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Identifying higher risk subgroups of health care workers for priority vaccination against COVID-19

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Abstract

Background: Health care workers (HCWs) are exposed to high risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection due to close contact with infected patients in hospital. The objective of this study was to estimate the seroprevalence and to identify the exposure risk of various subgroups among HCWs to prioritize them for early vaccination.

Methods: This was a multicentre cross-sectional study conducted between 15 and 29 June 2020. A total of 987 HCWs were recruited randomly from two major tertiary-care hospitals of Peshawar city, Pakistan. The HCWs included doctors, nurses, paramedics and hospital support staff. The US Food and Drug Administration (FDA)–approved kit was used for the detection of SARS-CoV-2 antibodies.

Results: Overall, 310 (31.4%) HCWs were seropositive for SARS-CoV-2 antibodies (95% confidence interval, CI: 28.5–34.4). Seroprevalence was higher in males (33.5%) and in age group 51–60 years (40.9%). Seropositivity increased with increasing age from 8.3% in age group ⩽20 to 40.9% in 51–60 years of age group ($p < 0.05$). The highest seroprevalence was identified in paramedical staff (42·5%, 95% CI: 36.6–48.6) followed by nursing staff (38·8%, 95% CI: 32.1–45.7). In logistic regression, being a male HCW led to higher risk of seropositivity (odds ratio, OR: 1.50, 95% CI: 1·06–2.13. $p < 0.05$) compared with female staff members. The odds of seropositivity was higher in nurses (OR: 3·47, 95% CI: 1.99–6.05. $p < 0.01$), paramedical staff (OR: 3·19, 95% CI: 1.93–5.28. $p < 0.01$) and hospital support staff (OR: 2·47, 95% CI: 1.29–4.7. $p < 0.01$) compared with consultants.

Conclusion: Overall, our results concluded that nursing and paramedical staff are at higher risk and should be vaccinated on priority.

Keywords: COVID-19, health care workers, priority, subgroups, vaccination

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Introduction

Frontline health care workers (HCWs) are exposed to and at higher risk of acquiring infection in hospitals while dealing with patients suffering from highly infectious diseases.[1] During coronavirus disease 2019 (COVID-19) pandemic, HCWs have been facing a significant higher risk of contracting infection and death due to excessive COVID-19 exposure.[2] HCWs accounted for 11% of all COVID-19 cases reported in the United States according to the Centers for Disease Control and Prevention (CDC).[3] As of December 2020, there have been 154 deaths among HCWs in Pakistan, including 128 doctors and 26 paramedical staff/nurses.[4]

Reverse transcription polymerase chain reaction (RT-PCR) screening may be negative even in acute phase in certain cases.[5] Antibodies tests [anti-severe acute respiratory syndrome coronavirus

2 (SARS-CoV-2) antibodies] may be useful in diagnosing PCR negative cases and also provide information about past infection.[5,6]

HCWs have been globally identified as priority group for vaccination because of the occupational exposure risk of severity of disease transferred to patients and critical situation of the health sector.[7–9] The CDC[10] recommended that HCWs should be the first to receive vaccination against COVID-19 since their well-being and availability play a critical role in caring and treating others; hence, their protection remains a national priority.

Since the benefits of an effective vaccine for individuals and communities can result in high and widespread demand, it is important that vaccine distribution are made in ethical, transparent and scientific manner.[11] It is expected that there will be a limited initial supply of COVID-19 vaccine. Under this scenario, it is necessary to investigate how to prioritize the first available doses in order to achieve the greatest impact. The purpose of this study was to estimate the seroprevalence and to identify the exposure risk of various subgroups among HCWs that would enable the concerned authorities to prioritize them for earlier vaccination.

Materials and methods

This was a multicentre cross-sectional study conducted in two major tertiary-care hospitals (Prime Foundation group of hospitals: Mercy Teaching Hospital and Kuwait Teaching Hospital), Peshawar city Pakistan. Participants of the study were selected from a list of HCWs through simple random sampling technique. A total number of 1000 HCWs were invited to participate (500 from Mercy Teaching Hospital and 500 from Kuwait Teaching Hospital). The sampling period was from 15 to 29 June 2020. The HCWs included doctors, nurses, paramedics and hospital support staff.

Informed consent was obtained from all HCWs. The study has been approved by Institutional Review Board (IRB) of Prime Foundation, Pakistan (IRB approval no. Prime/IRB/2020-394). Data on sociodemographic characteristics were collected on a semi-structured proforma. From each study participant, 5 ml of peripheral venous blood was collected in lithium heparin tubes. Serum was separated using 2500 r/min centrifuge and stored in labelled serum cup for analysis using 20 µl serum volume while the rest was subsequently stored at –80°C temperature. COBAS e411 system was used for immunoassay.

The US Food and Drug Administration (FDA) approved kit was used for detection of SARS-CoV-2 antibodies with specificity: 100% and sensitivity: >98·8% according to the manufacturers.[12] Results were interpreted against a cut-off value of 1 AU/ml, where less than 1 AU/ml was considered negative and more than or equal to 1 AU/ml as positive.

Statistical analyses were performed using SPSS, version 24. Chi-square test was used to compare between categorical variables like gender, age groups, professional categories and seropositivity. Age was categorized into ⩽20, 21–30, 31–40, 41–50 and 51–60 years. Professional category of the HCWs was categorized as consultants, junior doctors, nursing staff, paramedical staff and hospital support staff. The logistic regression analysis was run to predict the odds of seropositivity among different professional categories. Variables with p values <0.05 in the univariable analysis were further used for a multivariable logistic regression analysis to adjust for confounder covariates like age and gender. The threshold for statistical significance was established at a p value ⩽0.05.

Results

A total number of 987 HCWs agreed to participate in this study. More than half (52.5%, $n = 519$) were younger than or equal to 30 years of age. The participants included 68% ($n = 672$) males and 32% ($n = 315$) females with a mean age of 33.2 years (standard deviation, SD: ±9.4). The professional categories of HCWs comprised 13.5% ($n = 133$) consultants, 29.9% ($n = 295$) junior doctors (trainee doctors, medical officers and house officers), 21.2% ($n = 209$) nursing staff, 27.7% ($n = 275$) paramedical staff and 7.6% ($n = 75$) hospital support staff (Table 1).

Overall, 310 (31.4%) HCWs were seropositive for SARS-CoV-2 antibodies (95% confidence interval, CI: 28.5–34.4). Seroprevalence was

Table 1. Sociodemographic characteristics and seroprevalence..

	Number of participants *N*	Seropositive *N* (%)	Seronegative *N* (%)	Seroprevalence (95% CI) binomial exact	*p* value
Overall	987	310 (31.4%)	677 (68.6%)	31.4% (28.5–34.4)	
Gender					
Male	672	225 (33.5%)	447 (66.5%)	33.5% (29.9–37.1)	<0.05[a]
Female	315	85 (27.0%)	230 (73.0%)	27.0% (22.1–32.2)	
Age groups					
⩽20	12	1 (8.3%)	11 (91.7%)	8.3% (2.1%–38.4%)	<0.05[a]
21–30	507	143 (28.2%)	364 (71.8%)	28.2% (24.2%–32.1%)	
31–40	266	90 (33.8%)	176 (66.2%)	33.8% (28.1%–39.8%)	
41–50	136	49 (36.0%)	87 (64.0%)	36.0% (27.9%–44.7%)	
51–60	66	27 (40.9%)	39 (59.1%)	40.9% (28.9%–53.7%)	
Professional category					
Consultant	133	28 (21.1%)	105 (78.9%)	21.1% (14.4–28.9)	<0.05[a]
Junior doctors	295	57 (19.3%)	238 (80.7%)	19.3% (14.9–24.3)	
Nursing staff	209	81 (38.8%)	128 (61.2%)	38.8% (32.1–45.7)	
Paramedical staff	275	117 (42.5%)	158 (57.5%)	42.5% (36.6–48.6)	
Hospital support staff	75	27 (36.0%)	48 (64.0%)	36.0% (25.2–47.9)	

CI, confidence interval.
[a]Chi-square test.

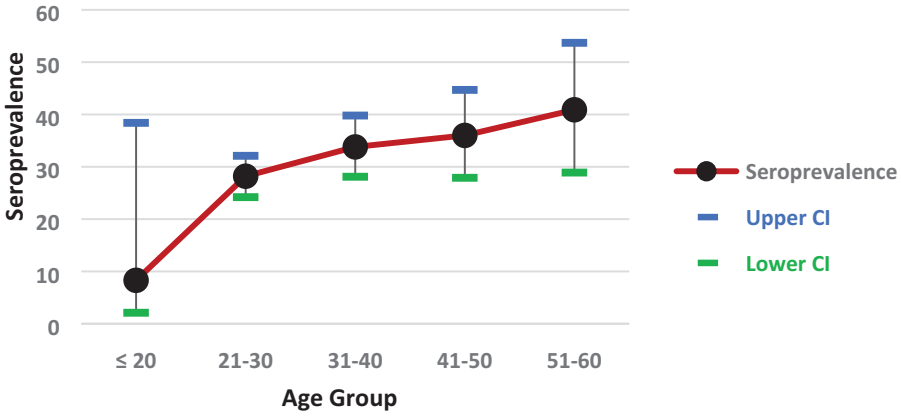
higher in males (33.5%) compared with females (27.0%) with statistical significant difference ($p < 0.05$; Table 1). Seroprevalence increased with increasing age from 8.3% in age group ⩽20 to 40.9% in 51–60 years of age group ($p < 0.05$) (Graph 1).

Seroprevalence in different professional category ranged from 19.3% (95% CI: 14.9–24.3) in juniors doctors to 42.5% (95% CI: 36.6–48.6) in paramedical staff. The highest seroprevalence was identified in paramedical staff (42.5%, 95% CI: 36.6–48.6) followed by nursing staff (38.8%, 95% CI: 32.1–45.7) and hospital support staff (36.0%, 95% CI: 25.2–47.9) while consultant and junior doctors had seroprevalence of 21.1% (95% CI: 14.4–28.9) and 19.3% (95% CI: 14.9–24.3), respectively (Table 1). The logistic regression model shows good calibration with Hosmer–Lemeshow test ($p = 0.299$).

In logistic regression, being a male HCW led to higher risk of seropositivity (odds ratio, OR: 1.50, 95% CI: 1.06–2.13, $p < 0.05$) compared with female staff members. The odds of seropositivity was higher in nurses (OR: 3.47, 95% CI: 1.99–6.05, $p < 0.01$), paramedical staff (OR: 3.19, 95% CI: 1.93–5.28, $p < 0.01$) and hospital support staff (OR: 2.47, 95% CI: 1.29–4.7, $p < 0.01$) compared with consultants (Table 2).

Discussion

Our study demonstrated a high seroprevalence rate (31.4%) of SARS-CoV-2 antibodies in HCWs. The seroprevalence was higher in age



Graph 1. Seroprevalence of SARS-CoV-2 by age group.

Table 2. Univariable and multivariable analysis of professional category with seropositivity.

Relative variable	Univariable analysis			Multivariable analysis		
	OR	95% CI	*p* value	OR	95% CI	*p* value
Age				1.01	1.01–1.03	0.02[a]
Gender						
Female (reference)						
Male	1.32	1.01–1.83	0.04[a]	1.50	1·06–2.13	0.02[a]
Professional category						
Consultant (reference)						
Junior doctor	0.89	0.54–1.49	0.67	1.25	0.71–2.20	0.42
Nursing staff	2.37	1.43–3.91	0.00[a]	3.47	1.99–6.05	0.00[a]
Paramedical staff	2.77	1.71–4.49	0.00[a]	3.19	1.93–5.28	0.00[a]
Hospital support staff	2.10	1.12–3.95	0.02[a]	2.47	1.29–4.71	0.00[a]

CI, confidence interval; OR, odds ratio.
[a]Refers to *p* value with statistically significant association.

group 51–60 years (40.9%) and in male HCWs (33.5%). The risk of seropositivity was significantly higher (OR: 3·47) in nursing staff compared with other hospital staff.

The seroprevalence of 31.4% revealed a comparatively higher infection rate among HCWs in this country than some others. Several studies from the United States, Spain and Germany have reported lower seroprevalence rate in HCWs,[2,13,14] but higher rates have also been reported among those high-risk HCWs serving in COVID-19 isolation unit/wards.[15,16]

In this study, the investigators observed variation in infection rates by professional category and their job role. The seropositivity was significantly higher in paramedical (42.5%) and nursing staff (38.8%) compared with junior (19.3%) and senior doctors (21.1%) which is consistent with the

findings observed in a New Jersey hospital study of 546 HCWs of whom majority of infected HCWs (62.5%) were staff nurses.[17] These findings are suggesting the likelihood of frequent exposure by the nurses and paramedical staff to infection by spending more time in patients' room. In a recent published review, the significance of heating, ventilation and air conditioning (HVAC) in the SARS outbreak was indirectly proven in six of the seven studies either by the spatial and temporal pattern of cases or using airflow-dynamics models.[18] Apart from higher exposure and longer duration of contact, it may also be due to inadequate use of personal protective equipment (PPE) and their awareness levels.[19,20] A recent meta-analysis published in *The Lancet* journal concluded that physical distancing, use of mask and goggles significantly decrease the risk of infection.[21]

This study revealed that the order of priority based on higher risk is given as nurses, paramedics, hospital support staff, young doctors and consultants. The early vaccination of HCWs is critical to ensuring safety and well-being of the frontline workforce that constitutes around 21 million individuals world over apart from those who daily come in contact with them.[10,22]

Our study also revealed significant difference in seropositivity rate between genders (male: 33.5% and female: 27%, $p < 0.05$). Some studies observed no significant difference in seroprevalence rate,[23] while several others have reported males are more susceptible to SARS-CoV-2 viral infection.[24] The high infection rate among male HCWs may be due to increased social interaction, ignoring social distancing and inadequate use of PPE.[25]

We also observed that seropositivity rate increased with increasing age with highest seroprevalence of 40.9% (95% CI: 28.9%–53.7%) in age group 51–60 years. Similar findings were observed in a study conducted on a larger sample of 35,883 in which highest seroprevalence was identified in age group 45 years and above.[26] The same was concluded in a mathematical model of epidemic data from six countries, and a positive correlation was found with increasing age and the susceptibility of young was almost half to that of adults.[27]

Despite the huge supply, COVID-19 vaccines are still far less than the global demand including in developed countries like the United States, Germany and Canada.[28–31]

The success of the COVID-19 vaccination plan among HCWs also depends on the uptake rate.[32] Efforts aimed at increasing employee awareness of vaccination efficacy should be encouraged among them in order to increase its acceptability.

The limited supply of COVID-19 vaccine may also affect vaccinating the HCWs especially in low- and middle-income countries. The subgrouping of HCWs with higher and lower risks will enable health authorities to prioritize them for vaccination against COVID-19. It will ensure fair play in the distribution and administration of vaccines among the various cadres of health staff. Such studies in various other professions may also benefit in analogical terms from the same principle. It will allow queuing the people in wait for vaccines in a transparent way due to its limited supply even in the developed countries.

Strengths and limitations

The key strength of this study is a high participation rate of HCWs from two major teaching hospitals. The participants were not selected based on the presence of symptoms, which gives a unique picture of seroprevalence in different categories of HCWs. Our study has certain limitations. First, this was a cross-sectional study. Second, the participants of the study belong to same group of hospitals and the results might be under-representative.

Conclusion

All HCWs should be vaccinated to reduce their risk of acquiring COVID-19. However, due to higher risk in subgroups among the HCWs, the nursing and paramedical staff should be vaccinated on priority. No study has been done on the same topic in the country; these results will add up to the workforce that is critically required in the current situation for ensuring a functional health care system. The analogy can be extended for equitable distribution of limited supplies of vaccines among other professions, also.

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Author contributions

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Availability of data and material

Study data are available from the corresponding author on reasonable request.

Conflict of interest statement

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