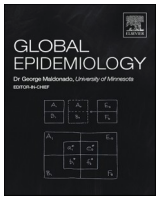
Global Epidemiology 8 (2024) 100149

Contents lists available at ScienceDirect

Global Epidemiology

journal homepage: www.sciencedirect.com/journal/global-epidemiology



SARS-CoV-2 infection prevalence, risk factors, and outcomes among non-clinical-related service providers in a national healthcare system

Moza Aishaq [a], Hanaa Nafady-Hego [b,c], Fatma Ben Abid [d,e], Jameela Ali Al Ajmi [a], Wedad S. Hamdi [a], Suni Vinoy [a], Anil George Thomas [a], Saddam Alrwashdh [a], Mohamed Shaheen [a], Tintu Elizabeth Mathew [a], Mohamed Elgendy [f], Sam Joseph [a], Christymol Thomas [a], Anju K. Alex [a], Asmaa Nafady [g], Peter V. Coyle [a], Hamed Elgendy [a,d,h,*]

[a] *Hamad Medical Corporation, Doha, Qatar*
[b] *Microbiology and Immunology Department, Faculty of Medicine, Assiut University, Assiut, Egypt*
[c] *Laboratory department, Al Tahrir medical center, Doha, Qatar*
[d] *Weill Cornell Medicine – Qatar, Doha, Qatar*
[e] *Division of Infectious Diseases, Department of Medicine, Hamad Medical Corporation, Doha, Qatar*
[f] *Faculty of Medicine, Universiti Sains of Malaysia, Kelantan, Malaysia*
[g] *Clinical and chemical pathology department, faculty of medicine, South Valley University, Qena, Egypt*
[h] *Anesthesia Department, Faculty of Medicine, Qatar University, Doha, Qatar*

ARTICLE INFO

Keywords:
COVID-19
Non-clinical staff
Qatar

ABSTRACT

Health care workers (HCWs) may be at a variable risk of SARS-CoV2 infection. Regardless of their involvement in providing direct clinical treatment, most of the prior research had included all HCWs. Understanding infection rates, risk factors and outcomes among different subgroups of HCWs is crucial. From February 28, 2020 to January 1, 2022, we conducted a retrospective analysis encompassing all full-time non-clinical staff (NCS) subcontracted with Hamad Medical Corporation (HMC) facilities. To determine current or previous SARS-CoV2 infection, all personnel underwent RT-PCR and/or serology testing. To identify the demographic factors linked to the risk of infection, we utilized Cox-Hazard regression analysis. Herein 3158/6231 (50.7%) subcontracted NCS tested positive for SARS-CoV-2 by RT-PCR or serology during the research period. The median age was 30 years (IQR 25,35), 69.8% of the population were males, 82.4% were from South Asia, 86.6% did not have any concomitant conditions. 6032 (96.8%) of the population lived in shared housing, while 4749 (76.2%) had low to median levels of education. While infection (PCR positive with or without seropositive results) was independently predicted by male gender, working in the catering, laundry, and security sectors and being intermediate (7–12 years of education), lower (0–6 years of education), higher (exposure to confirmed case), and having symptoms. Male gender, working in the security sectors and being intermediate (7–12 years of education) were independently associated with accidently detected cases (PCR negative and seropositive). 299 (4.8%) required hospitalization, of them 3 cases were severe pneumonia and one required ICU admission without mechanical ventilation, with no deaths reported. In conclusion Infection rates among NCS are high. The majority are asymptomatic and may contribute to ongoing illness spread in the public or in healthcare facilities. During a pandemic, routine screening of this population is crucial and may aid in containing the spread of infection.

Introduction

Due to their frequent exposure to and close contact with patients who have the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2 virus), healthcare workers (HCW) may be more susceptible to becoming infected. Despite this, numerous studies have shown that the infection rate among HCWs is lower, which is probably because they are more aware of and employ stringent infection prevention and control procedures [1]. HCWs, however, are a heterogeneous group with a range of patient contact levels and clinical and non-clinical activities.

* Corresponding author at: Hamad Medical Corporation, Doha, Qatar.
E-mail address: helgendy2@hamad.qa (H. Elgendy).

https://doi.org/10.1016/j.gloepi.2024.100149
Received 29 October 2023; Received in revised form 28 May 2024; Accepted 12 June 2024
Available online 13 June 2024

Using RT-PCR or serological testing, Al-Kuwari et al. revealed that HCWs in clinical roles had a reduced risk of infection in basic health care centers. When compared to the average attack rate of non-clinical employees, which ranged from 29.5 to 100%, the average attack rate among clinical staff was between 6 and 12%, which is much lower [2].

A further study by Al Ishaq et al. showed that the rate was lower among HCWs who provided direct clinical care and that non-clinical staff (NCS) were more likely to contract an infection outside of the workplace [1]. The incidence and risk factors for SARS-CoV-2 infection among different NCS working in healthcare institutions are poorly understood. The degree of exposure to patients may vary even within such NCS depending on the precise nature of their position. Additionally, due to disparities in social, economic, and cultural characteristics, the risk of exposure among these employees working outside of healthcare institutions may range dramatically from that of the clinical personnel. Understanding the rates and risk factors of infection among sub-groups of HCWs is crucial since the risk of SARS-CoV-2 virus transmission is bi-directional, meaning that it can occur from patients to HCWs as well as from HCWs to patients.

The ancestral virus was the primary cause of SARS-CoV-2 incidence during the research period. But over time of the study, several variations—alpha, beta, delta were reported. The pandemic was divided into several stages according to the frequency of SARS-CoV-2 infections and the most common variation. These phases included the following: the ancestral virus wave (February 28, 2020 - July 31, 2020) [3] a prolonged low incidence ancestral virus phase (August 1, 2020 - January 17, 2021) [4] the alpha wave (January 18, 2021 - March 7, 2021) [5] the beta wave (March 8, 2021 - May 31, 2021), [6] a prolonged low incidence delta phase (June 1, 2021 - December 18, 2021), [7].

Methods

Study population and setting

We conducted a retrospective analysis of all SARS-CoV-2 testing information from full-time, outsourced NCS who were subcontracted to provide a variety of non-clinical activities at a national healthcare system (Hamad Medical Corporation, HMC) in Qatar between February 28, 2020, and January 1, 2022. HMC runs 14 healthcare facilities, including specialty care hospitals and general hospitals with secondary and tertiary care. HMC is the State of Qatar's primary and largest public healthcare provider. The National Virology Laboratory, which serves as the reference lab for viral isolates for the entire State of Qatar, is also housed within HMC.

The study covered all subcontracted NCS deployed full-time at any HMC facility. All personnel were routinely tested if they reported or had any symptoms consistent with an upper respiratory tract infection, based on internal procedures and national monitoring recommendations. All staff were also required to go through screening using an RT-PCR on a nasopharyngeal swab at least once throughout the study period, and more frequently for those who worked in high-risk clinical settings including the emergency room and intensive care unit [8,9].

All travelers arriving in Qatar from abroad and contacts of known instances were subjected to additional screening [10].

In compliance with the most recent Helsinki Declaration, all tests were carried out.

The National COVID-19 database, which includes information on all residents of Qatar's demographics, testing results, and vaccinations, was used to retrieve SARS-CoV-2 RT-PCR testing data [11–13].

Medical record examinations provided further information on the presence of comorbidities, symptoms, exposure to SARS-CoV-2 cases, housing situation, and employment specifics.

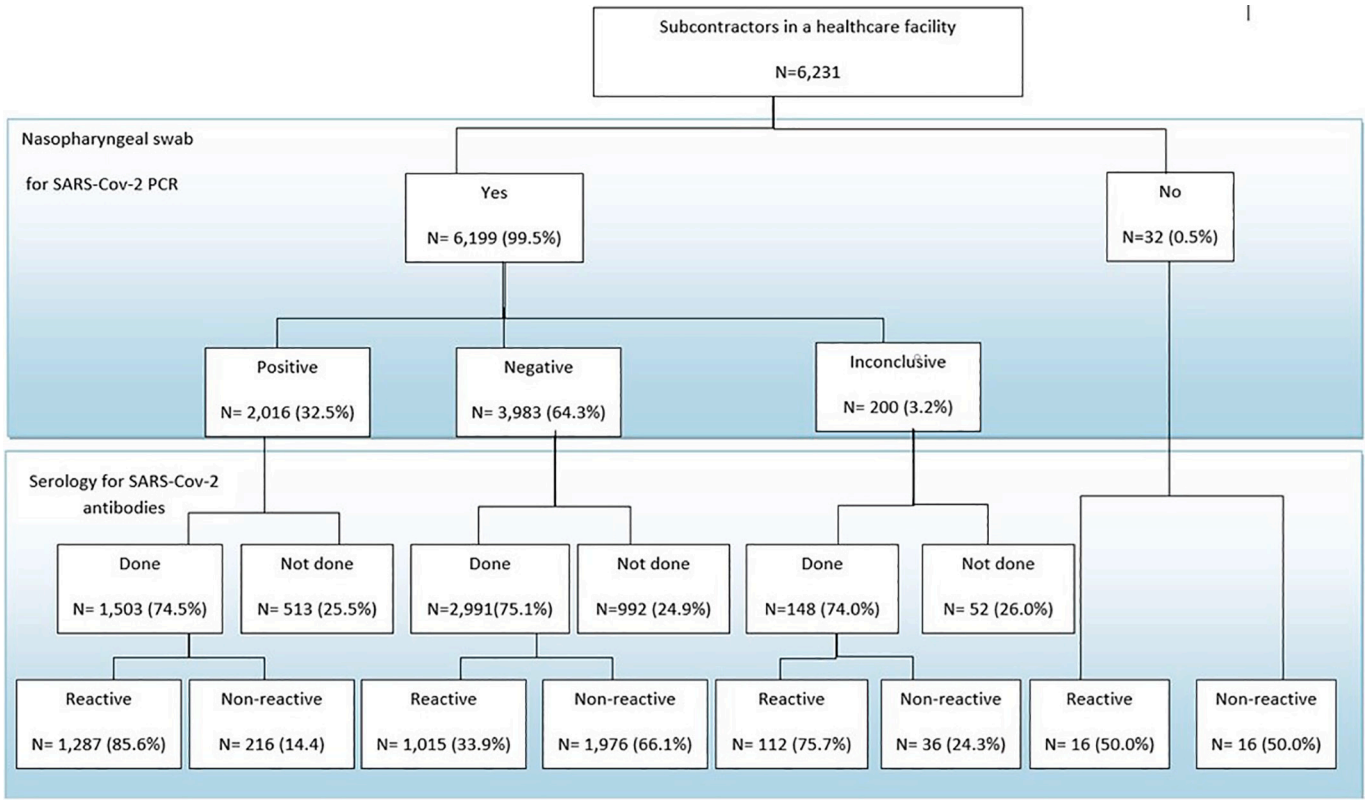


Fig. 1. Flow chart of the study.

Table 1A
Characteristics of SARS-CoV-2 infections (confirmed by RT-PCR and/or anti SARSCov-2 antibodies) phases among participants of different job titles.

	Ancestral virus wave	Ancestral virus wave*	Alpha wave	Beta wave	Delta phase	Total
No. (%)	1850 (58.6)	890 (28.2)	218 (6.9)	152 (4.8)	48 (1.5)	3158 (100)
Administration/supervisors/ managers/storekeeper/ production	124 (6.7)	78 (8.8)	27 (12.4)	12 (7.9)	7 (14.6)	248 (7.9)
Aide/ labor	68 (3.7)	15 (1.7)	5 (2.3)	0	0	88 (2.8)
Chef/ food handlers	185 (10)	76 (8.5)	11 (5.0)	12 (7.9)	2 (4.2)	286 (9.1)
Clinical services (Nasopharyngeal swab handlers)	13 (0.7)	4 (0.4)	0	0	1 (2.1)	18 (0.6)
Laundry workers (machine operator/carry/ wash/ fold/ iron)	155 (8.4)	1 (0.1)	0	2 (1.3)	1 (2.1)	159 (5.0)
Driver	27 (1.5)	35 (3.9)	1 (0.5)	1 (0.7)	0	64 (2.0)
Customer service/ receptionist/ waiters/ Janitor/ uniform attendee	287 (15.5)	176 (19.8)	28 (12.8)	17 (11.2)	8 (16.7)	516 (16.3)
Engineer/ technician/ OCTU operators)	39 (2.1)	9 (1.0)	6 (2.8)	2 (1.3)	2 (4.2)	58 (1.8)
Security guards	101 (5.5)	178 (20.0)	0	5 (3.3)	3 (6.3)	287 (9.1)
Housekeeping	851 (46)	318 (35.7)	140 (64.2)	101 (66.4)	24 (50.0)	1434 (45.4)

* Prolonged low incidence ancestral virus wave.

Definitions

Non-frontline HCWs hired by contractual businesses outside of HMC and employed by HMC are referred to as subcontractors at HMC. Based on their job descriptions, we divided full-time subcontracted NCS at HMC into the following categories: housekeeping (HS), security (SS), catering (CS), laundry (LS), and others (OS). Low educational attainment (0–6 years), medium educational attainment (7–12 years), and high educational attainment (13 years and above) were used to categorize the degree of education. Housing situations were divided into three categories: single-occupancy housing, shared living with immediate family, and shared housing with non-family. It should be noted that shared housing with non-family members is typically congested. A positive PCR test for SARS-CoV2 >90 days after the initial RT-PCR was considered a sign of reinfection (Ct 35) [14].

Testing

According to the guidelines, nasopharyngeal swabs were taken for RT-PCR testing. All subcontracted employees were given the option to have their serum tested for SARS-CoV-2 antibodies, and those who voluntarily chose to do so were tested. The National Central Virology Laboratory at HMC served as the site for all laboratory testing. Reverse transcription polymerase chain reaction (RT-PCR) was used to test for SARS-CoV-2 using the TaqPathTM COVID-19 Combo Kit from Thermo Fisher Scientific in the United States, the AccuPower SARS-CoV-2 Real-Time RT-PCR Kit from Pioneer in Korea, or the Roche cobas1 SARS-CoV-2 Test from Roche in Switzerland. The Roche Elecsys1 Anti-SARS-CoV-2 [Roche, Switzerland] electrochemiluminescence immunoassay was used to check the serological samples for SARS-CoV-2-specific antibodies. Notably, SARS-CoV-2-specific antibodies were tested prior to Qatar's introduction of the COVID-19 vaccine. Reactive for cutoff indices >1.0 and non-reactive for cutoff indices 1.0 were the results' interpretations, respectively, as per the manufacturer's instructions. [11,15,16].

Main outcome measures

The number and percentage of NCS cases that tested positive for SARS-CoV-2 PCR on a nasopharyngeal swab was the primary outcome. In addition, we calculated the seroprevalence among those who donated blood for analysis. Additionally calculated were the quantity of hospital admissions, ICU admissions, morbidities, and fatalities.

Statistical analysis

The Mann-Whitney *U* test was used to compare the study groups, and the median and IQR [interquartile range] were used to show the quantitative results. Comparing qualitative data—which was given as frequency and percentage—with categorical data included using the chi-square test. The study of Cox-Hazard regression was performed to determine the infection risk. The multivariable model was expanded to include variables whose *p*-value was <0.1. The cutoff point for statistical significance was set at $P < 0.05$. The Statistical Package for Social Sciences (IBM-SPSS 21) was used to analyse the data. [SPSS: An IBM Company, Armonk, NY, USA; IBM Corporation, version 21.0].

Results

A total of 6231 subcontracted NCS were identified during the study period among whom 3158 (50.7%) tested positive for SARS-CoV-2 infection by either RT-PCR or serology. RT-PCR was done for 6199 subcontractors (99.5%) and was positive in 2016 (32.5%). Serology was done for 4674 subcontractors, of whom 2430 (52.0%) were reactive. Out of the 3983 with initial negative RT-PCR, serology was done for 2991 (75.1%) and it was reactive in 1015 (33.9%) Fig. 1**.** Most of SARS-CoV-2 infections occurred early on of the pandemic, with 1850 (58.6%) testing positive during the ancestral virus wave, 890 (28.2%) testing positive during Prolonged low incidence ancestral virus wave, 218 (6.9%) testing positive during the alpha wave, 152 (4.8%) testing positive during the beta wave and 48 (1.5%) testing positive during the delta wave . Our study ended on O micron wave, but no positive cases detected during that time. Cleaners were the main subcontractors of infection followed by staff working in Customer service/ receptionist/ waiters/ Janitor/ uniform attendee. The detailed pattern of infection according to the job categories in Tables 1A and 1B. Furthermore, 172 (90.5%) of infected LS, 476 (46.5%) of infected HS, 38 (27.9%) of infected OS, 34 (6.3%) of infected CS and finally 8 (6.3%) of infected SS happened during the first two months of the pandemic**.** Fig. 2.

Table 1B
Characteristics of SARS-CoV-2 infections (confirmed by RT-PCR and/or anti SARSCov-2 antibodies) phases among participants of different job categories.

	Ancestral virus wave	Ancestral virus wave*	Alpha wave	beta wave	Delta phase	Total
No. (%)	1850 (58.6)	890 (28.2)	218 (6.9)	152 (4.8)	48 (1.5)	3158 (100)
Housekeeping Staff (HS)	967 (52.3)	395 (44.4)	163 (74.8)	102 (67.1)	26 (54.2)	1653 (52.3)
Catering Staff (CS)	451 (24.4)	239 (26.9)	45 (20.6)	34 (22.4)	11 (22.9)	780 (24.7)
Security Staff (SS)	106 (5.7)	188 (21.1)	1 (0.5)	7 (4.6)	4 (8.3)	306 (9.7)
Laundry Staff (LS)	212 (11.5)	3 (0.3)	1 (0.5)	5 (3.3)	3 (6.3)	224 (7.1)
Other Staff (OS)	114 (6.2)	65 (7.3)	8 (3.7)	4 (2.6)	4 (8.3)	195 (6.2)

* Prolonged low incidence ancestral virus wave.

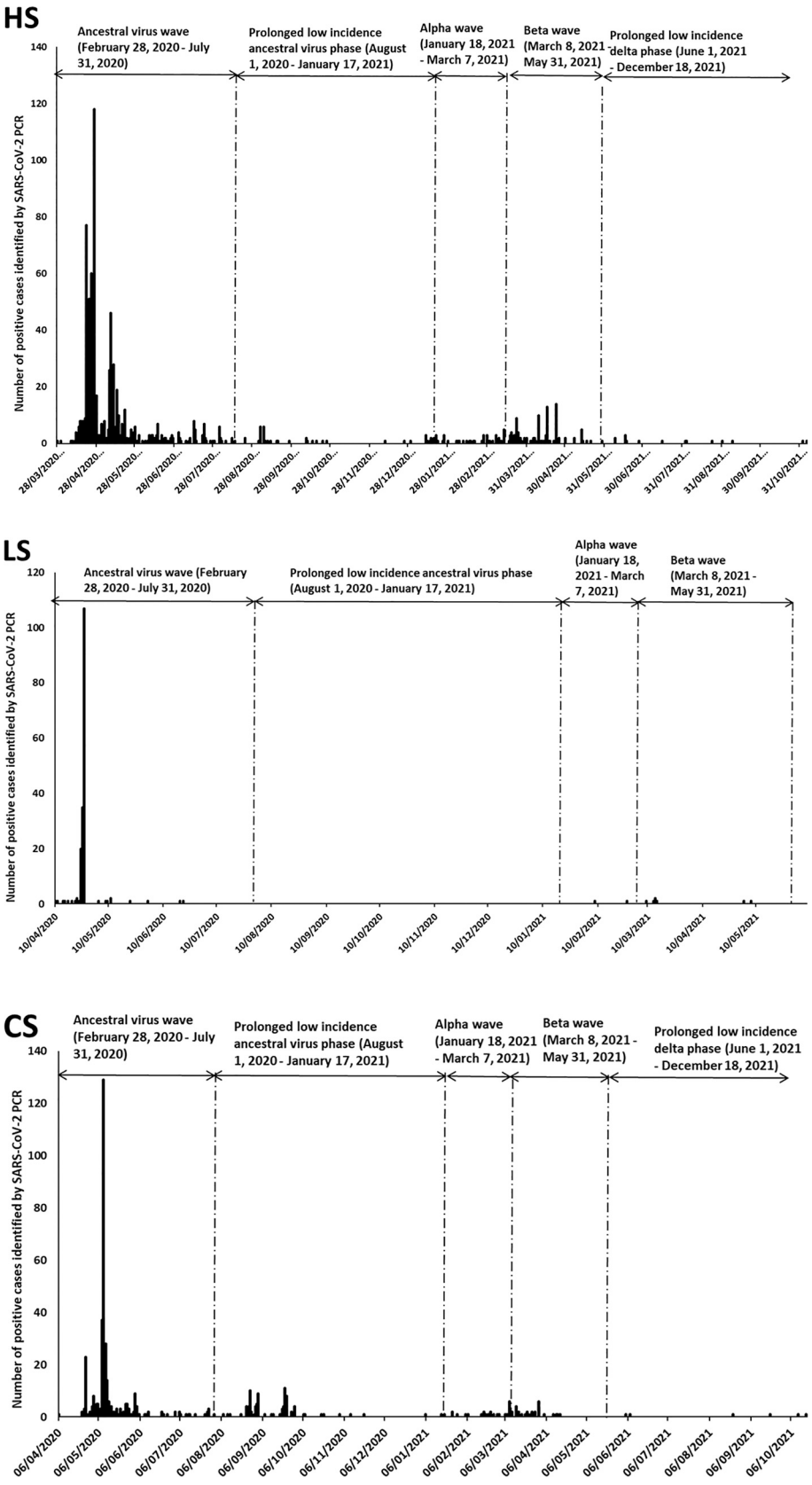


Fig. 2. Timeline for SARS-CoV-2 detected by RT-PCR among the subcontractors.

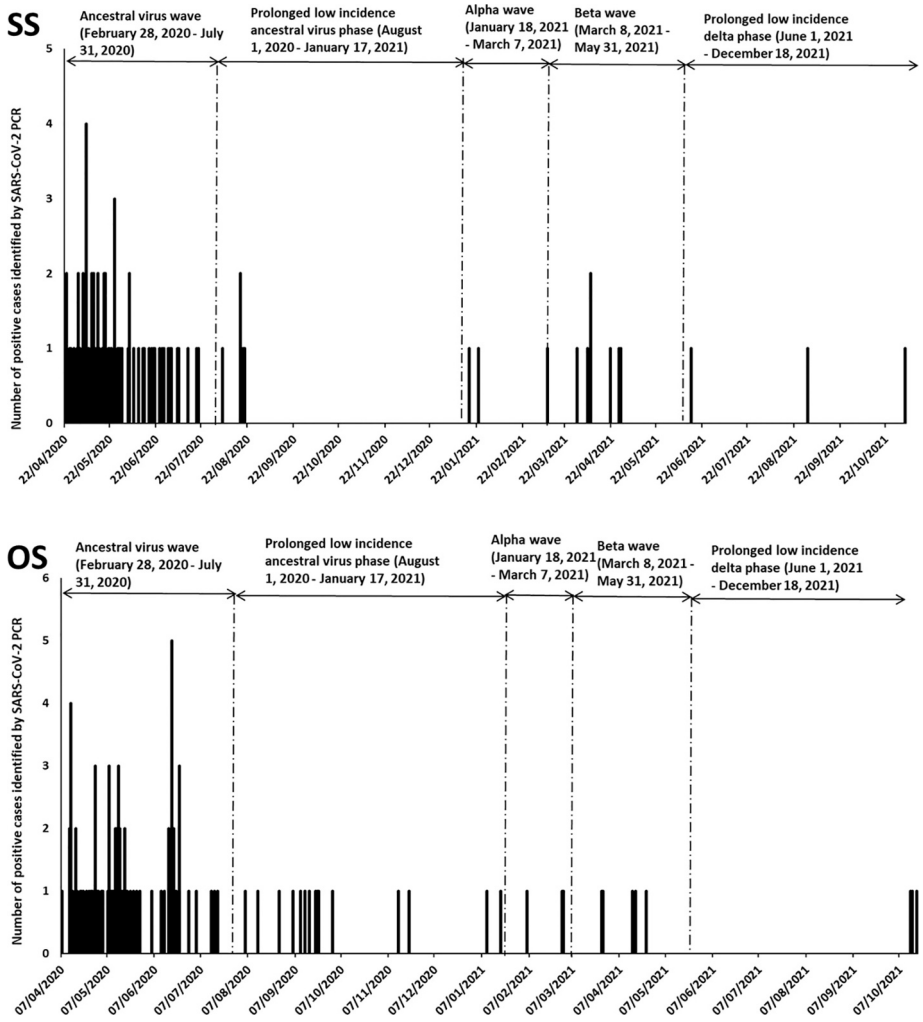


Fig. 2. (*continued*).

The baseline characteristics for all participants are summarized in Table 2. All patients with positive RT-PCR (2016) had 1858 (92.2%) without comorbidities, 1425 (70.7) with no symptoms, and 299 (14.8%) required hospitalization. Three cases were severe pneumonia and one of them needed ICU admission and developed restrictive lung disease later post COVID.

Table 3A. 2016 patients (32.5%) were detected positive for RT-PCR. Their demographics were like the general community, and 1425 (70.7%) of them were asymptomatic and 299 (14.9%) of them required hospital admission, and 13 (0.3%) of them exhibited reinfection. Table 3B. 2430 patients (52.0%) of the tested staff had positive serology results. Their demographics were like the general community, and 1964 (80.8%) of them were asymptomatic and 17 (0.7%) of them required hospital admission, and 13 (0.5%) of them exhibited reinfection Table 3C. 1015 patients (21.7%) had initial negative RT-PCR results but positive serology results. Their demographics were like the general community, and 967 (95.3%) of them were asymptomatic. Only 2 (0.2%) of them required hospital admission, and 13 (0.2%) of them exhibited reinfection. There were statistically significant differences in sex and employment type (catering and security) between individuals with positive RT-PCR results and those who only had positive serology results and negative RT-PCR results.

Comprehensive lists of connected and independent risk variables were provided in Table 4.

In Cox Hazard regression analysis, male gender [HR 2.54, 95% CI (2.22–2.89), p-value <0.001] independently predicted SARS--CoV-2 infection [PCR positive]. Compared to Nepalese [(Indian showed 16%, *p*-value =0.01; Filipino showed 32%, p-value <0.001, Kenyan showed 33%, p-value <0.001, Sri Lankan showed 29%, p-value =0.005, Tunisian showed 59%, p-value <0.001, and other nationalities showed 49% p-value <0.001, respectively) risk reduction. Compared to Housekeeping, Catering and Laundry [HR 1.16, 95% CI (1.03–1.31) and HR 2.80, 95% CI (2.35–3.34), both *p*-value <0.001] independently predicted SARS–CoV-2 infection [PCR positive] while Security showed 35%, p-value <0.001 reduced risk. In addition, 0–6 years of education [HR 1.91, 95% CI (1.62–2.24)], *p* value <0.001], 7–12 years of education [HR 1.34, 95% CI (1.16–1.54)], p-value <0.001], compared to >12 years education independently predicted SARS–CoV-2 infection [PCR positive]. contact with a confirmed case [HR 2.47, 95% CI (2.18–2.79), p-value <0.001], and presence of symptoms in the preceding 2 weeks [1–2 symptoms [HR 3.09, 95% CI (2.73–3.5), p-value <0.001], 3 or more symptoms [HR 4.14, 95% CI (3.58–4.8), p-value <0.001]. Independently predicted SARS-CoV-2 infection [PCR positive]. Similarly, male gender [HR 3.54, 95% CI (2.92–4.29), p-value <0.001] Independently predicted anti SARSCov-2 antibodies positivity (PCR negative), compared to Nepalese [(Indian showed 24%, p-value =0.02; Filipino showed 45%, p-value <0.001, Sri Lankan showed 40%, p-value =0.002, Tunisian showed 52%, p-value =0.002, and other nationalities showed 56% p-value <0.001, respectively) risk reduction, while Bangladeshi [HR 1.59, 95% CI (1.33–1.9), *p* value <0.001 independently predicted SARSCov-2 antibodies positivity (PCR negative). Compared to Housekeeping, Catering showed 42%, p-value <0.001 reduced risk while

Table 2
Baseline characteristics of all participants.

	Housekeeping Staff (HS)	Catering Staff (CS)	Security Staff (SS)	Laundry Staff (LS)	Other Staff (OS)	Total
No (%)	3343 (53.7)	1611 (25.9)	565 (9.1)	300 (4.8)	412 (6.6)	6231
Median age (IQR), years	28 (24, 34)	30 (26, 35)	32 (28, 37)	31 (26, 36)	36 (30, 44)	
Male sex (%)	2300 (68.8)	959 (59.5)	457 (80.9)	282 (94.0)	350 (85.0)	4348 (69.8)
Nationality no (%)						
Nepalese	1655 (49.5)	447 (27.7)	36 (6.4)	172 (57.3)	86 (20.9)	2396 (38.5)
Indian	422 (12.6)	225 (14.0)	40 (7.1)	37 (12.3)	139 (33.7)	863 (13.9)
Filipino	221 (6.6)	522 (32.4)	27 (4.8)	11 (3.7)	56 (13.6)	837 (13.4)
Bangladeshi	663 (19.8)	87 (5.4)	0	41 (13.7)	14 (3.4)	805 (12.9)
Kenyan	203 (6.1)	103 (6.4)	136 (24.1)	26 (8.7)	2 (0.5)	470 (7.5)
Sri Lankan	124 (3.7)	63 (3.9)	1 (0.2)	12 (4.0)	35 (8.5)	235 (3.8)
Ugandan	30 (0.9)	104 (6.5)	84 (14.9)	0	0	218 (3.5)
Tunisian	1 (0.05)	19 (1.2)	113 (20.0)	1 (0.3)	5 (1.2)	139 (2.2)
Others	24 (0.7)	41 (2.5)	128 (22.7)	0	75 (18.2)	268 (4.3)
Type of accommodation no (%)						
Single	17 (0.5)	23 (1.4)	0	7 (2.3)	23 (5.6)	70 (1.1)
Shared	3307 (98.9)	1553 (96.4)	565 (100)	288 (96.0)	319 (77.4)	6032 (96.8)
Family	19 (0.6)	35 (2.2)	0	5 (1.7)	70 (17.0)	129 (2.1)
Job category, N (%)						
Administration/supervisors/managers/storekeeper/ production	104 (3.1)	274 (17)	28 (5.0)	25 (8.3)	182 (44.2)	613 (9.8)
Aide/labor	1 (0.03)	83 (5.2)	1 (0.2)	8 (2.7)	27 (6.6)	120 (1.9)
Chef/food handlers	0	528 (32.8)	0	0	2 (0.5)	530 (8.5)
Clinical services (Nasopharyngeal swab handlers)	0	0	0	0	79 (19.2)	79 (1.3)
Laundry workers (machine operator/carry/wash/fold/ iron)	0	0	0	202 (67.3)	0	202 (3.2)
Driver	2 (0.06)	24 (1.5)	0	6 (2.0)	71 (17.2)	103 (1.7)
Customer service/receptionist/waiters/Janitor/uniform attendee	242 (7.2)	664 (41.2)	0	33 (11.0)	12 (2.9)	951 (15.3)
Engineer/technician/OCTU operators)	21 (0.6)	12 (0.7)	13 (2.3)	25 (8.3)	41 (10.0)	112 (1.8)
Security guards	0	0	523 (92.6)	0	0	523 (8.4)
Housekeeping	2972 (88.9)	27 (1.7)	0	1 (0.3)	0	3000 (48.1)
Years of education						
0–6	1920 (57.4)	159 (9.9)	6 (1.1)	24 (8.0)	18 (4.4)	2127 (34.1)
7–12	1188 (35.5)	769 (47.7)	258 (45.7)	236 (78.7)	173 (41.9)	2624 (42.1)
>12	235 (7.0)	684 (46.2)	301 (53.3)	40 (2.7)	222 (53.8)	1482 (23.8)

Table 3A
Clinical characteristics of study participants identified by PCR-SARS-CoV-2 positivity.

PCR-SARS-CoV-2 positivity						
	Housekeeping Staff (HS)	Catering Staff (CS)	Security Staff (SS)	Laundry Staff (LS)	Other Staff (OS)	Total
No. of tested	3319	1611	565	300	404	6199
PCR-SARS-CoV-2 positivity No. (%)	1024 (30.9)	539 (33.5)	127 (22.5)	190 (63.3)	136 (33.7)	2016 (32.5)
History of contact with COVID-19 confirmed cases	85 (8.3)	124 (23.0)	58 (45.7)	70 (36.8)	55 (40.4)	392 (19.4)
Clinical symptoms						
No	802 (78.3)	355 (65.9)	54 (42.5)	137 (72.1)	77 (56.6)	1425 (70.7)
One or two	142 (13.9)	106 (19.7)	34 (26.8)	35 (18.4)	25 (18.4)	342 (17.0)
Three or more	80 (7.8)	78 (14.5)	39 (30.7)	18 (9.5)	34 (25.0)	249 (12.4)
Isolation						
Home isolation	513 (50.1)	156 (28.9)	34 (26.8)	24 (12.6)	59 (43.4)	786 (39.0)
Quarantine Admission	445 (43.5)	284 (52.7)	40 (31.5)	101 (53.2)	61 (44.9)	931 (46.2)
Hospitalization	66 (6.4)	99 (18.4)	53 (41.7)	65 (34.2)	16 (11.8)	299 (14.9)
Co morbidities						
No	967 (94.4)	494 (91.7)	119 (93.7)	177 (93.2)	101 (74.3)	1858 (92.2)
One or two	53 (5.2)	42 (7.8)	8 (6.3)	12 (6.3)	31 (22.8)	146 (7.2)
Three or more	4 (0.4)	3 (0.6)	0	1 (0.5)	4 (2.9)	12 (0.6)
No. of Reinfection	8 (0.8)	1 (0.2)	1 (0.8)	3 (1.5)	0	13 (0.3)

security [HR 1.71, 95% CI (1.33–2.21), p-value <0.001] independently predicted SARSCov-2 antibodies positivity (PCR negative). 7–12 years of education [HR 1.30, 95% CI (1.08–1.56)], p-value = 0.005], compared to >12 years education independently predicted SARSCov-2 antibodies positivity (PCR negative).

Discussion

The largest healthcare facility in Qatar's largest subcategory of non-frontline HCWs was the focus of this investigation. We discovered that SARS-CoV-2 test positive was prevalent among subcontracted NCS. Even

Table 3B
Clinical characteristics of study participants identified by Anti-SARS-CoV-2 positivity.

Anti-SARS-CoV-2 positivity						
	Housekeeping Staff (HS)	Catering Staff (CS)	Security Staff (SS)	Laundry Staff (LS)	Other Staff (OS)	Total
No. of tested	1963	1506	561	261	383	4674
Anti-SARS-CoV-2 positivity No. (%)	1092 (55.6)	685 (45.5)	288 (51.3)	196 (75.1)	169 (44.1)	2430 (52.0)
History of contact with COVID-19 confirmed cases	57 (5.2)	122 (17.8)	63 (21.9)	70 (35.7)	61 (36.1)	373 (15.3)
Clinical symptoms						
No	991 (90.8)	517 (75.5)	191 (66.3)	145 (74)	120 (71)	1964 (80.8)
One or two	67 (6.1)	98 (14.3)	53 (18.4)	34 (17.3)	22 (13)	274 (11.3)
Three or more	34 (3.1)	70 (10.2)	44 (15.3)	17 (8.7)	27 (16)	192 (7.9)
Isolation						
Home isolation	4 (0.4)	5 (0.7)	0	4 (2.0)	9 (5.3)	22 (0.9)
Quarantine Admission	1085 (99.4)	675 (98.5)	288 (100)	192 (98.0)	151 (89.3)	2391 (98.4)
Hospitalization	3 (0.3)	5 (0.7)	0	0	9 (5.3)	17 (0.7)
Co morbidities						
No	1030 (94.3)	622 (90.8)	265 (92.0)	181 (92.3)	134 (79.3)	2232 (91.9)
One or two	58 (5.3)	61 (8.9)	23 (8.0)	15 (7.7)	34 (20.1)	191 (7.9)
Three or more	4 (0.4)	2 (0.3)	0	0	1 (0.6)	7 (0.3)
No. of Reinfection	8 (0.7)	1 (0.1)	1 (0.3)	3 (1.5)	0	13 (0.5)

Table 3C
Clinical characteristics of study participants identified by Anti-SARS-CoV-2 positivity and their initial PCR results were negative.

Anti-SARS-CoV-2 positivity and their initial PCR results were negative						
	Housekeeping Staff (HS)	Catering Staff (CS)	Security Staff (SS)	Laundry Staff (LS)	Other Staff (OS)	Total
No. of tested	1963	1506	561	261	383	4674
Anti-SARS-CoV-2 positivity No. (%)	556 (28.3)	213 (14.1)	159 (28.3)	32 (12.3)	55 (14.4)	1015 (21.7)
History of contact with COVID-19 confirmed cases	7 (1.3)	5 (2.3)	7 (4.4)	2 (6.2)	11 (20.0)	32 (3.2)
Clinical symptoms						
No	549 (98.7)	202 (94.8)	131 (82.4)	32 (100)	53 (96.4)	967 (95.3)
One or two	6 (1.1)	9 (4.2)	22 (13.8)	0	2 (3.6)	39 (3.8)
Three or more	1 (0.2)	2 (0.9)	6 (3.8)	0	0	9 (0.9)
Isolation						
Home isolation	555 (99.8)	213 (100)	159 (100)	31 (96.9)	55 (100)	1013 (99.8)
Quarantine Admission	1 (0.2)	0	0	1 (3.1)	0	2 (0.2)
Hospitalization	0	0	0	0	0	0
Co morbidities						
No	525 (94.4)	188 (88.3)	143 (89.9)	27 (84.4)	47 (85.5)	930 (91.6)
One or two	29 (5.2)	24 (11.3)	16 (10.1)	5 (15.6)	8 (14.5)	82 (8.1)
Three or more	2 (0.4)	1 (0.5)	0	0	0	3 (0.3)
No. of Reinfection	5 (0.9)	0	1 (0.6	2 (6.3)	0	8 (0.8)

though HCWs are a diverse community with a wide range in positivity rates between 1.6 and 34%, previous research has largely presented infection rates for HCWs as a homogenous category [8,17–20].

Since most infections happened during the era of ancestral viruses, there has been a noticeable decline in infections throughout time. This might involve several factors, such as strict infection control protocols including continuous staff training and awareness, staff compliance monitoring, immediate contact tracing, updating of visitor policies, and continuous patient and carer monitoring that was consistence with our previous finding [8,21,22]; exhaustion of susceptible among NCS as addressed in previous reports from Qatar as a suggestive of reaching the herd immunity threshold. [16,23]; change in living characteristics outside the hospital as most of NCS are living in shared hospital housing and reached their work using shared hospital transportation.

Among the nonclinical services, it's interesting to note that some jobs (like LS vs HS, SS, and CS) had lower infection rates than others. This difference can be attributed to environmental factors like the hygienic measures in place to shield laundry employees from contaminated materials. Regarding the demographics and potential risk factors for SARS-COV2 infection among non-frontline HCWs, little information is available. We discovered that a higher risk of infection was related to younger age, male sex, non-clinical employment grades, and sharing a non-family residence. Numerous investigations shown that overcrowding and poor housing conditions are linked to a higher risk of SARS-CoV2 death. [24]

For instance, across the US, there was a 50% higher risk of COVID-19 incidence (1.50, 95% CI: 1.38–1.62) and a 42% higher risk of COVID-19 mortality (1.42, 95% CI: 1.25–1.61) for every 5% increase in the percentage of households with subpar housing conditions. [25].

The increased rate of SARS-CoV2 infection among our subcontracted NCS may have been caused by sharing an overcrowded residence.

In comparison to the general population, we discovered a significant number of patients who were asymptomatic and tested positive for SARS-CoV2 infection by either RT-PCR or serology (70.7% among those who tested positive with RT-PCR and 95.3% among those who had initial negative RT-PCR and positive serology) versus 58.5% in Qatar [3].

Herein, we reported a high proportion of asymptomatic infection that may be partially explained by the young age and absence of comorbidities in our cohort. These people are likely to transfer the virus to their contacts while having no symptoms. In consistence with our finding previous reports demonstrated that the incidence of asymptomaticness in children was substantially greater than that of the elderly, at 46.7% (95% CI: 32.0 to 62.0%) and 19.7% (95% CI: 12.7 to 29.4%), respectively [26]. Moreover, another meta-analysis highlighted that the symptomaticity increased in adolescents at the age of 13.5 years (36.2%, 95% CI 26.0%–46.5%), reduced through time, and peaked at 90.5 years of age (8.1%, 95% CI 3.4%–12.7%) [27–29]. Working in the catering was associated with a risk of symptomatic infection, whereas the security sector was associated with an asymptomatic infection, when we compared the risk factors between patients who were symptomatic or highly suggestive of infection and for whom PCR was performed, and

Table 4
Factors associated with SARS-CoV-2 infection (confirmed by reverse transcriptase polymerase chain reaction and anti SARSCov-2 antibodies by multivariable Cox hazard analysis.

	SARSCov-2 PCR positivity			Anti SARSCov-2 antibodies positivity (PCR negative)		
	Multivariable Cox hazard analysis			Multivariable Cox hazard analysis		
	Hazard ratio	95% CI	p value	Hazard ratio	95% CI	p value
Age per 10 increase	1.04	0.97–1.12	0.23	0.95	0.86–1.04	0.26
Male gender	2.54	2.22–2.89	<0.001	3.54	2.92–4.29	<0.001
Nationality (comparator Nepalese)						
Indian	0.84	0.73–0.97	0.01	0.76	0.61–0.96	0.02
Filipino	0.68	0.56–0.83	<0.001	0.55	0.41–0.74	<0.001
Bangladeshi	1.08	0.95–1.2	0.24	1.59	1.33–1.9	<0.001
Kenyan	0.67	0.53–0.83	<0.001	0.88	0.69–1.13	0.32
Sri Lankan	0.71	0.56–0.90	0.005	0.60	0.44–0.84	0.002
Ugandan	0.92	0.72–1.18	0.52	1.28	0.92–1.78	0.14
Tunisian	0.41	0.25–0.66	<0.001	0.48	0.30–0.77	0.002
Others	0.51	0.38–0.70	<0.001	0.44	0.31–0.63	<0.001
Job destination (section) (Housekeeping**)**						
Catering	1.16	1.03–1.31	0.02	0.58	0.49–0.69	<0.001
Security	0.65	0.51–0.82	<0.001	1.71	1.33–2.21	<0.001
Laundry	2.80	2.35–3.34	<0.001	0.95	0.66–1.37	0.77
Others	0.88	0.71–1.09	0.24	0.90	0.67–1.21	0.49
Years of education (>12 years)						
0–6	1.91	1.62–2.24	<0.001	0.94	0.74–1.20	0.60
7–12	1.34	1.16–1.54	<0.001	1.30	1.08–1.56	0.005
History of contact with a known living SARS-CoV-2 confirmed case	2.47	2.18–2.79	<0.001	0.94	0.66–1.34	0.73
Clinical symptoms before diagnosis (comparator non)						
One or two	3.09	2.73–3.50	<0.001	0.81	0.58–1.13	0.21
Three or more	4.14	3.58–4.80	<0.001	0.80	0.41–1.57	0.52
Co morbidities (comparator non)						
One or two	0.86	7.2–1.03	0.1	1.06	0.84–1.33	0.65
Three or more	0.75	0.41–1.38	0.35	0.65	0.20–2.04	0.46

those who were asymptomatic and unintentionally found out about their prior infection. Conversely, history of contact, low education level and symptom manifestation were associated with a higher chance of SARS-CoV2 PCR positive than anti-SARS-CoV2 seropositivity.

To combat the pandemic and any other developing infectious diseases, future strategies to detect asymptomatic infections will be required, such as contact tracing, tight social distance by eliminating overcrowded accommodations, and packed public transit.

Conclusion

In this study, we concentrated on the NCS subtype of HCWs. Most individuals had no symptoms, and the infection incidence was relatively high. For this category of subcontracted NCS, infection control needs to be reevaluated and extra mitigation measures applied. To stop the spread of the SARS-CoV 2 virus or any other new infectious diseases, overcrowding in housing must be addressed. Everyone, including this group of workers, must be aware of the COVID-19 infection and get information on how to use infection control measures.

Strength and limitations

The focus on a homogenous subset of the HCWs, who are typically ignored in screening, extremely active and mobile, and can easily transmit the infection from the backdoors, is one of our study's strengths. As far as we are aware, this will be the first study focusing solely on subcontractors to be published from Qatar. An overwhelming majority of HCWs gave samples for testing, and testing was done for free. Lack of knowledge about exposure to confirmed instances and specific living situations are limitations.

Ethical approval

'Due to the retrospective nature of data collection and processing, the Institutional Review Board at HMC, Doha, Qatar (MRC-01-20-982) **approved** the study with a waiver for the informed consent requirement. In compliance with the most recent Helsinki Declaration, all tests were carried out.

Consent for publication

Not applicable.

Funding

None.

Availability of data and materials

All data are presented in the paper and available upon request from the Corresponding author: Prof. Hamed Elgendy.

CRediT authorship contribution statement

Moza Aishaq: Supervision, Resources, Project administration, Data curation, Conceptualization. **Hanaa Nafady-Hego:** Visualization, Validation, Supervision, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Fatma Ben Abid:** Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Jameela Ali Al Ajmi:** Supervision, Formal analysis, Data curation, Conceptualization. **Wedad S. Hamdi:** Methodology, Data curation, Conceptualization. **Suni Vinoy:** Methodology, Investigation, Data curation. **Anil George Thomas:** Methodology, Investigation, Data curation. **Saddam Alrwashdh:** Methodology, Investigation, Data curation. **Tintu Elizabeth Mathew:** Methodology, Investigation. **Mohamed Elgendy:** Methodology, Investigation. **Sam Joseph:** Writing – review & editing, Methodology, Investigation. **Christymol Thomas:** Methodology, Investigation. **Anju K. Alex:** Methodology, Investigation. **Asmaa Nafady:** Writing – review & editing, Investigation. **Peter V. Coyle:** Validation, Supervision, Methodology, Investigation. **Hamed Elgendy:** Writing – review & editing, Investigation, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The Ministry of Public Health in Qatar, the System-Wide Incident Command and Control Center, the Business Intelligence Unit at Hamad Medical Corporation, and all the committed frontline healthcare workers who have selflessly served and provided care and comfort to all patients in Qatar are all acknowledged for their leadership and assistance by the authors. The writers' opinions are expressed in this piece; they may not, however, represent those of the Ministry of Public Health, Hamad Medical Corporation, or any other official body.

References

[1] He L, Zeng Y, Zeng C, Zhou Y, Li Y, Xie X, et al. Positive rate of serology and RT-PCR for COVID-19 among community residents and healthcare workers in Wuhan, China. Jpn J Infect Dis 2021;74(4):333–6.
[2] Al-Kuwari MG, AbdulMalik MA, Al-Nuaimi AA, Abdulmajeed J, Al-Romaihi HE, Semaan S, et al. Epidemiology characteristics of COVID-19 infection amongst primary health care workers in Qatar: march-October 2020. Front Public Health 2021;9:679254.
[3] Abu-Raddad LJ, Chemaitelly H, Ayoub HH, Al Kanaani Z, Al Khal A, Al Kuwari E, et al. Characterizing the Qatar advanced-phase SARS-CoV-2 epidemic. Sci Rep 2021;11(1):6233.
[4] Chemaitelly H, Tang P, Hasan MR, AlMukdad S, Yassine HM, Benslimane FM, et al. Waning of BNT162b2 vaccine protection against SARS-CoV-2 infection in Qatar. N Engl J Med 2021;385(24):e83.
[5] Abu-Raddad LJ, Chemaitelly H, Ayoub HH, Coyle P, Malek JA, Ahmed AA, et al. Introduction and expansion of the SARS-CoV-2 B.1.1.7 variant and reinfections in Qatar: a nationally representative cohort study. PLoS Med 2021;18(12):e1003879.
[6] Chemaitelly H, Bertollini R, Abu-Raddad LJ. National Study Group for C-E: efficacy of natural immunity against SARS-CoV-2 reinfection with the beta variant. N Engl J Med 2021;385(27):2585–6.
[7] Tang P, Hasan MR, Chemaitelly H, Yassine HM, Benslimane FM, Al Khatib HA, et al. BNT162b2 and mRNA-1273 COVID-19 vaccine effectiveness against the SARS-CoV-2 Delta variant in Qatar. Nat Med 2021;27(12):2136–43.
[8] Alajmi J, Jeremijenko AM, Abraham JC, Alishaq M, Concepcion EG, Butt AA, et al. COVID-19 infection among healthcare workers in a national healthcare system: the Qatar experience. Int J Infect Dis 2020;100:386–9.
[9] Alishaq M, Nafady-Hego H, Jeremijenko A, Al Ajmi JA, Elgendy M, Vinoy S, et al. Risk factors for breakthrough SARS-CoV-2 infection in vaccinated healthcare workers. PLoS One 2021;16(10):e0258820.
[10] Butt AA, Al-Halabi AM, Ghazouani H, Rhouma MBH, Ayoub HH, Masoodi NA, et al. SARS-CoV-2 infection rates in air passengers arriving in Qatar. J Travel Med 2021;28(8).
[11] Coyle PV, Chemaitelly H, Ben Hadj Kacem MA, Abdulla Al Molawi NH, El Kahlout RA, Gilliani I, et al. SARS-CoV-2 seroprevalence in the urban population of Qatar: an analysis of antibody testing on a sample of 112,941 individuals. iScience 2021;24(6):102646.
[12] Butt AA, Nafady-Hego H, Chemaitelly H, Abou-Samra AB, Khal AA, Coyle PV, et al. Outcomes among patients with breakthrough SARS-CoV-2 infection after vaccination. Int J Infect Dis 2021;110:353–8.
[13] Seedat S, Chemaitelly H, Ayoub HH, Makhoul M, Mumtaz GR, Al Kanaani Z, et al. SARS-CoV-2 infection hospitalization, severity, criticality, and fatality rates in Qatar. Sci Rep 2021;11(1):18182.
[14] Yahav D, Yelin D, Eckerle I, Eberhardt CS, Wang J, Cao B, et al. Definitions for coronavirus disease 2019 reinfection, relapse and PCR re-positivity. Clin Microbiol Infect 2021;27(3):315–8.
[15] Abu-Raddad LJ, Chemaitelly H, Coyle P, Malek JA, Ahmed AA, Mohamoud YA, et al. SARS-CoV-2 antibody-positivity protects against reinfection for at least seven months with 95% efficacy. EClinicalMedicine 2021;35:100861.
[16] Jeremijenko A, Chemaitelly H, Ayoub HH, Alishaq M, Abou-Samra AB, Al Ajmi J, et al. Herd immunity against severe acute respiratory syndrome coronavirus 2 infection in 10 communities, Qatar. Emerg Infect Dis 2021;27(5):1343–52.
[17] Hildebrandt A, Hokelekli O, Uflacker L, Rudolf H, Gatermann SG. COVID-19: hotspot hospital?- seroprevalence of SARS-CoV-2 antibodies in hospital employees in a secondary care hospital network in Germany: intermediate results of a prospective surveillance study. Int J Hyg Environ Health 2021;235:113771.
[18] Suarez-Garcia I, Martinez de Aramayona Lopez MJ, Saez Vicente A. Lobo Abascal P: SARS-CoV-2 infection among healthcare workers in a hospital in Madrid, Spain. J Hosp Infect 2020;106(2):357–63.
[19] Jeremias A, Nguyen J, Levine J, Pollack S, Engellenner W, Thakore A, et al. Prevalence of SARS-CoV-2 infection among health Care Workers in a Tertiary Community Hospital. JAMA Intern Med 2020;180(12):1707–9.
[20] Caballero N, Nieto MA, Suarez-Zamora DA, Moreno S, Remolina CI, Duran D, et al. Prevalence of SARS-CoV-2 infection and SARS-CoV-2-specific antibody detection among healthcare workers and hospital staff of a university hospital in Colombia. IJID Reg 2022;3:150–6.
[21] Al Hamad H, Malkawi MMM, Al Ajmi J, Al-Mutawa M, Doiphode SH, Sathian B. Investigation of a COVID-19 outbreak and its successful containment in a long term Care Facility in Qatar. Front Public Health 2021;9:779410.
[22] Alishaq M, Jeremijenko A, Al-Kanaani Z, Nafady-Hego H, Jboor DH, Saba R, et al. Prevalence and risk factors for SARS-CoV-2 infection and seroprevalence among clinical and non-clinical staff in a national healthcare system. PLoS One 2021;16(9):e0257845.
[23] Al-Thani MH, Farag E, Bertollini R, Al Romaihi HE, Abdeen S, Abdelkarim A, et al. SARS-CoV-2 infection is at herd immunity in the majority segment of the population of Qatar. Open Forum Infect Dis 2021;8(8). ofab221.
[24] Alahmad B, Kurdi H, Colonna K, Gasana J, Agnew J, Fox MA. COVID-19 stressors on migrant workers in Kuwait: cumulative risk considerations. BMJ Glob Health 2020;5(7).
[25] Ahmad K, Erqou S, Shah N, Nazir U, Morrison AR, Choudhary G, et al. Association of poor housing conditions with COVID-19 incidence and mortality across US counties. PLoS One 2020;15(11):e0241327.
[26] Sah P, Fitzpatrick MC, Zimmer CF, Abdollahi E, Juden-Kelly L, Moghadas SM, et al. Asymptomatic SARS-CoV-2 infection: a systematic review and meta-analysis. Proc Natl Acad Sci USA 2021;118(34).
[27] Wang B, Andraweera P, Elliott S, Mohammed H, Lassi Z, Twigger A, et al. Asymptomatic SARS-CoV-2 infection by age: a global systematic review and meta-analysis. Pediatr Infect Dis J 2023;42(3):232–9.
[28] Wilmes P, Zimmer J, Schulz J, Glod F, Veiber L, Mombaerts L, et al. SARS-CoV-2 transmission risk from asymptomatic carriers: results from a mass screening programme in Luxembourg. Lancet Reg Health Eur 2021;4:100056.
[29] Grant JJ, Wilmore SMS, McCann NS, Donnelly O, Lai RWL, Kinsella MJ, et al. Seroprevalence of SARS-CoV-2 antibodies in healthcare workers at a London NHS trust. Infect Control Hosp Epidemiol 2021;42(2):212–4.