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SARS-CoV-2 seropositivity among pediatric health care personnel after the first peak of the pandemic: nationwide surveillance in Turkey



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ABSTRACT

Background: Understanding SARS-CoV-2 seroprevalence among health care personnel is important to explore risk factors for transmission, develop elimination strategies and form a view on the necessity and frequency of surveillance in the future.

Methods: We enrolled 4927 health care personnel working in pediatric units at 32 hospitals from 7 different regions of Turkey in a study to determine SARS Co-V-2 seroprevalence after the first peak of the COVID-19 pandemic. A point of care serologic lateral flow rapid test kit for immunoglobulin (Ig)M/IgG was used. Seroprevalence and its association with demographic characteristics and possible risk factors were analyzed.

Results: SARS-CoV-2 seropositivity prevalence in health care personnel tested was 6.1%. Seropositivity was more common among those who did not universally wear protective masks (10.6% vs 6.1%). Having a COVID-19-positive co-worker increased the likelihood of infection. The least and the most experienced personnel were more likely to be infected. Most of the seropositive health care personnel (68.0%) did not suspect that they had previously had COVID-19.

Conclusions: Health surveillance for health care personnel involving routine point-of-care nucleic acid testing and monitoring personal protective equipment adherence are suggested as important strategies to protect health care personnel from COVID-19 and reduce nosocomial SARS-CoV-2 transmission.

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Introduction

SARS-CoV-2 has had a huge impact on people's lives across the world since December 2019. The burden experienced by health care personnel has been particularly heavy. Apart from working against a new pathogen and trying to save lives, they have also had to protect themselves from the virus in order to continue to work and not spread the virus to their patients, colleagues, friends and families. Working on the front line, many health care personnel have lost their lives (Zhan et al., 2020). As of 1 May 2020, there were 12 526 COVID-19 related deaths among residents in care homes and hospitals of England and Wales and, as of 20 April 2020, 106 deaths among their health care personnel. In Italy, as of 1 June 2020, 27 952 health care personnel were officially recognized as COVID-19-infected by the Italian National Health Institute, and 167 physicians and 40 nurses had died (Chirico, Nucera, 2020).

It is suggested that repeated exposure to the virus during the care of COVID-19 patients increases infection risk (Chou et al., 2021; Ran et al., 2020). Studies have argued that it is essential to determine the risk factors for health care personnel in order to take precautions to minimize that risk (Zhan et al., 2020; Abou-Abbas et al., 2020). Furthermore, COVID-19 has been proposed as an occupational injury and is already accepted as such in Italy

(Chirico and Magnavita, 2020a). Since the beginning of the pandemic, detection of SARS-CoV-2 RNA has been the standard approach for COVID-19 diagnosis (CDC a 2020). Unlike nucleic acid tests designed to detect SARS-CoV-2 genetic material during acute infection, serological assays measure antibodies that remain detectable after acute infection, thus providing a useful method to detect cases that were not identified during the acute infectious phase (Li, 2020). Numerous point of care serological tests have been developed since the beginning of the pandemic with variable sensitivity and specificity.

With this multicenter study, we aimed to determine seropositivity early in the pandemic to explore potential risk factors for transmission among health care personnel, develop elimination strategies and form a view on the necessity and frequency of surveillance for future pandemic periods. We conducted the study solely on health care personnel working with children. Since the beginning of the pandemic, children are considered to be mildly affected (Abbasi et al. 2020; CDC b 2020; Dong et al., 2020) compared with adults for reasons that are still obscure, and they are less likely to transmit the infection (Wu, McGoogan, 2020).

Consensus agreements were obtained from all 32 centers, and the study was approved by the Institutional Review Board and the Ethics Committee of Hacettepe University (approval number 2020/11-57)

Material and method

Design and setting

We conducted a cross-sectional seroprevalence study for antibodies to SARS-CoV-2 among health care personnel working in pediatric units at 32 hospitals from 7 different regions of Turkey. Study participants were enrolled between 25 May and 10 June 2020. The first confirmed case of COVID-19 was reported on 11 March 2020 in Turkey in Marmara Region, and at the time of the study, the total number of cases was 173 958; April was the peak month, with newly diagnosed cases exceeding 5000 per day.

Population: Health care personnel at each study hospital were eligible to be enrolled in the study if they regularly had direct or indirect contact with pediatric patients with COVID-19, who were cared for in the emergency department, intensive care unit, or outpatient COVID-19 units or COVID-19 wards. Physicians from professors to residents, nurses, radiology technicians and other medical staff were enrolled. Participants were informed about the study through staff meetings. Health care personnel volunteered to participate by presenting to the assigned person for each center. They were screened for inclusion criteria, gave written informed consent for volunteer participation, completed a brief survey, and underwent a prick test. Survey data included demographics, medical history, occupation, years in occupation, workplace (clean or contaminated area), working hours per week, dates and results of prior nucleic acid and serologic tests, personal protective equipment (PPE) and face shield wearing practices, adoption of social distancing, COVID-19 diagnosis in colleagues or family, and whether they believed or suspected they had previously had COVID-19. In addition, participants were asked if they had symptoms such as fever, runny nose, cough, myalgia, loss of taste and smell in the last 3 months and any contact history with a COVID-19 patient without wearing a mask.

Emergency departments, intensive care units, outpatient clinics and wards reserved for potential or confirmed COVID-19 patients were considered ‘contaminated areas’ while ‘clean areas’ were administrative areas and wards where patients who had tested negative for COVID-19 by polymerase chain reaction (PCR) were accepted.

Universal mask usage—masks worn by personnel throughout their shift and by patients >2 years old and with no contraindications where breathing would be compromised—was mandatory nationwide. The health care personnel from each center had similar working days and working hours per week (mean 24 hours/week) since 6 April 2020; physicians and nurses had the longest working hours.

Point of care testing was carried out for all participants by the same assigned person at each center.

Ecotest CE rapid test for IgM/IgG Assure Tech. Co. Ltd was used for serologic tests. The test manufacturer reports relative sensitivity and specificity for immunoglobulin (Ig)M to be 93.7% and 99%, respectively, and 98.8% and 98.7% for IgG. Tests were applied and interpreted according to the manufacturer’s instructions. IgM, IgG or both IgM and IgG positivity was considered to be a positive result.

Data analysis

All participants’ data were collected and analyzed using SPSS IBM version 26. We compared groups using Fisher’s Exact Test for categorical variables and Wilcoxon Cox for continuous variables to identify potential factors associated with positive serology.

Table 1.

Table 1
Demographic characteristics of health care personnel by profession

Occupation	Number (%)	Age Mean Years (Range)	Sex F/M	Years In Profession Mean Years (Range)	Comorbidities						Serology		
					None	HT	DM	Isupp Tx	Cancer	ESRD	Asthma	Other	Positive (N) (%)
Prof. Dr.	149 (3.1)	52.7 (42-67)	81/65	28.44 (15-44)	92	6	26	0	0	10	14	2(1.4)	146 (98.6)
Assoc. Prof. Dr.	188 (3.9)	44.17 (36-64)	134/50	20.32 (9-40)	140	10	12	2	0	7	13	13(6.9)	173 (93.1)
Asst. Prof. Dr.	149 (3.1)	36.01 (25-59)	108/41	10.64 (1-37)	116	4	8	1	0	6	13	14(10.1)	134 (89.9)
Consult. Dr.	654 (13.4)	38.64 (25-67)	395/222	13.87 (1-44)	521	20	30	4	3	26	45	41(6.9)	593 (93.1)
Resident	983 (20)	28.25 (20-34)	654/280	3.57 (0-32)	861	7	4	2	2	0	22	39(13.1)	982 (20.7)
Nurse	1702 (34.5)	32.38 (19-62)	1460/211	10.37 (1-42)	1377	34	36	11	9	68	157	122(7.3)	1677 (92.7)
Others	1079 (22)	37.77 (19-64)	622/42	10.88 (0-39)	841	40	34	6	8	50	87	61(5.7)	994 (93.4)

F: Female
M: Male
HT: Hypertension
DM: Diabetes mellitus
Isupp tx: Immunosuppressive treatment
ESRD: End-stage renal disease

Table 2
Demographic characteristics of health care personnel by seroconversion

Characteristics of personnel (n=4927)	Serology+ n (%) = 299 (6.1)	Serology – n (%) = 4584 (93.9)	p
Age (median) (range 9-67 years)	32	32	
F/M	229/70	3316/1268	0.1
Chronic medical conditions n (%)			
None	248 (82.9)	3757 (82)	
HT	8 (2.8)	105 (2.3)	
DM	4 (1.4)	137 (3)	
Immune suppressive treatment	3 (1)	18 (0.4)	
Cancer	1 (0.3)	22 (0.5)	
ESRD	0 (0)	1(0)	
Asthma	10 (3.3)	172(3.8)	
Other	25(8.4)	372(8)	
Primary location of clinical work, n (%)			
Contaminated Areas (ER ICU COVID Wards)	176 (60.5)	2750 (63.2)	0.35
Clean Area	115 (39.5)	1601 (36.8)	
Clinical role, n (%) 4710			
Physician, 2025 (43)	105 (36.8)	1920 (43.4)	
Nurse 1671(35.5)	123 (43.2)	1548 (35)	0.018
Other 1014 (21.5)	57 (20)	957 (21.6)	
Typical number of clinical work- days/week (median)	4	6	
Typical number of clinical work hours /week (mean+SD)	25.74±31.7	23.88±29.41	
Did not universally use a surgical mask, N-95 respirator, or PAPR during all clinical encounters, n (%)	18 (10.2)	279 (6.4)	0.036
Did not use face shield, n (%)	153 (52.3)	1833 (42.3)	0.001
Did use face shield n (%)	138 (47.4)	2496 (57.7)	
Social distancing			
Yes	277 (93.3)	4135 (93.7)	0.7
No	20 (6.7)	277 (6.3)	
Participant's belief he/she had COVID-19			
Yes	114 (38.1)	999 (22.7)	
No	183 (6)	3405 (77.3)	
SARS Co-V-2 + co-worker contact	132 (44.4)	1669 (37.8)	
SARS Co-V-2 + household contact	37 (12.5)	105 (2.4)	
Previous SARS Co-V-2 PCR			
positive	69 (23.2)	120 (2.7)	
negative	74 (24.9)	1264 (28.7)	
not done	154 (51.9)	3027 (68.6)	
Geographic distribution			
Middle Anatolia region	31 (4.4)	668 (95.6)	
Marmara region	133 (6.9)	1806 (93.1)	
Aegean region	25 (3)	820 (97)	
East Anatolia region	13 (5.2)	236 (94.8)	
South-east Anatolian region	68 (12)	500 (88)	
Black Sea region	13 (6.4)	190 (93.6)	
Mediterranean region	3 (1.5)	202 (98.5)	
Years in profession			
1-5 years	124 (42.9)	1834 (42.4)	
5-10 years	61 (21.1)	855 (19.7)	
10-20 years	61 (21.1)	1057 (24.4)	
>20 years	43 (14.9)	585 (13.5)	

n: Number

HT: Hypertension

DM: Diabetes mellitus

Isupp tx: Immunosuppressive treatment

ESRD: End-stage renal disease

Results

We enrolled 4927 health care personnel, all working in pediatric units, including 2123 (43.1%) physicians, 1702 (34.5%) nurses and 1079 (21.9%) other health care personnel, from 32 hospitals in 20 cities, across 7 regions throughout Turkey. The median number of participants was 171 (34–289) from each center. The study was carried out at the end of the third month and the beginning of the fourth month of the pandemic, just after national cases had reached peak numbers. Most personnel were young adults (median age 32 years; range 19–67 years, mean age 34.4) without chronic illness; 80.3% (n=3958) had no comorbidities. Among enrolled personnel, 2854 (57.9%) worked primarily in contaminated areas and 1720 (34.9%) in clean areas. A total of 299 (6.1%) tested

seropositive for SARS-CoV-2, of whom the most affected group was nurses (41.4%), followed by physicians (38.0%). The brief survey results in Table 2 show that seropositive and negative participants were similar in age, sex, working areas, and comorbidities, except for diabetes mellitus (n = 21), which was more frequent in the seronegative group (n = 18, 3.1%). Seropositive participants worked a median 4 days per week while seronegative participants worked 6; however, working hours were similar (mean 24 hours/week). Seropositivity was more common among participants who did not universally wear protective masks, surgical masks or other (n = 180, 10.4%) versus those who did (n = 4697, 6.1%) (P = 0.036). Seropositivity was lower among those who wore face shields (n=2597) than those who did not (n = 2046, 5.2% vs 7.7%, P = 0.001).

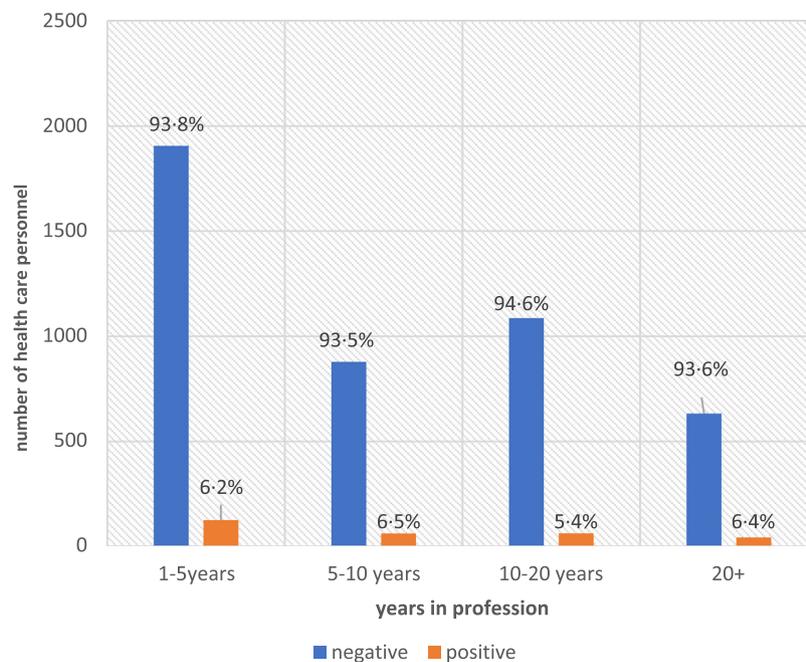


Figure 1. Health care personnel serology results by years in profession

A history of a SARS-CoV-2-positive co-worker ($n = 132$ (44.4%)) appears to increase the likelihood of seropositivity more than a household COVID-19 contact ($n = 37$, 12.5%). Only 38.4% of seropositive participants stated that they had previously had COVID-19. The total number of participants whose prior PCR test status could be retrieved was 4751 of whom 1572 (32.4%) had a prior PCR test and 189 (4.0%) were tested positive. Sixty-nine (23.2%) also tested positive for SARS-CoV-2 antibodies. Of those with a negative PCR result 74 (5.5%) tested positive for SARS-CoV-2 antibodies.

Being the least or the most experienced in the profession seemed to influence seroconversion. Participants with 1–10 years in the profession had the highest positivity rate (6.5%) for SARS-CoV-2 antibodies, followed by participants with >20 years in the profession (6.2%). Seropositivity for those in their first 1–5 years of the profession was high (6.2%), only decreasing at the 10–20 year interval (5.4%) (Figure 1).

Seropositivity also varied by region of the country. The highest seropositivity prevalence was in South East Anatolia, followed by Marmara region; the Aegean and Mediterranean regions had the lowest prevalence (Figure 2).

Discussion

Among 4927 health care personnel from 32 centers distributed throughout 7 regions in Turkey with mild to moderate local SARS-CoV-2 activity, 299 (6.1%) tested seropositive for SARS-CoV-2 69 days after the first national COVID-19 case was reported and 30 days after the peak of the first wave in Turkey at 5234 new cases per day (Figure 2).

Only 38.0% of the healthcare personnel who had antibodies detected reported any symptoms consistent with SARS-CoV-2 or believed they had previously had COVID-19. The percentage of asymptomatic SARS-CoV-2 infected people is estimated to be approximately 40%–45% (Oran and AM, 2020; CDC, 2020). Our study revealed a higher percentage of asymptomatic cases; potentially, healthcare personnel might have underestimated mild symptoms or attributed them to tiredness.

Only 1527 (31%) healthcare personnel had prior PCR testing for SARS-CoV-2; all were either symptomatic or with an unpro-

tested close contact history with a confirmed COVID-19 case. Only 23.2% of participants with PCR-positive tests had antibodies against SARS-CoV-2. Among participants who tested PCR-negative, 5.5% were seropositive. It has been suggested that health care providers should undertake regular serological testing and symptom monitoring to protect health care personnel from the disease and prevent nosocomial transmission (Chirico et al., 2021).

Our study showed that health care personnel with 5–10 years of experience and >20 years of experience had similar seropositivity for SARS-CoV-2, with a tendency towards seropositivity among inexperienced personnel. Although working hours are the same but inexperienced personnel usually do most of the work had more patient contact, potentially impacting seropositivity. High seropositivity among health care personnel with >20 years of experience might be due to overconfidence leading to laxity in self-protection. In our study, work location (clean or contaminated area) or number of working days were not associated with seropositivity. Hence, inexperience and over-experience seemed to be independent risk factors. Therefore, we should develop strategies to educate less experienced personnel and warn the most experienced about self-protection. Widespread health surveillance of health care personnel should also be considered as a strategy to protect health care workers and prevent transmission. Conducting health surveillance programs with the intervention of occupational health professionals in the hospital setting could prevent both workers and patients from getting sick (Chirico, Magnavita, 2020b).

Although not statistically significant ($P=0.024$), personnel who did not universally wear a mask, surgical mask or PPE tested positive for SARS-CoV-2 antibodies more frequently. In addition, those who did not wear face shields tested positive more often than those who did.

Colleagues rather than household contacts led to infection more frequently among those who tested positive for SARS-CoV-2 antibodies.

One of the study's limitations is that we did not ask for the prior PCR test timing. Most health care personnel with PCR positivity were seronegative. Either these people did not develop antibodies at all, or the antibodies declined to levels that could not be measured with the test kit we used (Patel et al., 2020). In

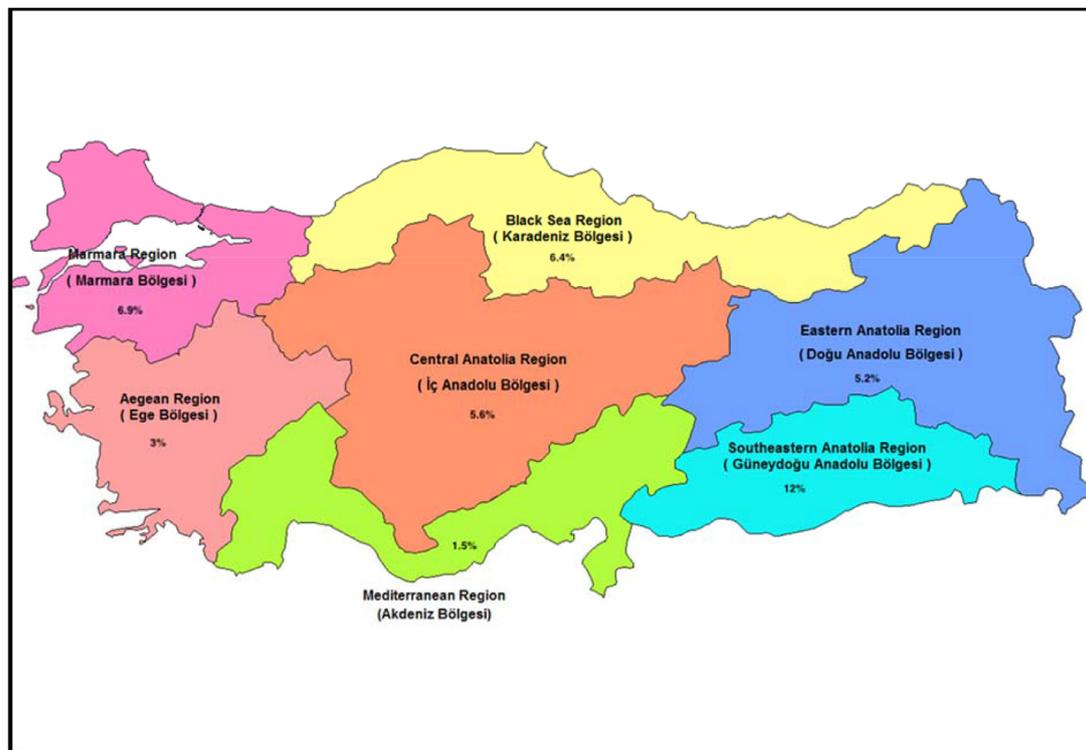


Figure 2. Distribution of seroprevalence of health care personnel by region

our study 6.1% of health care personnel had SARS-CoV-2 antibodies within 3–4 months of COVID-19 being reported nationally. The majority with positive serology tests did not suspect that they had been infected nor had been tested for SARS-CoV-2 with PCR. In conclusion, our study results suggest that developing health surveillance strategies for health care personnel involving routine point-of-care nucleic acid testing and monitoring PPE adherence would be important to protect health care personnel from COVID-19 and reduce nosocomial SARS-CoV-2 transmission.

Conflict of interest

All contributing authors declare no conflict of interest.

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