Risk of COVID-19 Among Unvaccinated Healthcare Workers in Yemen: Challenges of Conflict and Limited Resources

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Abstract

Background: The COVID-19 pandemic presented significant challenges to healthcare centers across Yemen. The lack of access to COVID-19 vaccines and limited availability of personal protective equipment (PPE) greatly increased the risk of SARS-CoV-2 exposure among healthcare workers (HCWs).

Objective: This study aimed to assess the seroprevalence of SARS-CoV-2 and associated risk factors among unvaccinated HCWs in Ibb, Yemen.

Methods: Blood samples, occupational information, and clinical data were collected from 396 unvaccinated HCWs actively providing healthcare services between July 2022 and January 2023. SARS-CoV-2 antibody presence was determined using a lateral flow immunoassay.

Results: Of the 396 HCWs tested, 268 (67.7%) were positive for SARS-CoV-2 antibodies, with no significant difference in seropositivity between genders. Key risk factors included occupation and workplace. Nurses (OR, 1.895; 95% CI: 1.100–3.264; P=.021), physician assistants (OR, 8.211; 95% CI: 1.040–64.794; P =.046), and those working in hospitals (OR, 2.769; 95% CI: 1.593–4.813; P<.001) had an elevated risk of infection. Eighty-two percent of seropositive HCWs reported COVID-19 related symptoms within the last 6 months (OR, 3.822; 95% CI: 2.399–6.087; P<.001), the majority being fever (71.2%), headache (65.3), cough (60.4%), or loss of taste or smell (57.8%).

Conclusions: Of the 396 HCWs tested, 268 (67.7%) were positive for SARS-CoV-2 antibodies, with no significant difference in seropositivity between genders. Key risk factors included occupation and workplace. Nurses (OR, 1.895; 95% CI: 1.100–3.264; P=.021), physician assistants (OR, 8.211; 95% CI: 1.040–64.794; P =.046), and those working in hospitals (OR, 2.769; 95% CI: 1.593–4.813; P<.001) had an elevated risk of infection. Eighty-two percent of seropositive HCWs reported COVID-19 related symptoms within the last 6 months (OR, 3.822; 95% CI: 2.399–6.087; P<.001), the majority being fever (71.2%), headache (65.3), cough (60.4%), or loss of taste or smell (57.8%).

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Conclusions: This study reveals a high prevalence of SARS-CoV-2 antibodies among healthcare workers in Ibb City, Yemen, underscoring the impact of limited vaccination and PPE availability during 2022–2023. These findings highlight the urgent need for improved protective measures and vaccination efforts in conflict-affected regions.

Key words: SARS-CoV-2 antibodies, COVID-19, healthcare workers, risk factors, Yemen.

Background

In December 2019, a novel coronavirus disease called COVID-19 emerged in Wuhan, China rapidly spreading to over 199 countries and territories by March, 2020 [1,2]. As of 4th August 2024 the World Health Organization (WHO) reported more than 775 million confirmed cases of COVID-19 worldwide with more than 7 million related deaths [3]. The clinical spectrum of COVID-19 ranges from asymptomatic infection to severe viral pneumonia, acute respiratory distress syndrome, and death [4]. Understanding the risk factors for SARS-CoV-2 infections [5] and developing severe disease and COVID-19-related hospitalization [6] is vital for guiding prevention strategies and clinical management.

In conflict-affected and resource-poor countries like Yemen, where political instability and ongoing conflict have severely weakened the healthcare infrastructure, the pandemic has exacerbated existing challenges, with limited access to vaccines and personal protective equipment (PPE). Years of conflict with airstrike and bombardment since 2015 have left hospitals destroyed, equipment scarce, and healthcare workers struggling to provide care [7,8]. The WHO Regional Office for the Eastern Mediterranean reports less than 12,000 cumulative cases of COVID-19 until February 2024 with an estimated overall case fatality rate of 18.1% [9], although these numbers are likely to be inaccurate and misleading for several reasons [10]. As seroprevalence studies are difficult to carry out in war-torn nations, and only few studies have attempted estimating the true burden of disease in Yemen [11,12].

Healthcare workers (HCWs) are positioned on the frontlines, face an elevated risk of contracting SARS-CoV-2 and potentially transmitting it to patients and others [13]. In the absence of an available vaccine, their knowledge and preparedness is instrumental in the diagnosis, prevention, and control of COVID-19 [14]. In regions where the SARS-CoV-2 vaccine is unavailable and PPE supplies are limited, there is no clear data on the seroprevalence of the disease. Only a few studies [15,16] have examined seroprevalence and COVID-19 burden among Yemeni HCWs. This study

aimed to assess the seroprevalence of SARS-CoV-2 and associated risk factors among unvaccinated HCWs in Ibb, Yemen.

Methods

This cross-sectional study recruited 396 healthcare workers (HCWs) employed in public and private hospitals, dispensaries, pharmacies, and laboratories in Ibb City, the capital of Ibb Governorate, located in the highlands of southwestern Yemen between July 2022 and January 2023. Occupational and clinical data were collected from all participants during sample collection. HCWs were categorized according to the Yemen Medical Council's classification, including physicians, nurses, dentists, pharmacists, physician assistants, and laboratory technicians.

Capillary whole blood samples were obtained from all participants, and SARS-CoV-2 IgM and IgG antibodies were detected using a lateral flow immunoassay test (Clungene, Shanghai International Holding Corp., Hamburg, Germany). Clinical symptoms within the past six months were recorded using a standardized questionnaire. The study received ethical approval from the Research Ethics Committee of Ibb University, Faculty of Medicine and Health Science (Registration number IBBUNI.AC.YEM. 2022.35).

Data analysis was performed using IBM SPSS version 25.0. The chi-square test was employed to evaluate associations between dichotomous variables. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were calculated to assess the strength of these associations. The frequency of positive test results was analyzed in relation to gender, age groups, occupation types, and symptoms. Statistical significance was defined as $P<.05$ for all tests without correction for multiple testing.

Results

Between July 2022 and January 2023, capillary blood samples from 396 HCWs from Ibb city, Yemen, were collected. The mean age of enrolled participants was 28.6 years The majority of HCWs in our study were nurses and laboratory technicians, accounting for 62.6% of the participants

(248/396) (**Table 1**). None of the study participants were vaccinated.

The overall seropositivity rate among HCWs was 67.7% with no significant difference in seropositivity between genders: 70.0% in females and 65.1% in males. Seroprevalence increased with age and was higher in HCWs aged 40 years or older (82.5%), compared to those younger than 40 years (66.0%) (*P*=.03).

Compared with laboratory technicians as a reference group, physician assistants (92.9%, 13/14; OR 8.21, CI 1.04–64.79), dentists (77.8%; OR 2.21, CI 0.83–5.87), and nurses (75.0%; OR 1.89, CI 1.10–3.26) were more frequently seropositive. Working in a hospital (74%, 194/262) was associated with higher odds of seropositivity (OR 2.77, CI 1.59–4.81) compared to HCWs in laboratories (**Table 1**).

Table 1: Demographic characteristics, occupation, and SARS-CoV-2 seropositivity among HCWs

Characteristic	N of Examined	Positive test		*P value*	Odds ratio	95% CI
		N	%			
All	396	268	67.7			
Gender						
Female	207	145	70.0		1.00 (Reference)	
Male	189	123	65.1	0.29	0.80	0.52-1.22
Age groups (years)						
< 30	264	176	66.7		1.00 (Reference)	
30-39	92	59	64.1	0.66	0.89	0.54-1.47
40-49	28	23	82.1	0.10	2.30	0.85-6.26
≥50	12	10	83.3	0.24	2.50	0.54-11.66
Occupation						
Lab. technician	124	76	61.3		1.00 (Reference)	
Physician	66	46	69.7	0.25	1.45	0.77-2.75
Nurse	124	93	75.0	0.02	1.89	1.10-3.26
Dentist	27	21	77.8	0.11	2.21	0.83-5.87
Pharmacist	41	19	46.3	0.10	0.55	0.27-1.11
Physician assistant	14	13	92.9	0.046	8.21	1.04-64.79
Working place						
Laboratory	67	34	50.7		1.00 (Reference)	
Hospital	262	194	74.0	<0.001	2.77	1.59-4.81
Private clinic	29	18	62.1	0.31	1.59	0.65-3.87

Dispensary	16	10	62.5	0.84	1.62	0.53-4.96
Pharmacy	22	12	54.5	0.76	1.16	0.44-3.01
Symptoms*						
No	108	49	45.4	1.00 (Reference)		
Yes	288	219	76.0	<0.001	3.82	2.40-6.09

N, number; CI, confidence interval. The *P value*s were calculated by chi-square test.
*Within the past 6 months.

Among 268 seropositive individuals, 81.7% reported COVID-19 related symptoms within the last 6 months, the majority being fever (71.2%), headache (65.3), cough (60.4%), or loss of taste or smell (57.8%) (**Table 2**).

Being symptomatic within the past 6 months was associated with SARS-CoV-2 seropositivity (OR 3.82, CI 2.40–6.09). Symptoms such as fever, chills, cough, headache, muscle aches, loss of taste, loss of smell, sore throat, and congestion (runny nose) were indicative of seropositivity (**Table 2**), with cough showing the strongest positive association (OR 3.021, 95% CI, *P*<.001). In contrast, gastrointestinal symptoms, including nausea, vomiting, and diarrhea, did not demonstrate a positive association with SARS-CoV-2 seropositivity.

Table 2: Association between the signs and symptoms and SARS-CoV-2 seropositivity among HCWs

Symptom	No. of Examined	Positive test		*P value*	Odds ratio	95% CI
		No.	%			
Fever						
No	140	77	55.0	1.00 (Reference)		
Yes	256	191	74.6	<0.001	2.40	1.56-3.72
Chills						
No	233	143	61.4	1.00 (Reference)		
Yes	163	125	76.7	0.001	2.07	1.32-3.24
Cough						
No	191	106	55.5	1.00 (Reference)		
Yes	205	162	79.0	<0.001	3.02	1.94-4.70
Headache						
No	166	93	56.0	1.00 (Reference)		
Yes	230	175	76.1	<0.001	2.50	1.62-3.84
Breathing problem						
No	296	197	66.6	1.00 (Reference)		
Yes	100	71	71.0	0.41	1.23	0.75-2.02
Muscle pain						
No	230	145	63.0	1.00 (Reference)		

Yes	166	123	74.1	0.02	1.68	1.08-2.60
Loss of taste						
No	194	113	58.2	1.00 (Reference)		
Yes	202	155	76.7	<0.001	2.36	1.53-3.65
Loss of smell						
No	205	122	59.5	1.00 (Reference)		
Yes	191	146	76.4	<0.001	2.21	1.43-3.41
Sore throat						
No	262	162	61.8	1.00 (Reference)		
Yes	134	106	79.1	<0.001	2.34	1.44-3.80
Congestion or runny nose						
No	258	163	63.2	1.00 (Reference)		
Yes	138	105	76.1	0.009	1.85	1.16-2.96
Nausea or vomiting						
No	346	234	67.6	1.00 (Reference)		
Yes	50	34	68.0	0.96	1.02	0.549-1.92
Diarrhea						
No	354	237	66.9	1.00 (Reference)		
Yes	42	31	73.8	0.37	1.39	0.68-2.87

N, number; CI, confidence interval. The *P value*s were calculated by chi-square test.

Discussion

Since the first laboratory-confirmed case of COVID-19 was reported in April 2020 in Mukalla City [17], Yemeni HCWs have faced the pandemic amid numerous challenges, including a scarcity of PPE, the absence of vaccines in many cities, ongoing conflict, and various crises affecting the country. We herein report the serostatus for SARS-CoV-2 in 396 unvaccinated HCWs in Ibb City in 2022/2023 to be 67%. Seropositivity was highest in individuals working in a hospital (74.0%) as compared to laboratory (50.7%) or pharmacy staff (54.5%).

During the early stages of the pandemic, studies around the world reported seropositivity rates in unvaccinated HCWs ranging from 8% to over 40% with large differences between countries and hospitals [18–20]. After the first wave of COVID-19 in Yemen between May and September 2020, 19.4% of asymptomatic HCWs at the Médecins Sans Frontières (MSF) Trauma Center in Aden, Yemen, tested seropositive for SARS-CoV-2 antibodies [15].

By late 2022 to early 2023, many countries also in the Arabic world began to consider COVID-19 as an endemic disease as infection rates began to stabilize, and COVID-19 cases became more

predictable with fewer severe outcomes [21]. The case fatality rate of confirmed infections gradually decreased in Taiz Governorate in southern Yemen from 27.0% in 2020 and to 12.8% and 5.8% in 2021 and 2022, respectively [12]. In parallel, the seroprevalence of SARS-CoV-2 in HCWs from 9 hospitals from the Lahj and AL-Dhalea governorates in Yemen had increased to 94.2% in the period from June 2022 to September 2022 underlining the transition to an endemic situation [16]. Although this study also included several professions including nurses, radiologists, dentists, laboratory personnel, pharmacists, respiratory therapists, and nutritionists, we here report a considerably lower seroprevalence in a comparable time frame with significant occupation-related differences. In our study, direct patient care as a physician assistant (92.9%), dentist (77.8%), nurse (75.0%), or physician (69.7%) was associated with the highest odds of seropositivity.

Our finding align with other studies that identified higher risks for healthcare staff providing direct patient care in confined spaces, having prolonged or repeated face-to-face contact or contact with environment/materials used by patients with COVID-19 being presumably related to the increased risk in these occupation groups [22–24]. The inadequate availability of PPE in hospitals may have additionally contributed to this risk, given the higher number of HCWs in hospitals compared to laboratories. Other studies [25–27] have found no significant correlation between occupation and infection possibly reflecting differences in the availability and use of PPE and possible exposure from colleagues and household members.

In our study, the highest seroprevalence of SARS-CoV-2 was observed in HCWs aged 40 years or older (82.5%), compared to those younger than 40 years (66.0%). This contrasts with studies from the Western world, where higher seropositivity rates have been reported among younger HCWs, possibly due to increased exposure through social behaviors, patient contact, and adherence to stringent protective measures [18,28].

Our analysis indicated a significantly higher risk of SARS-CoV2 seropositivity associated with typical symptoms such as fever, chills, headache, loss of taste, loss of smell, and sore throat. Other

studies in HCWs have highlighted a strong association of loss of taste or smell with seropositivity [29–31]. In our study, loss of taste or smell was observed in 57.8% of seropositive HCWs and associated with 2.3-fold odds. Notably, anosmia within the last 6 months was also reported by 45 (35%) of seronegative HCWs, which is considerably higher than the self-reported olfactory loss (<15%) or objective smell dysfunction (<25%) in the general population [32]. This might in part be explained by false negative results of the used assays as a limitation of the study.

In summary, the observed seroprevalence of SARS-CoV-2 among healthcare workers (HCWs) in Ibb City, Yemen, highlights the ongoing vulnerability of HCWs, particularly those with close patient contact, in resource-limited and conflict-affected regions. These findings underscore the urgent need for sustained efforts to enhance infection control measures, including the provision of personal protective equipment (PPE) and broader access to vaccines. Monitoring occupation-related risks and the evolving epidemiological landscape is crucial to informing future public health strategies. Continued research is essential to understand the long-term implications of COVID-19 exposure among HCWs and to develop targeted interventions that can more effectively protect this critical workforce in similar settings worldwide.

Transparency declaration

The authors of this work declare that there are no conflicts of interest relevant to this research.

Author contributions

EA was involved in all aspects of this article and is the guarantor for the data. Sample collection was carried out by KH, MM, ZM, AS, and BA. MA, FA, and MA performed laboratory procedures. EA, MB, MF, and TB analysed the data and wrote the manuscript. RS and AA reviewed the manuscript.

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