) | 0.503  |
| Ivermectin                    | 116 (27.7%) | 89 (26.3%) | 27 (33.3%) | 0.206  |
| Zinc                          | 50 (12.1%) | 37 (11.1%) | 13 (16.3%) | 0.202  |
| It is possible to avoid the disease |       |              |         |
| I don’t know                  | 182 (9.6%) | 166 (9.5%) | 16 (10.5%) | 0.893  |
| No                            | 104 (5.5%) | 94 (5.4%) | 10 (6.6%) |         |
| Maybe                         | 597 (31.4%) | 550 (31.4%) | 47 (30.9%) |         |
| Yes                           | 1018 (53.6%) | 939 (53.7%) | 79 (52.0%) |         |
| Looked for a doctor           | 156 (70.0%) | 115 (67.3%) | 41 (78.8%) | 0.110  |
| Had COVID-19                  | 409 (21.5%) | 328 (18.8%) | 81 (53.3%) | <0.001 |
| Laboratory confirmation COVID-19 | 76 (34.9%) | 56 (33.7%) | 20 (38.5%) | 0.533  |
| You think you got COVID-19 from someone you know | 119 (53.4%) | 86 (50.3%) | 33 (63.5%) | 0.096  |

Subtitle: *p<0.05, Fisher’s exact test or Pearson’s chi-square test.

found in this study. A possible explanation for this low prevalence is that some teachers were working remotely at the time of the research. Another explanation for this difference is that we did not perform IgM antibody detection.

Prevalence studies conducted during the first wave of the disease reported varying results owing to the population studied, sampling, and type of laboratory test used. In this study, most factors associated with SARS-CoV-2 infection were identified outside the workplace, suggesting that current infection prevention strategies within schools can be effective in preventing transmission in the workplace.

These assays detected the presence of antibodies, but neutralization assays would be fundamental and complementary in determining the functional role of antibodies in immune protection.

This study showed that almost half of the IgG-positive cases were asymptomatic. Anosmia and ageusia predominated among the symptomatic cases. A study conducted by a private laboratory in the city of Fortaleza showed that 18.8% of the reported cases were asymptomatic. Among those who reported symptoms, the most frequently reported symptoms were headache (36.40%), cough (29.62%), weakness (25.68%), and fever (27.42%).

The percentage of asymptomatic patients was consistent with that reported in the literature. Therefore, it is important to continue to reinforce the need for the correct use of proper face masks by professionals, as asymptomatic cases may suggest a lower antibody response and titers decrease more quickly. However, due to the large number of asymptomatic cases or mild infections and the difficulty of access to laboratory diagnosis in developing countries such as Brazil, the available data of laboratory-confirmed cases do not capture the true extent of virus spread. Therefore, the serological detection of specific antibodies against SARS-CoV-2 can be used to better estimate the true number of infections.

The current evidence shows that schools have not evolved into silent hotspots of SARS-CoV-2 transmission. This is especially important as there are severe adverse effects of prolonged
TABLE 5: Influence of professional profile on seroconversion in school teachers and employees during the first wave of the COVID-19 pandemic in the city of Fortaleza, Brazil.

| Professional Profile | Total | Function |
|----------------------|-------|----------|
|                      |       | Teacher  | Collaborator |
| Shift work           |       |          |              |
| Morning              | 1615  | 738 (83.9%) | 877 (85.9%)  |
| Afternoon            | 1358  | 541 (61.5%) | 817 (80.0%)  |
| Night                | 351   | 185 (21.0%) | 166 (16.3%)  |
| Number of shifts you work |       |          |              |
| <1                   | 2     | 1 (0.1%)  | 1 (0.1%)    |
| 1                    | 610   | 359 (40.8%) | 251 (24.6%)  |
| 2                    | 1153  | 455 (51.7%) | 698 (68.4%)  |
| 3                    | 136   | 65 (7.4%)  | 71 (7.0%)   |
| Time spent teaching in the classroom£ |       |          |              |
| Up to 5 years        | 199   | 199 (23.0%) | 0 (0.0%)    |
| 6–10 years old       | 238   | 237 (27.4%) | 1 (100.0%)  |
| 11–20 years old      | 247   | 247 (28.6%) | 0 (0.0%)    |
| >20 years            | 182   | 182 (21.0%) | 0 (0.0%)    |
| Transportation used to go to work |       |          |              |
| Bicycle              | 52    | 6 (0.7%)  | 46 (4.5%)   |
| Hitchhiking with co-workers |     | 87 (4.6%) | 47 (5.3%)  |
| Car alone            | 873   | 601 (68.3%) | 272 (26.7%)  |
| Motorcycle with co-worker |   | 26 (1.4%) | 3 (0.3%)  |
| Motorcycle alone     | 101   | 27 (3.1%)  | 74 (7.3%)   |
| Collective Transportation | 606 | 123 (14.0%) | 483 (47.4%)  |
| Other                | 155   | 73 (8.3%)  | 82 (8.0%)   |
| Was removed from classroom activities during quarantine |       |          |              |
| No                   | 493   | 232 (26.4%) | 261 (25.6%)  |
| Yes                  | 1407  | 648 (73.6%) | 759 (74.4%)  |
| Has health insurance | 1462  | 789 (89.8%) | 673 (65.9%)  |
| Works in more than one institution | 245 | 213 (24.2%) | 32 (3.1%)   |

Subtitle: *p<0.05, Fisher’s exact test or Pearson’s chi-square test; £For faculty only.

school closure, especially on populations that are more socially vulnerable	extsuperscript{21,24}. Furthermore, we cannot fail to mention that in socially disadvantaged contexts, even with school closure, social contacts and non-school encounters continue	extsuperscript{25}, thus reducing the potential benefit of school closure.

Our findings showed that those with higher education had a lower chance of a previous infection. This probably occurred because those with higher education had more access to information and, consequently, to disease prevention measures, such as social distancing, use of masks and changing them within the period established by the competent bodies, use of face shields as physical barriers, and respiratory etiquette, among others recommended by the Brazilian Ministry of Health	extsuperscript{12}. Furthermore, the greater adherence and compliance to safety rules by education professionals is notable.

Even in the scenario of high SARS-CoV-2 transmission, the spread within schools was very low. Modelling studies on the effect of school closure often rely on strong theoretical assumptions that do not easily adequately control for important confounders because of their ecological nature and, despite being interesting from a scientific point of view, they should not replace studies based on prospectively collected data. Schools should not be closed for a prolonged period, as they lead to overall harmful consequences on health, society, and the economy, in addition to increasing the existing inequalities between public and private education networks	extsuperscript{26-28}. As evidence for COVID-19 evolves, there is heightened awareness of the disproportionate impact on the school community resulting from the closure of schools and an intensified call to reopen schools safely	extsuperscript{29}.

The need to respond to the pandemic has led to the closure of school buildings across the country, with little time to ensure continuity of instruction or to create a framework for deciding when and how to reopen schools	extsuperscript{30}. This was the first time in our country that all schools were closed for so long, which provided a unique opportunity to assess the influence of school closure not only on schoolchildren but also on the economy. A recent study conducted in the Gaza Strip highlighted the profound economic
and social consequences. As a result, parents, schools, and social organizations need to pay more attention to the psychological state of students, especially those in elementary school who have remained out of school for long. Furthermore, our study involved professionals from private schools. Even though most of them, especially teachers, were public school teachers, they may present a different socioeconomic context than those who worked exclusively in public schools.

The presence of a person with a confirmed diagnosis of COVID-19 in the home increased the chance of testing positive by more than fivefold (5.58). The attack rates among family members were higher, and this finding reinforces previous literature that indicated the importance of isolation of close contacts and the need for mask use and intradomiciliary care.

Our study showed that the population of teachers and employees of private institutions aged over 45 years showed more than twice as high positivity (2.39) compared to the younger population. These findings corroborate the literature regarding age, indicating a higher positivity among older people.

No significant sex-related difference was observed, although women represented 68% of the sample. Moreover, there were no differences in housing conditions, job function, shift, time or duration of teaching, type of transportation, area of activity in the school, and whether they were away from classroom activities. There was a higher incidence of positive COVID-19 cases in the brown and black populations. The reality of socioeconomic vulnerability is also associated with a housing issue, wherein households limited to a smaller geographic space having a high number of household contacts (above three people) worsen the spread of SARS-CoV-2. The pandemic presented deep racial and social disparities, with more severe consequences in brown and black people.

In the face of the unprecedented global health crisis in recent decades, public health authorities need seroprevalence data to estimate the exposure of the most vulnerable groups, especially in developing countries where access to molecular diagnostics is limited. These prevalence estimates should be used to calibrate the projections of the epidemic and its actual mortality rate. Several lessons have been learned over these months, and we hope that educators and decision-makers will be better prepared to act promptly in future education crises involving interrupted classroom instruction. Currently, there is broad agreement that school closures involve heavy burdens on students, parents, and the economy with profound equity implications.

Future studies should investigate the structural conditions of the school, such as the size of the physical space of the institution and the capacity of the sanitary facilities, which may favor or prevent the spread of the virus. Governments should reinforce, as soon as possible, policies that decrease transmission in the community and implement control measures within schools so that they can simultaneously address both the health crisis represented by COVID-19 and the adverse consequences of prolonged school closures. Variation across schools in this condition is an additional complication in ensuring the health of students and staff at schools. To reopen safely, schools are encouraged to ensure ventilation and air filtration, clean surfaces frequently, provide facilities for regular handwashing, and provide space for physical distancing.

During the first epidemic wave, many countries included school closures among the measures implemented to limit viral transmission. Part of this decision was based on the experience of influenza transmission in schoolchildren. With the circulation of new variants, it is critical to assess the risk of viral circulation among students and their teachers in schools, because, to the best of our knowledge, secondary transmission of SARS-CoV-2 in school settings has been limited, as reported in Australia, Ireland, and France.

It is also important to better understand the extent of infection among teachers and its role in transmission within the school, given the likely negative effects of school closures on educational performance and economic outcomes. Future decisions regarding school closures during the pandemic should give greater weight to the potential effects of school closure on children’s health.

A limitation that must be reported is that the tests may result in false negatives for very recent infections, especially in the first two weeks after infection; therefore, this prevalence would reflect the infection levels one or two weeks prior to the date of the survey. In addition, it is important to note that, at the time of the study, the expression of the new strains was quite limited, and we had not yet isolated P.1., which became predominant in February 2021. The use of online questionnaires and the convenience of sample size may have led to a bias in the results due to the interest of the persons participating in the study; however, we believe that given the high interest in the interviewees in taking the test for COVID-19, and given that the test was necessary for the return to work by the government of Ceará, this bias was minimized. In addition, the data collection of this study was carried out in a short period of time due to the need to obtain results that would enable an assessment of the association of the health situation of the employees with COVID-19. Furthermore, this study was conducted with professionals from private schools, and that its results must be extrapolated with restrictions to professionals from public schools, given the different working conditions of these professionals.

Therefore, in this new scenario, and considering the positive results of the measles vaccination, it is essential to encourage vaccination not only for teachers and adolescents but also for the pediatric population. Without a doubt, schools need to reopen safely so that they can better serve students, families, and communities that depend on them.

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