Frontline Healthcare Workers' Awareness and Preparedness During the First Wave of Coronavirus Disease 2019 (COVID-19): A Cross-Sectional Study from Four National Referral Hospitals in Muscat, Oman

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Abstract

Objectives: Hospital healthcare workers (HCWs) face elevated risks of acquiring and transmitting COVID-19. High levels of awareness and preparedness are essential for pandemic preparedness, response and infection control. This study assessed the awareness and preparedness of frontline HCWs during the first wave of COVID-19 in Oman.

Methods: We conducted a cross-sectional survey between May and August 2020 among HCWs at four national referral hospitals in Muscat, Oman. We invited a convenience sample of medical, nursing, and allied health professionals to complete an online questionnaire measuring COVID-19-related awareness (score range: 0-8) and preparedness (score range: 0-14). We used descriptive statistics and multivariable regression to analyse key predictors.

Results: A total of 439 HCWs participated; 73.3% were women, and 50.3% were nurses. The median age was 38 years (IQR 33–43). The median awareness and preparedness scores were 3 (IQR 1–4) and 12 (IQR 10–13), respectively. Government agencies (82.9%) were the most frequently cited sources of information, followed by mainstream media (70.8%) and social media (69%). Awareness scores were significantly associated with younger age ($p < 0.001$), while preparedness was associated with female gender, being a nurse, previous outbreak experience, and COVID-19-specific training ($p < 0.05$).

Conclusion: Frontline HCWs in Oman demonstrated relatively high preparedness scores, whereas awareness scores should be interpreted cautiously given the characteristics of the awareness instrument and the timing of the survey during the early stages of the pandemic.

Keywords: Health Personnel, pandemics, COVID-19, Awareness, Disaster Preparedness, Oman

Introduction

Coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), rapidly spread across the globe and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020.[1] As of February 2025, the pandemic has resulted in over 777.4 million confirmed cases and over 7 million deaths worldwide, making it one of the most significant public health crises in modern history.[2] The virus primarily spreads through respiratory droplets, aerosols, and contaminated surfaces, leading to severe respiratory illness, multi-organ failure, and death in critical cases.[3] The rapid spread and severity of COVID-19 placed immense pressure on healthcare systems globally, revealing critical gaps in preparedness, particularly in emerging economies with developing healthcare infrastructures, such as Oman.[4]

In Oman, the first COVID-19 case was confirmed on 24 February 2020, with community transmission confirmed by March 2020.[5] By the end of 2023, Oman had reported approximately 400,000 confirmed cases and over 4,600 deaths,[6] resulting in profound social, economic, and health-related impacts.[4,7-9]

The COVID-19 pandemic has had a profound negative impact on healthcare workers (HCWs) globally, exacerbating stress within an already overburdened workforce.[10-12] In Oman, both frontline and non-frontline HCWs faced exceptional challenges, including elevated infection risk, psychological distress, and burnout.[13] According to the Ministry of Health, 847 HCWs had contracted COVID-19 by the end of June 2020, corresponding to an incidence rate of 1.5%.[14] A national survey of physicians, one-third of whom were directly involved in the care of COVID-19 patients, revealed significant levels of psychological distress and emotional exhaustion.[9] Similarly, those working in COVID-19 field hospitals reported symptoms of anxiety, depression, and sleep disturbances.[13] In addition, frontline HCWs experience significantly higher levels of depression, anxiety, stress, and insomnia than their non-frontline counterparts.[15] Collectively, these findings underscore the urgent need for institutional mental health support to safeguard the well-being of HCWs, as prolonged psychological strain can undermine preparedness and reduce workforce retention during extended public health crises.

This study aimed to evaluate the awareness, preparedness, and associated factors among frontline HCWs in four national referral hospitals in Muscat, Oman, during the first wave of the COVID-19 pandemic. The objective was to identify knowledge gaps, assess institutional readiness, and inform policy strategies to improve national pandemic preparedness.

Methods

This was a cross-sectional study conducted between May 10 and August 10, 2020, targeting HCWs across four national referral hospitals in Muscat, Oman: Royal Hospital, Sultan Qaboos University Hospital, Khoula Hospital, and Al Nahdha Hospital. A convenience sampling method was employed. Eligible participants included clinical staff (physicians and nurses), allied health professionals (e.g., pharmacists, physiotherapists, speech-language therapists, radiographers), and other HCWs involved in the provision or coordination of COVID-19-related care. HCWs on leave during the data collection period were excluded.

Data were collected using a structured, self-administered, online questionnaire disseminated via Google Forms©. Given the limitations imposed by social distancing measures, online distribution was deemed most appropriate. A single-submission policy per unique IP address was implemented to reduce response duplication. The survey link was circulated within hospital email networks following approval from local hospital administrators. Additionally, the questionnaire was shared with potential participants using the social networking application WhatsApp. An information sheet was provided on the survey's first page, and informed consent was implied upon submission. Participant anonymity was maintained throughout.

The questionnaire used in the study was developed, pretested, and validated in the TMGH-Global COVID-19 Collaborative, a multinational, multicentre, cross-sectional study that examined COVID-19 awareness and preparedness among frontline HCWs at 371 hospitals across in 57 countries during the first COVID-19 wave in 2020.[16] The questionnaire was administered in English and included dichotomous, multiple-choice, and open-ended items. The questionnaire comprised 26 items divided into two major sections. Survey items covered sociodemographic data (6 items), prior outbreak experience and current COVID-19 exposure (2 items), source of information and infection control training (2 items), awareness of COVID-19 (4 items), institutional

preparedness (14 items), and a final open-ended question inviting comments on how to improve future pandemic preparedness (1 item).

Responses for the 4 awareness questions were scored as follows: 2 for choosing all possible correct choices, 1 for choosing some of the possible correct choices, and 0 for items with any incorrect choice(s). The overall awareness score was a sum of the points for the four items (maximum 8, minimum 0). Responses for each preparedness item were scored as yes (1) or no/I don't know (0). The overall preparedness score was the total sum of scores for the 14 items (minimum 0, maximum 14). Higher scores indicate better awareness and preparedness. Although no score categorisations were applied to define specific levels of awareness or preparedness, the results were compared with those of the parent study and relevant literature to aid contextual interpretation.[16,17]

Descriptive statistics (frequencies, percentages, means, and standard deviations) and multivariable linear regression, using a complete case method, were utilised to examine associations between demographic and professional variables and awareness (score out of 8) and preparedness (score out of 14). Mean differences (MD), 95% confidence intervals (CI), and p-values were calculated.[16,17] The MDs were then compared with results from the original multinational study.[16] Analyses were conducted using SPSS (version 27). The effect of COVID-19 training on awareness and preparedness scores was examined using a scatter plot in R (version 4.3.1). A p-value of <0.05 was considered statistically significant.

Ethical approval was obtained from the Research and Ethical Review and Approval Committee at the Ministry of Health, Oman (Ref. No: MoH/DGPS/CSR/PROPOSAL_APPROVED/17/2020), and the Medical Research Ethics Committee of the College of Medicine and Health Sciences, Sultan Qaboos University (Ref. No: SQU-EC/120/2020).

Results

Between May 10 and August 10, 2020, responses were received from 439 HCWs (39.6% Khoula Hospital, 28.7% Sultan Qaboos University Hospital, 23% Al-Nahda Hospital and 8.7% Royal Hospital). The median age was 38 (IQR 33-43; mean 38.5 ± 8.8; range 23-65), and females represented 73% (n = 322) of participants. The median self-reported professional experience was 13 years (IQR: 9-19) (mean 14.1 ± 8, range 1-46). Most participants were nurses (50.3%) or doctors (42.1%), while allied health professionals and other staff represented a small proportion of the sample (6.8% and 0.7%, respectively). **Table 1** presents the respondents' demographic characteristics.

Of the respondents, 38% (n = 167) reported past outbreak experience. At the time of survey, 332 (75.6%) HCWs were aware of confirmed COVID-19 cases in their hospitals and 130 (29.6%) received specific COVID-19 training.

Table 1: Sociodemographic and clinical characteristics of study participants (n=439)

Characteristic	N (%)
Sociodemographic	
Age, years †	38 (IQR:33-43)
Gender	
Female	322 (73.3)
Male	117 (26.7)
Work experience, years †	13 (IQR: 9-19)
Profession	
Allied health	30 (6.8)
Doctor	185 (42.1)
Nurse	221 (50.3)
Other*	3 (0.7)
Hospital	
Al-Nahda Hospital	101 (23)

Khoula Hospital	174 (39.6)
Royal Hospital	38 (8.7)
Sultan Qaboos University Hospital	126 (28.7)
Hospital department	
Emergency department	65 (14.8)
General medicine/COVID-19 isolation	60 (13.7)
Intensive care unit	24 (5.5)
Outpatient clinic	21 (4.8)
Paediatric department	22 (5)
Other	247 (56.3)
Past outbreak experience	
Any	167 (38)
Bird flu	68 (15.5)
MERS	80 (18.2)
SARS	90 (20.5)
Swine flu (influenza A, H1N1)	34 (7.7)
Other	7 (1.6)
Confirmed COVID-19 cases	
Yes, in my city	220 (50.1)
Yes, in my hospital	332 (75.6)

† *Reported as median (IQR)*
** Administrative (n=2) and IT (n=1) staff*

Government organisations (e.g., Ministry of Health) (n = 364, 82.9%) followed by mainstream media (e.g., newspapers, television, and radio) (n = 311, 70.8%) and social networking websites/applications (e.g., Facebook, Twitter, blogs) (n = 303, 69%) were the most reported source of COVID-19 related information/knowledge. The majority of respondents (n = 416, 94.8%) expressed some degree of confidence in handling patients with suspected COVID-19, but less than half (n = 193, 44%) were satisfied with the medical equipment provided by their hospitals for the management of the COVID-19 outbreak **(Table 1 & 2)**.

Table 2: Sources of COVID-19 information and attitudes of study participants

Variable (n=439)	**n (%)**
Sources of information about COVID-19	
Government Organizations	364 (82.9)
Mainstream media	311 (70.8)
Social media/networking applications	303 (69)
Colleagues/hospital	195 (44.4)
Academic training courses	122 (27.8)
Other	28 (6.4)
Participated in COVID-19 training courses	130 (29.6)
Satisfaction with medical equipment for COVID-19 management	
Very unsatisfied	3 (0.7)
Unsatisfied	85 (19.4)
Neutral	158 (36.0)
Satisfied	162 (36.9)
Very satisfied	31 (7.1)
Confidence in handling suspected COVID-19 patients	
None	23 (5.2)

To a little extent	44 (10)
To some extent	141 (32.1)
To a considerable extent	163 (37.1)
To a great extent	68 (15.5)

Complete responses (n = 439) were received for the awareness and preparedness questions. The median awareness score was 3 out of 8 (IQR 1–4), with a mean of 2.83 ± 1.86. The median preparedness score was 12 out of 14 (IQR 10–13), with a mean of 11.39 ± 2.59.

The majority of participants reported that their hospitals had triage and isolation protocols for patients with suspected COVID-19 infection (n = 434, 98.9%) and procedures for controlling visitors to known or suspected COVID-19 patients (n = 393, 89.5%). In contrast, approximately two-thirds of respondents (n = 294, 67%) were aware of the availability of isolation (negative pressure) rooms in their hospitals **(Figure 1)**.

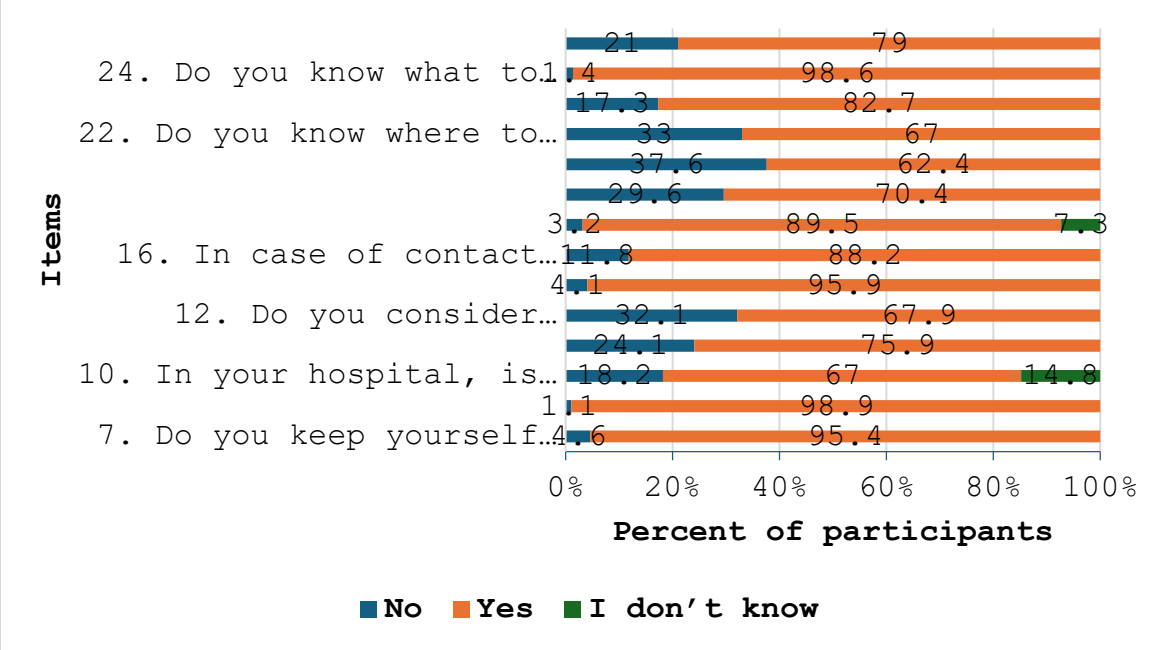

Figure 1: Participant responses to 14 closed items regarding preparedness against COVID-19.

Only age was significantly associated with awareness scores **(Table 3)**. Awareness decreased significantly with age, with every 10-year increase associated with lower scores (MD = -0.698; CI = -1.110 to -0.287; p < 0.001). No significant differences were observed across gender, profession, clinical experience, previous outbreak experience, or COVID-19 training.

Table 3: Multivariable regression models for awareness and preparedness scores of frontline healthcare workers during the first wave of the COVID-19 pandemic in Oman

Variable	**Local Analysis**			**Multinational (parent) study**		
	MD	(95%CI)	p	MD	(95%CI)	p
Awareness						
Gender						
Women	Reference			Reference		
Men	0.137	-0.257, 0.53	0.496	-0.02	-0.19, 0.15	0.791
Age (10-year increase)	-0.698	-1.110, -0.287	**<0.001**	-0.16	-0.34, 0.01	0.068
Profession						
Doctor	Reference			Reference		
Nurse	-0.208	-2.356, 1.880	0.847	-1.97	-2.16, -1.78	**<0.001**

Allied Health	0.533	1.67, 2.737	0.635	-2.24	-2.69, -2.19	**<0.001**
Experience (10-year increase)	0.259	-0.158, 0.704	0.252	0.06	-0.13, 0.25	0.547
Previous Outbreak Experience (Yes)	-0.250	-0.608, 0.108	0.171	0.49	0.33, 0.66	**<0.001**
COVID-19 Training (Yes)	-0.056	-0.437, 0.326	0.775			
Preparedness						
Gender						
Women	Reference			Reference		
Men	-0.796	-0.251, -1.341	**0.004**	0.35	0.23,0.47	**<0.001**
Age (10-year increase)	0.415	-0.418, 0.978	0.148	0.40	0.28,0.53	**<0.001**
Profession						
Doctor	Reference			Reference		
Nurse	1.106	0.617, 1.595	**<0.001**	0.66	0.54, 0.81	**<0.001**
Allied Health	-0.999	-1.968, -0.030	**0.043**	-0.86	-1.13, -0.39	**<0.001**
Experience (10-year increase)	0.546	-0.062, 1.155	0.078	0.10	-0.03, 0.24	0.136
Previous Outbreak Experience (Yes)	0.709	0.212, 1.205	**0.005**	0.56	0.44, 0.67	**<0.001**
COVID-19 Training (Yes)	1.526	1.013, 2.039	**<0.001**			

The preparedness score was significantly associated with several demographic and professional variables (Table 3). Men had significantly lower preparedness scores than women (MD = -0.796; CI = -1.341 to -0.251; $p = 0.004$). Nurses scored significantly higher than doctors (MD = 1.106; CI = 0.617 to 1.595; $p < 0.001$), while allied health professionals had lower scores with marginal significance (MD = -0.999; CI = -1.968 to -0.030; $p = 0.043$). Previous outbreak experience (MD = 0.709; CI = 0.212 to 1.205; $p = 0.005$) and COVID-19-specific training (MD = 1.526; CI = 1.013 to 2.039; $p < 0.001$) were both associated with higher preparedness scores. Age and clinical experience were not statistically significant predictors **(Table 3)**.

Awareness and preparedness scores were negatively correlated (Pearson's correlation coefficient $r = -0.178$, $p < 0.001$). COVID-19-specific training was associated with higher preparedness scores but had little effect on the distribution of awareness scores **(Figure 2)**, consistent with the findings of the regression analysis.

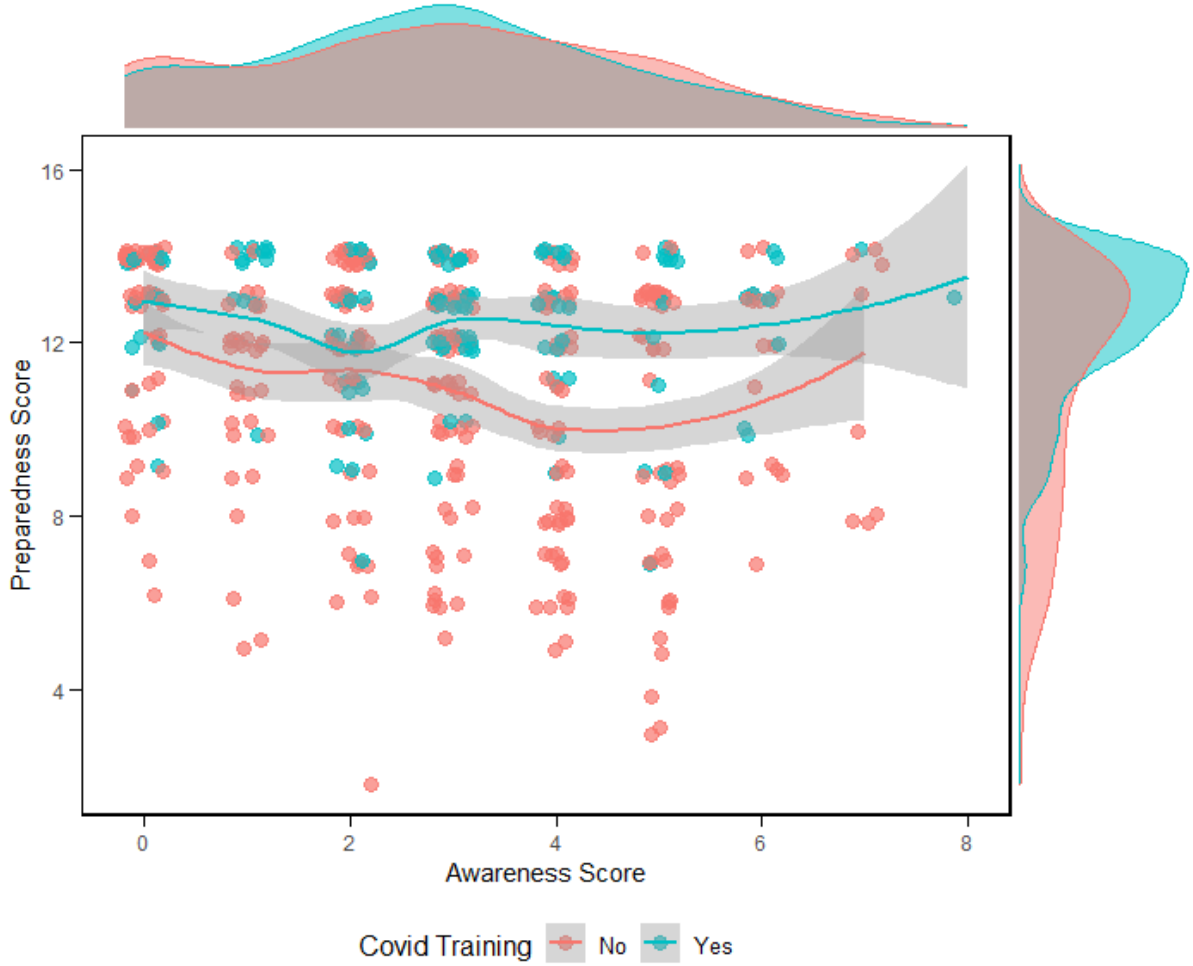

Figure 2: Two multivariate cowplots illustrating the effect of training on COVID-19 preparedness and awareness. Part A illustrates the distribution of awareness scores. Part B shows individual total scores of preparedness and awareness. The centre lines were computed using LOESS method with the shadow representing their 95% confidence intervals. Part C illustrates the distribution of preparedness scores (n=439). ***HCWs attitudes and COVID-19 source information.***

Discussion

This study examined the awareness and preparedness of HCWs in four tertiary healthcare facilities in Muscat, Oman, during the first wave of the COVID-19 pandemic. Despite limited prior outbreak experience, participants demonstrated relatively high preparedness scores, whereas awareness scores were comparatively lower. These findings should be interpreted cautiously, as the awareness instrument used a stringent scoring system and was administered during the early stages of the pandemic when knowledge regarding COVID-19 was rapidly evolving. The higher preparedness scores may reflect rapid implementation of institutional infection prevention measures and operational protocols rather than comprehensive knowledge of the emerging disease. Overall, our findings are broadly consistent with those of the parent study by Huy et al.,[16] although the specific factors associated with awareness and preparedness differed between the multinational and Omani cohorts. These findings support the importance of continued role-specific education, training, and dissemination of evidence-based information to strengthen preparedness for future infectious disease outbreaks.

The findings of this study reflect patterns observed globally in HCW preparedness and awareness during the COVID-19 pandemic. As observed in Aotearoa New Zealand[17] and the parent multinational study,[16] rapid institutional efforts helped enhance frontline readiness, although awareness scores remained lower than preparedness scores in the Omani cohort. Unlike the New Zealand study, which reported higher awareness than preparedness, our findings showed the opposite pattern. This may suggest that institutional protocols and operational preparedness were implemented rapidly during the early stages of the pandemic, while knowledge regarding the novel virus was still evolving.

In the multinational study, regions with high COVID-19 caseloads generally demonstrated greater preparedness, likely reflecting more intensive public health responses and training initiatives.[16] The relatively high preparedness observed in Oman, despite lower case numbers during the study period, may reflect proactive governmental responses and infection prevention measures implemented across healthcare facilities.[18]

Additionally, reliance on social media and mainstream media as information sources during early pandemic stages may have contributed to variability in the quality and accuracy of information available to HCWs, potentially influencing awareness scores in both Oman and other countries such as New Zealand.[17] This underscores the necessity for centralized, evidence-based communication strategies to ensure consistent and accurate information for frontline staff.

This study demonstrated that age was the only variable significantly associated with awareness scores, with awareness decreasing as age increased. No significant associations were observed between awareness scores and gender, profession, clinical experience, previous outbreak experience, or COVID-19-specific training. This differs from the parent multinational study, in which several demographic and professional characteristics were associated with awareness.[16] These findings suggest that factors influencing awareness may vary across healthcare systems and should be interpreted within the local context. Furthermore, the awareness instrument employed a stringent scoring method, which may have underestimated partial knowledge and should be considered when interpreting these findings.

Preparedness was significantly associated with gender, profession, previous outbreak experience, and COVID-19-specific training. Women, nurses, HCWs with previous outbreak experience, and those who had received COVID-19-specific training demonstrated higher preparedness scores. These findings suggest that both previous experience and targeted training may contribute to greater perceived readiness to respond during emerging infectious disease outbreaks. Unlike the parent multinational study, age and clinical experience were not significantly associated with preparedness in the Omani cohort, suggesting that determinants of preparedness may differ across healthcare settings.

COVID-19-specific training emerged as a key predictor of preparedness. HCWs who received targeted training demonstrated significantly higher preparedness scores, highlighting the value of structured educational programs in improving operational readiness during infectious disease outbreaks. Consistent with the regression analysis, COVID-19-specific training was not associated with awareness scores, suggesting that preparedness and awareness may represent related but distinct constructs.

Interestingly, awareness and preparedness scores demonstrated a weak negative correlation. This finding should be interpreted cautiously, as the awareness and preparedness measures assessed related but distinct constructs, and the awareness instrument employed a stringent scoring method that may have underestimated partial knowledge. It is also possible that institutional preparedness improved rapidly through the implementation of infection prevention protocols, workplace communication, and operational procedures, whereas awareness reflected knowledge of a novel disease that was still evolving during the first wave of the COVID-19 pandemic. Further research is warranted to better understand the relationship between these two constructs and how they influence HCWs' readiness during future infectious disease outbreaks.

The findings from this study underscore the critical need for comprehensive, context-specific training programs to strengthen pandemic preparedness among HCWs. Future training initiatives should prioritise practical competencies, such as infection prevention, emergency response, and the implementation of institutional protocols, while also ensuring that HCWs receive timely, evidence-based information during emerging infectious disease outbreaks. Given that COVID-19-specific training was significantly associated with preparedness, expanding access to structured training programs across all professional groups may help improve healthcare system readiness.

Policymakers should consider integrating pandemic preparedness modules into national healthcare strategies to enable rapid, coordinated responses to future health crises. The significant association between COVID-19-specific training and preparedness supports the institutionalisation of structured education across all HCW cadres, as demonstrated in both this and comparable international studies.[16,17]

Although fewer than one-third (29.6%) of participants reported receiving COVID-19-specific training, preparedness scores were relatively high. This suggests that preparedness may also have been supported through

institutional protocols, workplace communication, and on-the-job learning during the rapidly evolving early phase of the pandemic. Nevertheless, the significant association between formal COVID-19-specific training and preparedness highlights the continued value of structured educational programs. Targeted investments in healthcare infrastructure, including personal protective equipment (PPE), negative pressure rooms, and standardised triage protocols, are also essential to improve frontline readiness. Continued investment in centrally coordinated, evidence-based communication strategies is also important to ensure frontline HCWs receive accurate and timely information. This is particularly important given the high reliance on social and mainstream media as information sources, which may contribute to misinformation or inconsistent understanding.[4,15]

In addition, institutional preparedness must incorporate mental health support mechanisms. Local studies conducted during the COVID-19 pandemic have documented significant psychological distress, burnout, and insomnia among frontline HCWs in Oman.[9,13] Sustaining workforce resilience during prolonged crises requires investment not only in clinical and logistical readiness, but also in emotional and psychological well-being.

Finally, ongoing research is needed to assess the long-term impact of training, communication practices, and institutional support systems on pandemic preparedness. This is especially important in settings with limited prior outbreak experience, such as Oman, to inform continuous policy development and health system resilience.

This study contributes novel data on HCW preparedness and awareness in Oman during the initial wave of COVID-19, using a validated instrument from the TMGH-Global COVID-19 Collaborative to support international comparison.[16,17] A key strength is its inclusion of four major tertiary hospitals, which increases the generalizability of findings across diverse healthcare settings within the capital.

However, several limitations should be acknowledged. First, this was a cross-sectional study using a convenience sample recruited through hospital email networks and WhatsApp, which may have introduced selection bias by preferentially including HCWs who were more engaged or willing to participate. Second, participation varied across the four study hospitals, with Royal Hospital contributing fewer participants than the other sites, which may have reduced its representation in the overall findings. Third, the study was restricted to four national referral hospitals in Muscat and therefore may not be representative of HCWs working in smaller, non-referral, rural, or less-resourced healthcare settings across Oman, limiting the generalisability of the findings. Fourth, awareness was assessed using a brief four-item instrument with a stringent scoring method, whereby selecting an incorrect response could reduce an item's score to zero despite partial knowledge. Consequently, awareness scores should be interpreted cautiously. Finally, the survey was conducted during the first wave of the COVID-19 pandemic when scientific knowledge and public health guidance were rapidly evolving, which may have influenced participants' awareness and responses.

Conclusion

This study provides important insights into the awareness and preparedness of frontline HCWs in Oman during the first wave of the COVID-19 pandemic. HCWs demonstrated relatively high preparedness scores, while awareness scores should be interpreted cautiously given the characteristics of the measurement instrument and the rapidly evolving knowledge surrounding COVID-19 at the time of data collection. Strengthening structured training programs, institutional preparedness, and evidence-based communication strategies may further enhance healthcare system readiness for future infectious disease outbreaks.

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