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Follow up of the health workers' responses to the preventive obligations amid changing COVID-19 pandemic behavior: A lessons from the crisis

Raouf M Afifi[1*], **Ashraf E Saad**[2], **Hassan M Aldossary**[3], **Hani M Alkhalaf**[3], **Bashir Ighile**[3,4], **Mazin YB Elkheer**[5], **Majed Kh Al Harthi**[6], **Fadi HA Althobaiti**[7], **Yousef Afifi**[1]

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Authors' Affiliation:
[1]Health Research Institute, SA Consultancy and Training, Tampa FL, USA
[2]Preventive Medicine Department, Armed Forced Hospital, Wadi Al Dawasir, KSA
[3]General Surgery Departments, Armed Forces Hospital, Wadi Al Dawasir, KSA
[4]Quality Improvement& Patient Safety Department, Armed Forces Hospital, Wadi Al Dawasir, KSA
[5]Family and Community Medicine Department, Armed Forces Hospital, Wadi Al Dawasir, KSA
[6]Academic Affairs, King Abdulaziz Specialist Hospital, Taif, KSA
[7]Medical Records Department, King Abdulaziz Specialist Hospital, Taif, KSA

[*]**Corresponding author**:
Health Research Institute, SA Consultancy and Training, Tampa FL, USA
Email: raoufafifi@hotmail.com

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ABSTRACT

Background: Despite the emergence of potentially prophylactic vaccines, COVID-19 transmission poses a persistent threat to healthcare providers (HCPs) communities. *Aim:* Assess the progress in the knowledge and attitudes of HCPs of Armed Forces Hospital Wadi Al Dawasir (AFHWD) toward COVID-19 measures and vaccines perception. *Methods:* A questionnaire was distributed online, 09-10, 2021, to achieve study aim. SPSS-22.0 software was used for the analysis; ANOVA; t-test used for comparing quantitative variables; χ^2 for categorical data; level of materiality set to 0.05. *Results:* Out of 149 HCPs, 38 (25.5%) were "physician" 44 (29.5%); "nurse"; 31 (20.8%) "allied health" 11 (7.4%)" pharmacist"; 25 (16.8%); "other"'. HCPs averaged 39.3±9.2y of age. Overall score (84.3%) greater than cutoff, set to 70%, also greater than that assessed earlier (69.5%) was achieved (p=0.005). The higher profession the higher score (p<0.05). "Age"; "clinician"; "infection prevention and control (IPC) training; "COVID-19 infection", were significant score predictors. COVID-19 "all knowledge" (general and IPC, combined) = 79% exceeded cutoff (70%), (p<0.001); also exceeded that identified earlier (69.6%), (p<0.001). The IPC perception score behaved likewise: 86.1% vs. 70%, 86.1% vs. 71.6%, (p<0.001), respectively. An overall vaccine response (68.3%) comparable to cutoff was verified (68.3%), (p=0.08). Most (86.6%) HCPs accepted a COVID-19 vaccine; 73.2% were vaccine confident; 23.3% of those immunized were concomitantly vaccine hesitant (p = 0.012). "Age" and "clinician" predicted vaccine response variability. *Conclusion:* Findings imply an ongoing improvement of the HCPs' responses on COVID-19 requirements. Continued education and adherence with updated protocols provide utmost protective environment for the HCP staff against COVID-19 consequences.

Keywords: Healthcare providers, COVID-19, vaccine, response, Central Saudi Arabia

1. INTRODUCTION

Since its declaration by the World Health organization (WHO) in March, 11 2020 as a pandemic, (WHO, 2020a) COVID-19 (SARS-CoV-2) still poses a threat to public health with a devastating burden upon international economies. The disease continues to surprise the healthcare community with rapid changes involving disease epidemiology, immunogenic behavior, morbidity and mortality (Eckerle et al., 2022; Saad et al., 2021). Unlike beta-coronavirus "severe respiratory acute syndrome" (SARS-CoV-1) or the "Middle East respiratory syndrome" (MERS-CoV) strain; the emerging SARS-CoV-2virus tended to behave more aggressively; especially transmission speed and contagiousness. Airborne droplets, coming into contact with a contaminated surface are the principal mode of transmission of recovered COVID-19 virus strains. Particularly the healthcare setting, transmission through body fluids is a concern (Langade et al., 2016). Symptoms of COVID-19 could be as mild, e.g., as fever, malaise, cough; up to a severe respiratory illness and a multi-system involvement, e.g., hematopoietic, cardiovascular, gastrointestinal, and immune manifestations. Risk factors include old age, chronic diseases, e.g., diabetes, chronic heart disease (CHD) (CDC, 2021a; Terpos et al., 2020). A state of "long COVID" (Crist, 2022a; Stein et al., 2022), mostly affecting HCP staff (Terpos et al., 2020), has been linked with the early virus dissemination ability, including the brain, contribute to ongoing symptoms. A year after the pandemic, few therapeutic agents have shown some effect against the virus; relevant of which include steroids and antibody-based formulas. As it transmits, SARS-CoV-2 virus accrues genomic mutations; adding to the uncertainty about transmission and infectivity. Most recently, Omicron variant (B.1.1.529) raised more concerns about transmission rate, evading vaccine-induced immunity (Lu et al., 2021), and non-response to immune modulating therapy, including steroids and antibody-based therapies (Franchini et al., 2021; WHO, 2021a).

Multi-epitope vaccine polypeptides, including inactivated whole virus, DNA, vectored, self-assembling virus-like particle vaccines or messenger RNA (mRNA) material with the potential immune reactivity against SARS-CoV-2 have been introduced (Rawat, et al., 2021). By December 2021, 14 of these vaccines have been assessed, finally approved within the "emergency use licensing//pre-qualification" (WHO-ELU/PQ) process for use, (WHO, 2021b) including two mRNA vaccines: "BNT-162b2" (by Pfizer- BioNTech) (Comirnaty) and "COVID-19 Vaccine Moderna" (Moderna Biotech Spain, SL); two using adenovirus vector-based technology: "Vaxzevria" (AstraZeneca AB, "ChAdOx1 nCov-19") and "COVID-19 Vaccine Janssen" (Janssen-Cilag International NV, "Ad26.COV2.S"); (WHO, 2020b) and three using inactivated virus material, (Sinopharm BIBP COVID-19 vaccine "BBIBP-CorV"; Sinovac "Sinovac Biotech" Ltd, China; Bharat Biotech "BBV152 COVAXIN vaccine", India).

Reportedly, no significant safety issues after over 700 million inoculated vaccine doses have been sustained globally; mild adverse events (AEs) above 2% and unlikely events, such as adverse hypersensitivity reactions, e.g., after mRNA and DNA vaccines in less than 0.6% of recipients have been reported (Cennimo, 2021). Hesitancy to COVID-19 vaccine has been observed in around 29% of HCPs; (Chwarzinger et al., 2021) mostly a vaccine "newness" concern and unforeseen AEs. Despite the safety profile of the WHO-EUL vaccines, commitment to recommended precautions including vaccination to preclude COVID-19 circulation is unavoidable. Particularly BNT162b2 and ChAdOx1 nCoV-19 vaccines are now associated with a significantly reduced onward virus transmission compared with unvaccinated people (Eyre et al., 2022). A robust immune response may develop because of a combined protection, either through a COVID-19 vaccine uptake followed by a breakthrough infection or vice versa.

The national COVID-19 immunization program in KSA is based on Pfizer- BioNTech, Moderna, and AstraZeneca vaccines; Janssen vaccine also approved for travellers (PHA, 2021). While there is a tendency to ease restrictions in some world zones, new COVID-19 surges, such as 60,000-260,000 new case/day, early March, 2022, across Western Europe suggest that a pandemic wave is arriving soon. Hospitalization rates started to mount out there, despite the higher vaccination records (Medscape, 2022). Omicron BA.2 appears to be subvariant fueling these outbreaks. By far, factors, namely vaccination rates, COVID-19 safety measures, access to antiviral medications affect how another wave is able to unfold. Importantly, too, it is still uncertain how far Omicron BA.1 infection could protect against BA.2. As such, challenges continue to be faced in the healthcare settings with such pandemic progression and lack of information in the presence of a rapidly changing epidemiological and immunological virus behavior, as well as the attitude to the vaccine roll out. Health workers though are becoming frustrated about the whole work environment, e.g., 23% HCPs are likely to quit soon, overwhelmed by threatening work conditions (Crist, 2022b).

In this study, AFHWD HCPs' knowledge and attitudes to COVID-19 procedures would be evaluated, compared both with expected levels and often those assessed earlier (Saad et al., 2021). Responses to COVID-19 vaccines, as well as correlates of all other responses would be assessed.

2. SUBJECTS AND METHODS

Setting and study type

The study was conducted at AFHWD setting, using a cross sectional approach to achieve study aim.

Study population

The study cohort consisted of HCP professions, including: 1) "clinician" (physicians, dentists, chiropractors, clinical therapists, 2) "nurse" (all nursing staff, such as registered nurse, licensed nurse, nurse aide); 3) "allied health" (health technicians, e.g., cardiovascular, anesthesiology, audiology, imaging, lab technician specialties; paramedic); 4) "pharmaceutical" professions; and 5) "other" HCP professions [supplementary services, e.g., housekeeping (HK), waste management, laundry, sterilization, catering].

Inclusion and exclusion criteria

All AFHWs employees, both sexes and all nationalities, were invited to take part in the study. No employee would be excluded because of other demographic or professional criteria.

Data collection

Study data were collected between August and September 2021. A validated questionnaire was designed, derived from relevant works (Huynh, et al., 2020; Saad, et al., 2021); updated national and international guidelines for HCPs' health and safety in COVID-19 era, (CDC, 2021b; WHO, 2021c) including personal protective equipment (PPE) and hand hygiene (HH) best practice guidelines, (NPCM, 2021; WHO 2020c) reviewed IPC policies, (SCDC, 2020) COVID-19 vaccination information (ACIP, 2020), national COVID-19 immunization protocols (MOH, 2021). The questionnaire mostly encompassed closed-ended items, responses to which may be "true/false"; or a multiple choice as "yes/no/don't know" or "agree/fair/disagree/can't decide".

The questionnaire falls into five sections, *a)* demographic and professional traits, *b)* HCPs' rating of health safety and general IPC policies, e.g., work load, regular medical checkup, first aid measures availability, safety education); applicable IPC measures, e.g., availability of HH and PPE facilities, risk prevention, e.g., skin damage from PPE/hand washing (HW), sharp injury and blood spell precautions, IPC staff education; dealing with contaminated surfaces; and HCWs vaccination program; *c)* COVID-19 general epidemiological and clinical knowledge, e.g., mode of COVID-19 transmission, signs and symptoms, treatment options, sources of information about COVID-19 pandemic outbreak, COVID-19 education/briefing; *d)* specific COVID-19 infection control procedures knowledge, HW/ alcohol-based hand rubbing (ABHR), COVID-19 case isolation procedures, standard/contact/droplet/airborne precautions, precautions during aerosol generating procedure (AGP): intubation, non-invasive ventilation, tracheostomy, CPR; PPE donning/ doffing, masks/ respirators practicing; *e)* attitudes and beliefs about COVID-19 vaccines, e.g., types, affectivity, adverse events (AEs), acceptance, confidence/hesitancy, vaccination scenarios in relation to COVID-19 infection, COVID-19 vaccination education. Questionnaire sections 2 - 5 would be scored using 4-point Likert scale, where 1 = least – and 4 most favorable response. Adding up all scores generates an overall score ranging between 36 and 150. A cutoff was set to 70% on each section score.

A pilot administration in the context of the weighting process of the questionnaire's reliability showed a reliability as strong as r= 0.89 – 92 and Cronobach's alpha 0.89. The questionnaire starts with a preamble explaining study aim and importance. It takes 15 - 20 minutes to complete. A written consent to take part in the study was obtained from participants, who were reassured of the utmost confidentiality of the provided information. The study instrument was adapted to a Google application and sent electronically. Only with ≥80% valid responses would be coded, entered to MS program with adequate backups until analyzed. In the analysis, qualitative data, e.g., profession, vaccine acceptance, would be summarized as count (%); quantitative data, e.g., age, score as the mean ± standard deviation (SD), where appropriate.

Study variables

Independent variables include items, most of which were qualitative data, the responses to which was offered as a binary - or multi-level, as above. Other than age, scores, e.g., overall score, general knowledge, attitudes, constitute most quantitative data to analyze. Quantitative data may often be binned as "adequate/ "inadequate", e.g., analyzing the response to specific IPC precautions by "profession"; in which case, profession may also be binned as "clinician" ("physician" + 9 clinical therapists among "allied health") against "all other". Multi-level variables, e.g., source of information can also be binned as "reliable"/"non-reliable". The principal outcome variable involves "overall score", which encompasses all of the knowledge and all perceptions scores, summed up. Intermediate outcomes involve: *a)* adequacy of general COVID-19 knowledge (section 3), *b)* specific COVID-19 IPC/PPE measures

knowledge (section 4); *c)* "all-knowledge" score (sum section 3, 4); *d)* perception on IPC measures (section 2); *e)* OVID-19 vaccines responses score (section 5).

Statistical analysis

The relationship between categorical variables, e.g., knowledge level category and profession, may be analyzed using chi square test (χ^2, or Fisher's exact, where appropriate); with adjusted odds ratio (aOR) to assess the strength of such association. Also, parametric techniques (PMT), such as one-sample t-test for the difference between a cutoff and a score, or one-way analysis of variance (ANOVA) for the differences between the means of ≥3 variables may be calculated, (assuming "normality" distribution). The "Statistical Package for Social Sciences" (SPSS) software for MS, version-22 (Armonk, NY) was used in analyses. Our level for rejecting true null hypothesis was $\alpha = 0.05$; results with a p-values <0.05 would be considered statistically significant.

3. RESULTS

The participants' averaged 39.3±9.2y old; 82 (55.0%) were male, 85(57%) married, 49(33%) single, 15(10%) divorced; and 68(46%)) were Saudi, (table 1 footnote). Out of 265 distributed instruments, 157 were returned, of which 149 contained valid responses to analyze, (response rate 56.2%). Physicians account 38 (25.5%), nurses= 44 (29.5%), allied health= 31 (20.8%), pharmacists= 11 (7.4%), "other" supportive/administrative staff = 25 (16.8%). "Clinician" accounts 47 (31.5%); (38"physician"+9"clinical therapists"); (table 1). Most (66.5%) HCPs performed satisfactorily, or above. Stratified, they were 43/47 "clinician" (91.5%) vs. 56/102 "all other" (54.9%), (figure 1), (aOR: 7.8, 95%CI, 2.9 –27.4). A mean overall score (110.2/150 = 73.5%) significantly greater than the cutoff (105/150 = 70%) was found [1 sample t-test: t (df 1) = 4.3, p<0.001], (table 1 footnote). This score was significantly greater than that recorded earlier, 69.8%, (Saad et al., 20021) [t(230)=2.9, p=0.005].

Table 1 HCPs' overall response to COVID-19 inquiries, by profession*

	Overall response (quantitative)								
Profession	n	% N=149	Mean	SD	% Score150	Min	Max	Statistic	Sig.
Physician	38	25.5	126.5	12.1	84.0	100.6	148.5		
Nurse	44	29.5	112.7	8.1	75.1	100.3	133.7		
Allied health	31	20.8	104.0	5.6	69.3	91.5	113.7	F (4, 144) = 64.7	p<0.001
Pharmacist	11	7.4	103.2	7.6	68.8	92.6	115.4		
Other	25	16.8	91.8	8.3	61.2	75.3	101.4		
Total	149 ǂ	100	110.2	14.7	73.5	75.3	148.5		
	Source of information (Q21)								
Profession (binary)	Reliable			Unreliable				Statistic	Sig.
	n	% Row	% Total	n	% Row	% Total	*Total*		
"Clinician"	33	70.2	22.1	14	29.8	9.4	47		
"All other"	64	62.7	43.0	38	37.3	25.5	102	$\chi^2(1) = 0.79$	0.37
Total	97	65.1	65.1	52	34.9	34.9	149	aOR: 1.25, 95%CI 0.75–2.0	

*Age 39.3±9.2y; 82(55%) male, 85(57%) married, 49(33%) single, 15(10%) divorced; 68(46%) Saudi, 81(54%) non-Saudi

ǂ 1-sample t-test: Mean overall score (110.2/150 = 73.5%) vs. cutoff (105/150= 70%): t (df 148) = 4.3, .p<0.001. OLS (method "stepwise selection): P| Overall score: =64.9+0.2(age) +13.5(clinician) + 9.4(score2:"adequate"=1) + 3.9(Q22 "COVID-educated") + 6.7(Q33 "H/OCOVID"). R^2= 0.33; ANOVA: F(5,140,145) = 47.5; p<0.001.

The score significantly varied between professions [ANOVA: F (4. 144) = 64.7, p<0.001]: generally, the higher profession rank the higher score (post hoc test, p<0.05); only pharmacists and "allied health" did not significantly vary (p=0.77). A larger proportion of the study group (97/149, 61.1%) tended to opt reliable sources, such as scientific, WHO, MOH, to keep up with COVID-19 information. However, the odds of this preference vs. less reliable sources, such as social media/TV/friends, by the HCPs stratified as "clinician"/"all other" was not significant (aOR 1.25, 95%CI 0.75–2.0), (table 1). A regression analysis shows that age, "clinician", section 2 score (binary), question 22 (COVID-19 education), and question 33 (H/O COVID-19 infection) are significant predictors of the variability in the overall score, [P| Score|: 64.9+ 0.2 (age) + 13.5 (occupation= "clinician") +9.4 (score2 "adequate") + 3.9 (question

22 "COVID education") + 6.7 (question 33 "H/O COVID")]; [ANOVA: F (5,140,145)=47.5; p<0.001]; (sex; question 12 "COVID-19-IPC training" were not significant). The model explains 33% of such variability, (R^2 0.33), (table 1 and figure 1).

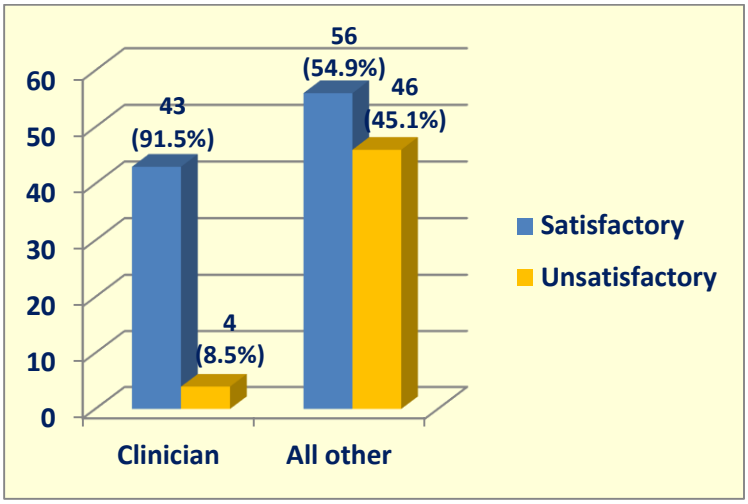

Figure 1 Distribution of the Overall score by profession

Table 2 The HCPs' level of COVID-19 knowledge by profession*

Profession	Section 3: COVID epidemiology, clinical knowledge ǂ							Section 4: Specific IPC/PPE knowledge ǂ					
	n	Mean	SD	Range	%Score32	Statistic	Sig.	Mean	SD	Range	% Score38	Statistic	Sig.
Physician	38	29.8	1.8	23.1-32.3	93.1	F(4,144) = 53.5	p<0.001	34.8	9.5	25.5-38.0	91.6	F (4,144) = 20.8	p<0.001
Nurse	44	27.6	2.2	21.4-31.9	86.3			30.4	2.6	22.0-35.1	80.0		
Allied health	31	24.1	1.7	21.0-28.0	75.1			26.7	2.1	20.0-30.3	70.3		
Pharmacist	11	25.1	2.9	20.7-29.6	78.4			28.07	3.2	23.0-31.2	75.7		
Other	25	22.3	3.1	18.0-28.5	69.8			22.9	3.4	19.2-25.2	60.3		
Total	149	26.3	3.5	18.3-29.5	82.2			29.3	6.6	19.9.38.0	77.1		

* 1-sample t-test: All knowledge score (section 3, 4): Mean 55.3/70 (79%) vs. cutoff 49/70 (70%); t (df 1)=10.1, p<0.001

ǂ 1- sample t-test (section-3): Mean 26.3/32 (82.2%) vs. cutoff 22.4/32 (70%); t (df 1) = 13.5, p<0.001

ǂ 1-sample t-test (section-4): Mean 29.3/38 (77.1%) vs. cutoff 26.6/38 (70%); t (df 1) = 4.9, p<0.001

The mean score (26.3/32) for general COVID-19 knowledge significantly varied between the professions [ANOVA: F (df 4, 144= 53.5, p<001], (table 2). There is also a consistently score increase by the level of profession, e.g., physicians 29.8, nurses 27.6, least 22.3 for "other" (post hoc calculation, p<0.05 all comparisons). Only pharmacists and allied health did not significantly vary, p=0.021). Further, section-3 score was significantly higher than the cutoff (22.4), [1-sample-t-test: t (df 1) = 13.5, p<0.001], (table 2 footnote). A mean score of specific IPC/PPE knowledge (section 4) 29.3/38 = 93.1%, exceeded the cutoff, 26.6/38=70.0%, [t (df 1) = 4.9, p<0.001], (table 2 footnote). Score on section 4 also varies by profession [ANOVA: F (df 4, 144= 20.8, p<001], (table 2). Physicians scored highest (post hoc, p<0.5); nurses overcame "allied health" and "other", but not the pharmacists (p>0.2). Score on all knowledge, 55.6/70 (79.4%), (section 3 +4, summed), significantly overcomes the cutoff (49/70=70%), [t (df 1) = 10.1, p<0.001], (table 2 footnote]. It also significantly exceeds that achieved earlier, (69.6%), (Saad et al., 20021), [t(250) = 7.0, p<0.001].

Table 3 Participants' perception on safety and IPC policies a midst COVID-19 pandemic, stratified by profession*

Profession	Section 2: Perception to IPC policies (quantitative)						
	n	Mean	SD	Range	% Score28	Statistic	Sig.
Physician	38	25.8	2.3	20.0-29.0	92.1	F (4,144) = 24.3	p<0.001
Nurse	44	25.1	2.7	13.5-28.0	89.6		
Allied Health	31	23.9	1.8	19.0-26.0	85.3		
Pharmacist	11	23.5	1.5	21.0-26.2	83.9		

Other	25	20.1	2.6	15.5-26.0	71.8		
Total	149	24.1	3.0	13.5-29.0	86.1		
	Response to AGP precautions (Q28)						
Profession (binary)	Adequate		Inadequate			Statistic	Sig.
	n	% row	n	% row	*Total*		
"Clinician"	31	65.1	16	34.1	47	$\chi^2(1) = 15.7$	p<0.001
"All other"	32	31.4	70	68.6	102		
Total	63	42.3	86	57.7	149	aOR: 3.7, 95% CI 2.0 – 8.8	

* IPC perception" mean score 24.1/28 (86.1%) vs. cutoff 19.5/28 (70%): t (148) = 18.4, p<0.001

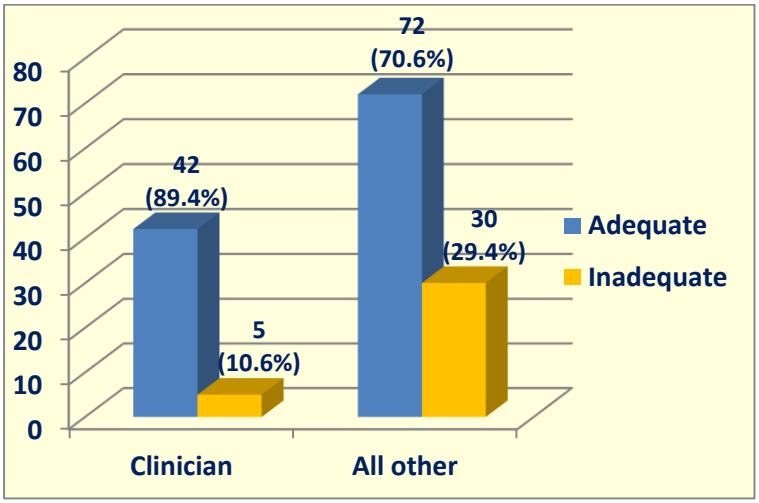

Figure 2 Responses to COVID-19 IPC measures

The participants were mostly committed to the health facility's IPC policies amidst the crisis (114/149 (76.5%). Stratified binary, "clinician" tended to do so more often, i.e., 42/47 (89.4%), (figure 2), (aOR: 3.5, 95% CI 1.3 – 9.7]. Score-wise, there was a significant difference between the professionals scores for IPC measures' perception [ANOVA: F (4,144) = 24.3, p<0.001]. Physicians' scored 25.8, significantly greater than all HCPs (post hoc, p<0.001, all comparisons) but not from the nurses' (25.1, p=0.17). The latter (25.1) was only significantly greater than that the allied health's (23.9, p=0.031) and "other" (20.1, p<0.001). The section's score (24.1/28, 86.1%) was significantly higher than the cutoff (19.5), [t (df 1) = 18.4, p<0.001], (table 3 footnote), same as when compared with that recorded beforehand 71.6% (Saad et al., 2021), [t (250 = 8.5, p<0.001]. The table also adjoins the responses to AGP precautions, where "clinicians" significantly surpassed "all other" workers (aOR: 3.7, 95% CI 2.0 – 8.8), (table 3).

Table 4 COVID-19 vaccine response*: acceptance and vaccine confidence (N = 149)

	Vaccination acceptance								
	Received/Planning/			Refused/Hesitant					
Profession	n	% Row	% Total	n	% Row	% Total	Total	Statistic	Sig.
"Clinician"	45	95.7	30.2	2	4.3	30.2	47	χ^2 (1) = 5.7	p= 0.026
"All other"	84	82.3	56.4	18	17.7	12.1	102		
Total	129	86.6	86.6	20	13.4	13.4	149	aOR 4.1, 95% CI: 1.1-17.1	
	Vaccine confidence								
Profession (binary)	Confident			Unconfident					
	n	% Row	% Total	n	% Row	% Total	Total	Statistic	Sig.
"Clinician"	40	85.1	26.8	7	14.9	4.7	47	χ^2 (1) = 4.5	p = 0.029
"All other"	69	67.5	46.3	33	32.5	22.1	102		
Total	109	73.2	73.2	40	26.8	26.8	149	aOR 2.2, 95% CI: 1.1 -4.5	

* 1-sample t-test: Overall vaccine response (section 5): Mean 35.5/52(68.3%) vs. cutoff 36.4/52 (70%): t(148)=–1.8, p = 0.08
OLS P |Vaccine response| ("enter"): Model: 23.6 + 0.1(age) 5-5 + (clinician); R^2= 0.2; ANOVA:F(4,141,145)=6.4; p<0.001

As in table 4, 86.6% participants accepted the vaccine [45/47 (95.7%) "clinician" and 84/102 (82.3%) "all other" (aOR 2.2, 95% CI: 1.1 -4.5). Also, 73.2% were vaccine confident [40/47 (85.1%) "clinician"; 69/102 (67.5%) "all other" (aOR 2.2, 95% CI: 1.1 -4.5). However, 23.3% (n=30) of those who have accepted a COVID-19 vaccine were concomitantly vaccine hesitant, aOR, 2.7, 95% CI: 1.2 - 6.1), (figure 3). A mean overall vaccine response of 35.5/52 (68.3%) was not significantly lower than the cutoff 36.4/52 (70.0%), [t (df 1) = –1.8, p = 0.08], (table 4 footnote). A regression model shows that "age" and "clinician" could significantly predict the variability in the overall vaccine score [F (4, 141, 145) = 6.4, p<0.001]; (sex and Q41 "COVID vaccine education" were not significant). The model explains 20%% of that variability ($R^2 = 0.2$), (table 4 footnote).

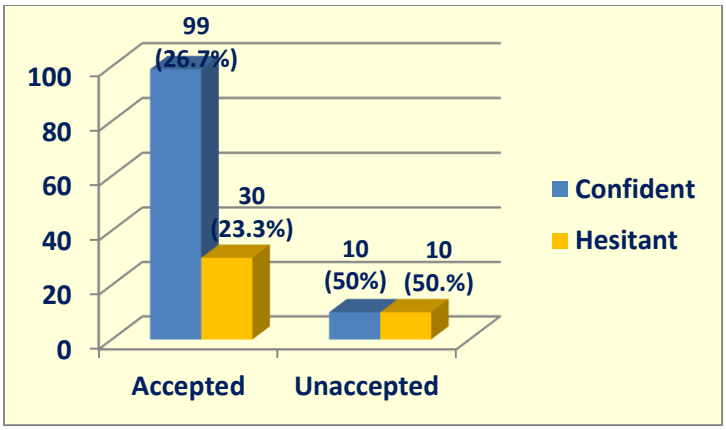

Figure 3 Vaccine confidences among vaccine acceptance group

4. DISCUSSION

This study was processed when an upsurge of infection records in winter was building up. Despite a milder disease it generally had, the coinciding emerging Omicron variant causes the majority of contagion load; e.g., an average 2,600/d 7-day related deaths in the US over 2021 (Ellis et al., 2022), a rate higher than the predecessor Delta variant surge's (CDC, 2022a; McNamara et al., 2022). In our study, we focused on measures, such as the IPC, PPE, AGP precautions and vaccination program. Specific clinical knowledge aspects were also explored.

Overall response and epidemiological COVID-19 Knowledge

An overall general response 84.3% exceeding target was yielded; a pattern which exceeds that (69.8%) reported earlier in the crisis in the same study population (Saad et al., 2021). General COVID-19 Knowledge level in AFHWD mounting to 82.2%, and exceeding that (78.4%) found earlier (Saad et al., 2021) is provided. An improved general COVID-19 knowledge pattern was often recorded, e.g., in Ethiopia when the knowledge among the health workers' community averaged 66.5% near the beginning of the crisis (Jemal et al., 2021) and then rose to 74.9% (Yesse et al., 2021) thereafter. On the other hand, a COVID-19 response in a prior global HCPs' survey as low as 61.0 - 63.6% (Bhagavathula et al., 2020) would not necessarily improve by time, e.g., only 24.3% of HCPs demonstrated an adequate COVID-19 update (Bhagavathula et al., 2022). This was probably because only 36.3% of the surveyed HCPs were willing to attend COVID-19 updates.

The contemporary knowledge level of our HCPs (82.2%) though, was comparable to some international figures, eg., 82.9% in India, (Gopalakrishnan et al., 2021), 79.2-91.7% in Egypt, (Mohammed, 2021) and in Uganda, where 83.9% of the HCPs had had a sufficient knowledge (Kamacooko et al., 2021). Generally, clinicians, as ours, and/or physicians, elsewhere, tend to excel on COVID-19 knowledge above health professional colleagues. For instance, the Egyptian doctors were more COVID-19 knowledgeable than nurses, and so forth (Galal et al., 2021; Mohammed, 2021). Likewise, being a clinical staff (or having health research experience) supports a higher knowledge level in Ugandan health workers (Kamacooko et al., 2021). Locally, a multicenter study in Riyadh, KSA introduces a quality COVID-19 knowledge in 67.8% of health workers (Almohammed et al., 2021), comparably with that, 66.4%, obtained by AFHWD colleagues. Locally, too, a nationwide COVID-19 knowledge level of 84.3% comparable to ours (82.2%) has also been estimated (Mohamad-Hani et al., 2021).

Knowledge of COVID-19 infection preventive and control measures

A recently specific IPC awareness level (77.1%) above cutoff was also above that previously described among AFHWD workers (64.2%). (Saad, et al., 2021) Elsewhere, COVD-19- preventive knowledge levels were scarcely touched on, e.g., 57.1% (4/7 points,

whereas cutoff =3.5/7, 50%), among Cypriot healthcare providers. (Roupa et al., 2021) The health workers' commitment to IPC/PPE, such as precautions performing AGP was consistently low, 57.7% (65.1 "clinicians" and 31.4% "all other") currently; and 52.4% (75.5% "physician" and 38.1% "all other") as previously. (Saad, et al., 2021) In a Japanese work, (Kadoya et al., 2021) such perception was also "inadequate", particularly among non-physicians. Otherwise, little, if any, studies have addressed AGP in the context of HCPs-COVID-19 inquiry. (Bhagavathula et al., 2020; Huynh et al., 2020; Ejeh et al., 2020) More often, modest IPC knowledge levels, including patient isolation, PPE skills, were only reached. (Kadoya et al., 2021) Early in the outbreak, uncertainty about the virus could justify any improper COVID-19 mitigation planning (Ejeh et al., 2020); yet after over two years of a pandemic, uncertainty alone may not be enough to endorse this connotation. Rationally, the continued threat of new COVID-19 variants shakes the integrity of accumulated information; leaving policy makers racing to modify effective tactics to impede the pandemic's health and economic toll.

Attitudes on COVID-19 IPC precautions

Our providers were mostly (76.5%) committed to the recommended IPC protocols amid the crisis. In contrast, they were insignificantly satisfied (71.6% vs. 70% cutoff, p=0.8) with those procedures, earlier (Saad et al., 2021). International reports, e.g., show that 84.2% - 94.7% of Ethiopian healthcare respondents often had good attitudes toward COVID-19 precautions, (Jemal et al., 2021; Yesse et al., 2021) despite a modest COVID-19 knowledge (Jemal et al., 2021). Likewise, 84% of health workers in India expressed positive attitudes and responded to COVID-19 procedures safely (Gopalakrishnan et al., 2021); alongside with a predominant (93%) fear caring for COVID-19 patients. In Uganda, 78.4% of the HCPs also significantly showed positive attitudes (Kamacooko et al., 2021). More recently, most of HCPs screened (79%) in USA were uncomfortable with the pandemic measures, expressing fear that the health care system would eminently collapse (Crist, 2022b). However, most of them (83%-85%) supported public COVID-19 policies, e.g., backing measures to provide N95 masks and providing COVID-19 tests. Generally, physicians/ clinicians performance level in this work tend to be more satisfactory than other professions, e.g., 91.6% - 93.1% vs. 60.3% - 69.8% as far as general COVID knowledge, and 92.1% vs. 71.8 - 89.6% as far as IPC protocols.

COVID-19 vaccine responses

The quick licensing of COVID-19 vaccines raised a controversy, between a glimmer of high hope of curbing the pandemic and growing concerns about the vaccines' safety and efficacy. Though, understanding factors impacting vaccine confidence becomes crucial in the maintenance of a solid health system (Lataifeh et al., 2022). To AFHWD, an overall vaccine response (86.6%) a head of target has been assured. That said; clinicians tended to accept the vaccine more frequently (95.7% vs. 82.3% "all other"). They were also more vaccine confident (85.1 vs. 73.2%). Hesitancy to COVID-19 vaccines has consistently been observed, e.g., in over 29% of healthcare workers worldwide (Chwarzinger et al., 2021); mostly an AE issue.

Our population's choice making pattern motivated 23.3% who were vaccine hesitant to accept a COVID-19 vaccine (mostly 2 doses only), preferring the risk of some AEs to not becoming subject to COVID-19 contagion dilemmas. Particularly vaccination stands as a genuine procedure against COVID-19 transmission and severity. As importantly, a booster dose is required to confer maximum immunity. Until late 2021-early 2022, most optimistic reports point out that less than 60% have ever received a booster dose (CDC, 2022b). Less frequently adequate vaccine response features the health workers' COVID-19 attitudes. For instance, an overall good response accounted only 60.5% of Ethiopian HCW population; meanwhile only 64.0% of them accepted a COVID-19 vaccine.

Further, 46.9% of those workers thought the vaccine would worsen pre-existing medical conditions (Adane et al., 2021). In a US survey, only 63.7% of Philadelphia health employees, too, reported planning for a COVID-19 shot; over 80% of those unwilling to get a shot expressed a concern about AEs or the vaccines' newness. Planning for a COVID-19 vaccine was likely associated with age, being male, and education (Kuter et al., 2021). In our study, age and being "clinician" were significant correlates; too, sex and prior vaccine education were not. In west KSA, vaccine acceptance by 148/171 (86.6%) of health workers was reported. Where sex, being a physician, prior COVID-19, and COVID education, but not age, was linked to good survey response (Afifi et al., 2022) also 36 (21.0%) workers reported a vaccine acceptance on top of a vaccine hesitation.

Knowledge sources

The AHHWD's tendency for reliable sources of information, such as scientific/MOH/WHO, for COVID-19 updates was unfavorable; otherwise this preference was rather acceptable earlier (aOR 2.6, 95%CI 1.1-5.6) (Saad et al., 2021). Our odds for an unreliable source was 0.83 (1/1.25), an association, e.g., as strong as 3.4% was often reported (Jemal et al., 2021). Rates, such as 61.0% were recognized globally (Bhagavathula et al., 2020). Locally, only 22.4- 23.3% of health employees implies relying mainly on

ranked source (e.g., MOH, WHO, CDC), for a reliable update on COVID-19, and over 36% depended on social media and news media channels (Almohammed et al., 2021).

Correlates of COVID-19 inquiry responses

General COVID-19 education influenced the HCPs' response adequacy, while IPC training did not boost their responses toward the recommended measures, so as COVID-19 vaccine education. Variable results have been found with this respect. For instance, COVID-19 education of Indian health providers did not influence COVID-19 knowledge soundness; demographics, eg., marriage, urban dwelling, higher qualification did (Gopalakrishnan et al., 2021). On the other hand, COVID-19 education, together with work place; higher education, influenced COVID-19 attitudes in case of Ethiopian health workers (Yesse et al., 2021). Not only is it transmissible or resistant to treatment more than the original strain BA.1, but the recently identified subvariant Omicron BA.2 may cause an aggressive disease with severer lung damage, e.g., recording daily fatality 5-times higher than the predecessor Delta variant (CDC, 2022b). Not uncommonly, the emergence of new variants remains a possibility. High disease incidence, therefore, promotes for the emergence of new mutations that could become dominant (Lecrubier, 2022). As with flu illnesses, "endemicity" of any residual COVID-19 virus is probability; in which case, vaccination may be scheduled seasonally. Until enough layers of immunity have been built up, a population-wide protection could be provided. To accept endemicity or to speculate epidemic resurgences, a question that only time can answer.

A lesson from HCPs' responses to COVID-19 revisited

Infection control guidance and the promptness and quality the health systems portray, played a leading role in the attempts to survive the crisis. Transmission, mortality, and COVID-19 ICU admission trends would be reassessed every time a new variant emerges. To us, an unstable pandemic behavior motivates the healthcare community to stay on alert. In situations where due IPC procedures were appreciated, as in the AFHWD experience, healthcare -acquired COVID-19 infections declined. The improved availability of some interventions should not persuade the populations to lose sight of the pandemic. On the field, differences between clinical and non-clinical professionals in COVID-19 perception do influence the perception of COVID-19 interventions, including vaccination.

Limitations

The study was a unique attempt to endorse the change in the level and quality of the commitment of the health workers to preventive polices in response to a surprising pandemic. All AFHWD professionals were invited to the study; yielding a response tendency of 56.2% during study period. A rather small number of participants may limit generalizing our findings to some other healthcare settings. However, AFHWD population was first "piloted", early in the outbreak (Saad et al., 2021), a step forward toward further evaluation down the road of the pandemic. In the two opportunities, there has been enough matching, eg., study setting, demographics, study instrument, leaving only the outcomes to vary. Maximum validity of the findings though would be assured. Other factors, eg., honesty responding to surveys traditionally limit studies of similar settings. On our part, confidentiality would also limit this probability. Comparing specific procedures, eg., AGP precautions could be confounded by profession; in which case stratification and using aOR, where appropriate, alleviated this concern.

5. CONCLUSION

The study presents a comprehensive database regarding the HCPs' responses to rigorous COVID-19 protocols throughout the pandemic. Most relevant requisites have been thoroughly explored, and compared. Several modest performances were improved, e.g., overall response, COVID-19 knowledge, the leading role of the physicians assuring a safer work environment. Particularly abidance by IPC recommendations, boosted by the response to planned IPC training was significantly emphasized. Maintaining successful COVID-19 tactics in the presence of a rather fresh vaccine experience, integrated with the ongoing national efforts is a merit to maximize. Findings from this research conform to the need to keep up with evaluating and improving hospital policies against COVID-19 variants and any emerging outbreaks. Particularly continued training, aiming to reduce the difference in the HCP groups' competency on procedures of a common importance is a priority.

Authors' contributions

Author R.M.A. set study design, methodology, shared in preparing study instrument, conducting statistical analysis, data display, discussion guidelines, and final write up. Author A.S. set research proposal, research concept, infection control plan, data entry,

data display; report review. Author H.M.A. held ethical approvals, study instrument validation, supervised data collection and study progress; set recommendations. Author H.A. shared in setting study context, data collection, reviewing study result, manuscript preparation. Author B.I. shared in setting study concept, data retrieval, results display; setting safety and quality guidelines. Author M.Y.E shared in comparative data collection and entry, setting clinical guidelines, and staff training. Author M Kh.A set clinical guidelines, critical revision of manuscript, evidencing and referencing, results interpretation. Author F.H.A. shared data collection, EMR data retrieval, data entry, manuscript preparation. Author Y.A shared setting study context, manuscript preparation, publication logistics, final manuscript editing. All authors read and approved the final manuscript.

Informed consent:

Written and oral informed consent was obtained from all individual participants included in the study. Additional informed consent was obtained from all individual participants for whom identifying information is included in this manuscript.

Ethical approval: Approval from Research and Ethics Committee, AFHWD "EMP #2819 April 5, 2021" has been granted.

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Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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