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Healthcare workers awareness and perception to COVID-19 measures and their attitude toward the vaccine rollout: A Saudi Arabian experience

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ABSTRACT

Background: COVID-19 still poses a threat to healthcare workers (HCW). *Aim:* Study knowledge and attitude of the HCWs of King Abdulaziz Specialist Hospital (KASH), Taif, Saudi Arabia, about COVID-19 and the vaccine rollout. *Methods:* A questionnaire was self-administered to achieve study aim. *Results:* The participants aged 39.3±3.9; 41.5% were physicians, 58.5% non-physicians. A questionnaire's mean overall score [93.5 (62.3%)] <cutoff [105 (70.0%); p<0.001] was recorded; "physician" was predictor for score variability (p<0.001). A mean "COVID-19 epidemiological/clinical knowledge" score [22.2/32 (69.4%)] comparable to the cutoff [22.4/32 (70%), p=0.64]; and that [21.7/38 (57.1%)] for "COVID-19 infection prevention/ control (IPC) guidelines" <cutoff [26.6/38 (70%), p<0.001] were recorded. Perception [21.3/28 (76.0%)] of the latter exceeded the cutoff [19.5/28 (70%), p<0.001]. Despite a modest vaccine response, 86.5% HCWs were vaccinated candidates. Being a physician, male, had COVID-19 infection were vaccination predictors. *Conclusion:* A satisfactory COVID-19 knowledge and a favorable IPC attitude; with a modest vaccine response yet a notable vaccination acceptance were reported. Supplementing our HCWs' adequate COVID-19 control practice, e.g., through holistic COVID-19 training until enough evidence for vaccine safety has been established is warranted.

Keywords: Healthcare workers, COVID-19, vaccine, perception, Saudi Arabia.

1. INTRODUCTION

Ever since its declaration as an emerging pandemic in March 2020, COVID-19 (SARS-CoV-2) still records hundreds of thousand infections and claims thousands of lives daily around the world (WHO, 2021a). Common COVID-19 symptomatology ranges between asymptomatic presentation to mild symptoms, e.g., fever, cough, malaise, breathlessness; anosmia. (CDC, 2020a);

risk factors for a severe disease include old age, male gender, chronic diseases (e.g., diabetes, and chronic heart disease) (Zhou et al., 2020). Beside the airborne droplet route, transmission through infectious body fluids is a HCWs' concern. Several mutant SARS-CoV-2 variants being monitored (VBM), have been recognized globally; some of which are variants of concern (VOC), important of which is the delta (B.1.617.2)- and recently Omicron (B.1.1.529) variant (WHO, 2021b), in terms of transmissibility, discernibility, the ability to evade both detection by specific tests and natural or vaccine-induced immunity; and resisting monoclonal antibody agents, (CDC, 2021). A plethora of researches have been reviewing multi-epitope vaccine polypeptides for activating the human immune system against SARS-CoV-2, e.g., live-attenuated whole virus, DNA vaccines, vectored vaccines, and messenger RNA (mRNA) immunogenic material. Particularly "BNT-162b2" (Pfizer- BioNTech) is a nucleoside-modified mRNA valent showed an efficacy up to 95% (Polack et al., 2020). Only mild adverse events (AEs) greater than 2%, e.g. were pain at the injection site, fatigue, while severer AEs affect less than 1% of all age groups (Cennimo, 2020; Marglani et al., 2021).

Despite the early approval of a number of COVID-19 vaccines under emergency use authorization, (Patterson, 2021; Kasemy et al., 2021; El-Rashid et al., 2021) and the increasingly encouraging results, comprehensive evidences for their remote safety and efficacy are yet to establish. For this reason, vigilance and adherence to IPC policies to prevent healthcare acquired infection is crucial. Attitude wise, a highest rate of vaccine hesitancy among demographic groups was in persons aged 30-49 (36%), rural residents (35%), and 33% of healthcare providers (ACIP, 2021). Apparently, the most common reason for reluctance is concern about AEs. Emergency authorization was another factor associated with lower acceptance (ACIP, 2021). The CDC is collecting vaccine safety information through multiple follow up channels. In Saudi Arabia, a vaccination campaign has started since December 17, 2020, mainly based on mRNA (BNT-162b2) and vectored vaccine AZA-1222 Ad5-CoV (AstraZeneca; Oxford University) (MOH, 2021). A web-based application ("Sehaty") has been established, and vaccination stations opened for inoculating the vaccine, part of phase 1 roll-out which included HCWs of highest risk (COVID-19 care givers, IPC staff, emergency personnel, and intensive care units-ICU staff). To date, there still is a range of uncertainty about some of the circulating COVID-19 virus's epidemiologic, risk, and immunological behavior.

The level of knowledge; the attitude of HCWs to COVID-19, including the vaccine needs a continual evaluation. This study aimed to explore the level of knowledge and acceptance of KASHHCWs to COVID-19 applicable preventive procedures, a long side with the attitude toward COVID-19 vaccine rollout, and potential correlates.

2. SUBJECTS AND METHODS

Design and study subjects

The HCWs were cross-sectioned, including direct care providers: a) "clinician" (physician, dentist, chiropractor; clinical psychology, physical therapy, respiratory therapy, speech therapy, dietician); b) "nurse"; c) "technician"; d) "allied health" (e.g., cardiovascular technologist, anesthesiology technologist, nuclear medicine technologists, paramedic); e) "pharmacist", and f) "other" (indirect care givers (supplementary services, e.g., sterilization, waste management, catering). "Clinician" will be referred to as "physician" and indirect care providers as "other". No HCW would be excluded because of sex, nationality or other demographic and professional criteria.

Data collection

The study's data collection started April – until June, 2021. A questionnaire was designed and validated, guided by relevant publications, (Huynh et al., 2020; Saad et al., 2020) updated guidelines for HCWs safety and protection amid coronavirus pandemic, (SCDC, 2020; WHO, 2020a; WHO, 2020b; CDC, 2020b), COVID-19 vaccination updates, (ACIP, 2021; Cennimo, 2020; Muthumani et al., 2021; Polack et al., 2020), local COVID-19 vaccination guidelines, (MOH, 2021)and IPC best practices, e.g., personal protective equipment (PPE) utilization and hand hygiene (HH) procedures (NIPCM, 2020; WHO, 2020c). The questionnaire consists mostly of closed-ended items, and multiple choices, e.g., yes/true, no/false, often/rare, unsure/don't know, or agree, fair, disagree, can't decide were given. The questionnaire falls into 5 sections: 1) Demographic and occupational characteristics to select most appropriate response. 2) Attitude to health safety and IPC guidelines amid COVId-19 outbreak (e.g., working hours, regular medical checkup, first aid information, health and safety education), rating general IPC guidelines [e.g., incident reporting, availability of HH and PPE facilities, IPC training, skin damage from PPE/hand washing (HW), sharp injury, body secretion exposure measures], rating the facility's IPC policy and risk assessment (e.g., PP measures, HCWs immunization policy). 3) COVID-19 related knowledge, including epidemiological and clinical facts, e.g., virus origin, mode of transmission, incubation period (IP), symptomatology, treatment modalities, reliability information sources about the pandemic (i.e., medical, governmental, social media, family/friends), COVID-19 education). 4) Specific IPC measures knowledge [such as, HW and alcohol-based hand rubbing (ABHR), measures caring

for a suspected COVID-19 cases, e.g., isolation procedures, standard/contact/droplet/airborne precautions, precautions during aerosol generating procedure (AGP, e.g., intubation, non-invasive ventilation, tracheotomy, CPR), PPE donning and doffing, masks and respirators knowledge]. 5) Knowledge and perception about the vaccine, including acceptance, attitude and beliefs, e.g., vaccine types, affectivity, reactogenic AEs, concerns, preferences, vaccination scenarios in relation to COVID-19 infection, COVID-19 vaccination status, vaccine confidence.

In a piloting, 25 health professionals were given the questionnaire twice to administer, with one- week duration in-between. A strong reliability and internal consistency (r 0.90– 93, Cronobach's alpha 0.90) have been found. Sections 2- 5 were scored on a 4-point Likert scale: 1 = least - and 4 = most favorable response. Summing up all scores yields a total score ranging between 36- 150. A cutoff 70% was set to delineate either "sufficient/good" / "insufficient" knowledge level or "favorable" / "unfavorable" perception. The questionnaire starts with explaining the study's aim and importance for the HCWs' amid COVID-19 crisis, assuring them of confidentiality of the information they provide. The questionnaire was formatted on a Google application sent via WhatsApp; and needs around 20 minutes to complete. Responses with ≥80% valid answers were coded, entered to MS program with adequate backups until analyzed.

Study variables

Qualitative data, e.g., demographic and items in other sections may offer either a binary response, e.g., yes / no, or a multi- level selection. The latter may be binned to "sufficient"/ "insufficient", e.g., certain IPC practices, AGP. An "overall" score = sum of section scores constitutes the study's principal outcome. The latter may often be binned as "sufficient / in sufficient". The score on each section represents an intermediate outcome to analyze, where needed. An institutional review board (IRB) clearance was granted by Directorate of Health Affairs - Taif Research and Studies Department to conduct the study. A hospital management's approval to commence data collection was obtained.

Statistical analysis

Qualitative data, e.g., profession would be described as count (%); quantitative data, e.g., item scores, as the mean ± standard deviation (SD), (where normality distribution allows). Techniques, such as one-sample t-test for the difference between an archived score and the cutoff, and one-way analysis of variance (ANOVA) for the mean differences between three or more variables, may be calculated (Normality distribution also was first assured). The association between categorical variables, e.g., COVID-19 knowledge-binary and professions, χ^2 test (or Fisher's exact, where appropriate) with adjusted odds ratio (aOR) and 95% confidence interval (CI) may be used. The "Statistical Package for Social Sciences" (SPSS) software for MS, version-22 (Armonk, NY) was used in the analyses. Our level for rejecting a true null hypothesis was α=0.05; results with a p-values <0.05 was considered statistically significant.

3. RESULTS

Out of 297 questionnaires distributed, 180 were returned, (response rate 60.4%), among which 171 were admitted to the analysis. The participants' age averaged 39.9±9.3y; most (61.4%) were male, 52.0% married, and 49.1% Saudi. Physicians accounted a majority (41.5%) of participants, then nurses (18.1%), technicians (14.6%), and least were allied HCWs (6.4%) and pharmacists (5.3%), (table 1).

The remaining 14.0% included supportive services staff. There was a significant difference in the overall mean score [93.5/150 (62.3%)] [F (df 5, 165) = 21.03, p<0.001]; yet, this score was significantly lower than the cutoff 105/150 (70%) [t (df 170) = – 6.8, p<0.001], (table 1 footnote). Only 64 (37.4%) HCWs scored "sufficient" "overall" performance [χ^2 (5) =41.9, p<0.001], (table 1). A linear regression modeling to predict the variability in overall score per unit change in the input variables revealed the equation: $P|overall\ score| = 78.9 + 0.24\ (age) + 12.7\ (physician)$.The model was significant [ANOVA: F (df 2, 168, 170) =29.5, p<0.001] and explains 25% of the change in score (R^2: 0.25), (table 1 footnote).

In table 2, "all-knowledge" mean (section 3+4) did not mount up to the cutoff [43.9 (62.7) vs. 49 (70%): t (170= –6.5, p<0.001]; only 64 (37.4%) of HCWs had a "satisfactory" "all-knowledge" [physicians v. "all- other HCWs": χ^2 (1)=12, p=0.04],(table 2 footnote). The mean [21.7/38 (57.1%) COVID-19 control knowledge (section 4, table 2) was lower than that expected [26.5/38 (70%)] (table 2); [t (df 170) = – 8.8, p<0.001] (table 2 footnote). However, the score for COVID-19 knowledge/clinical a lone (section 3) met the target [22.2/32 (69.4%) vs. 22.4/32 (70.0%), t(df 170) = – 0.46, p=0.64], and 66 (39%) had satisfactory clinical COVID-19 knowledge [χ^2(1)=8.8, p<0.001],(table 2 footnote). This performance also varied by profession [F (df 5, 165) = 3.5, p=0.005] (table 2), e.g., physicians scored higher other HCWs [post hoc: physician (23.7) v. technician (22.2), and v. allied HCW (22.8), p<0.05], (table 2 footnote).

Table 1 Performance on study survey: Demographic and overall scoring pattern (N = 171)

Demographics											
Age	Mean 39.3 ± 9.3; range 25 - 61										
Sex	Male 105 (61.4%), female 66 (38.6%) mal : female 1.6 : 1										
Marital status	Married 89 (52.0%), single 62 (36.3), divorced 20 (11.7%)										
Nationality	Saudi 84 (49.1%), non-Saudi 87(51.0%)										
Profession	n	%	Mean score⊩	SD	% of Max.	Min.	Max.	Statistic, sig.	Sufficient n (%)	Insufficient n (%)	Statistic, sig.
Physician	71	41.5	102.6	14.7	68.0	71.65	146.2	F(5, 165) = 21.03 p<0.001	35 (49.3)	36 (50.7)	χ^2 (5)=41.9 p<0.001
Nurse	31	18.1	93.2	9.7	62.1	72.50	110.5		10 (32.7)	21 (67.3)	
Technician⁊	25	14.6	92.9	12.8	61.9	71.80	114.0		7 (28.0)	18 (72.0)	
Allied HCW⁊	11	6.4	78.6	8.1	52.4	67.50	88.9		4 (36.4)	7 (63.6)	
Pharmacist	9	5.3	90.2	1.9	60.1	88.40	93.4		3 (33.3)	6 (66.7)	
Other	24	14.0	75.7	10.8	50.5	51.05	92.6		6 (25.0)	18 (75.0)	
Total	171	100	93.5*	15.6	62.3	51.05	146.1		64 (37.4)	107 (62.6)	

*1-sample t-test (1-tailed): Mean performance score 93.5/150 (62.3%) vs. cutoff 105 (70%): t (df 170) = –9.6, p<0.001

⊩Regression: P⁞ Overall score⁞: [78.7+0.24 (age) +12.7 (Occupation); p<0.05 all]. R^2 0.25; ANOVA: F (2,168,170)=29.5, p<0.001

⁊ Allied HCW (technicians + allied HCWs: n=36, mean score = 88.6/150 (59.0%).

Table 2 COVID-19 knowledge" level stratified by HCWs' profession (N= 171)

	COVID-19 epidemiological and clinical knowledge (section 3)⊩				*Specific COVID-19 IPC/ PPE knowledge (section 4)*⊩				*COVID-19 " all-knowledge" (section 3+4)*⊩			
Profession	Mean	SD	% (of 32)	Statistic, sig.	Mean	SD	% (of 38)	Statistic, sig.	Mean	SD	% (of 70)	Statistic, sig.
Physician	23.7*	4.8	74.0	F(6,165) = 3.5 p=0.005	24.8	7.6	65.3	F(6,165) = 3.5 p=0.005	44.4	10.1	63.4	F(6,165) = 11.4 p<0.001
Nurse	22.5*	6.0	70.3		20.2	5.7	53.1		44.1	10.8	63.0	
Allied HCW	19.7	4.8	61.6		22.8	5.87	60.0		44.0	9.5	62.8	
Technician	19.2	5.4	60.0		23.0	6.27	60.5		45.2	11.2	64.6	
Pharmacist	21.4	2.0	66.9		17.8	4.5	46.8		41.9	7.9	59.8	
Other	21.8	4.3	68.1		14.2	3.2	37.4		42.4	10.4	60.6	
Total	22.2	5.1	69.4⁊		21.7 ⊣	7.2	57.1		43.9 ⊦	10.2	62.7	

* Post hoc (section 3): Physicians score significantly > the technicians' and allied HCWs. Nurses behaved likewise

⁊ 1-sample t-test (section-3): Mean score 22.2/32 (69.4%) vs. cutoff 22.4/32 (70%): t (170) = – 0.46, p=0.64

⊣1-sample t-test (section-4): Mean score= 21.7/38 (57.1%) vs. cutoff 26.6/38 (70%): t (170) = – 8.8, p<0.001

⊦1-sample t-test "all COVID-19 knowledge" (section 3+4): Mean 43.9/70 (62.7) vs. cutoff 49/70 (70%): t (170=–6.5, p<0.001

⊩ χ^2tests: Section 3: 66(39%) [χ^2(1)8.8, p<0.001]. Section 4: 57(33.3%) [χ^2(1)12, p0.04]. Section3+ 4: 64(37.4%) [χ^2(1)12, p=0.04].

The perception mean score to IPC guidelines (21.3/28 (76.0%) was significantly above the cutoff 19.5/28 (70%; [t (170) = 4.6, p<0.005)], (table 3 footnote). In parallel, 121 (70.8%) participants (53 physician + 68 "all other HCWs") had such favorable perception, (figure 1). Physicians scored > allied HCWs (20.7), (p<0.001, post hoc) but not differently from nurses (23.6, p=0.18), [F (df 5, 165) = 9.1, p<0.001]. Nurses scored higher then allied specialist (20.7) and technicians (15.5), (p<0.05), (table 3 footnote). Stratified as "physicians"/ "all other HCWs", too, there was an equivocal awareness of AGP precautions [31 (18.1%) and 33 (19.3%), respectively; χ^2 (1) = 2.01, p = 0.15]. The mean for this item was lower than the cutoff [2.2/4 (55%) vs. 2.8/4 (70%); t (170) = – 6.9, p<0.001]. Also, the reliability of COVID-19 information sources was equivocal among participants [χ^2 (1) = 0.2, p = 0.65], and was higher than that expected [mean 2.9, vs. 2.8, t (170) = 2.3, p = 0.019].

Table 3 Participants' perception to safety and IPC guidelines amid COVID-19 pandemic, stratified by profession

Profession		*Health and IPC guidelines amid Covod-19 (section 2)*‖					
	n	%	Mean	SD	% (of 28)	Statistic	Sig.
Physician *	71	41.5	22.3	4.8	79.6	F(6,165) = 9.1	p<0.001
Nurse *	31	18.1	23.6	3.5	83.2		
Allied HCW	25	14.6	20.7	4.1	73.9		
Technician	11	6.4	15.5	5.9	55.3		
Pharmacist	9	5.3	23. 7	1.3	84.6		
Other	24	14.0	17.9	5.1	63.9		
Total	171	100.0	21.3 ǂ	5.0	76.1		

* Post hoc: Physicians v. allied HCWs: p<0.001. Nurse vs. allied HCWs and vs. technicians, p<0.05

ǂ 1-sample t-test (section 2): Mean score 21.3/28.vs. cutoff 19.5/28 (70%): t (170) = 4.6, p<0.001

‖ χ^2 test: Physician +ve v. –ve: 53 v. 18; "All other": 68 v. 32; Total: 121v. 80; [$\chi^2(1) = 9.2$, p = 0.026].

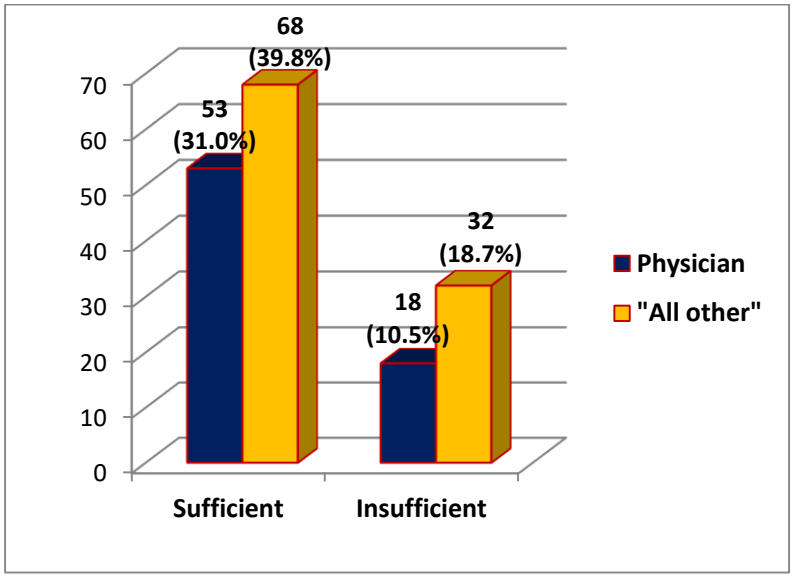

Figure 1 Perception to IPC measures by profession: physical vs. "all other"

Less than half (40.3% of the participants had a "good" overall response to vaccine inquiry (table 4 footnote), with a mean score of 28.1/52 (54.4%); which was generally lower than the cutoff [36.4/52 (70%); [t (170) = –15.2, p<0.001] (table 4 footnote). In linear relationship testing, "all-knowledge" mean score (sections 3+4) and COVID-19 vaccine response were not correlated (r = 0.29, p=0.081). Most HCWs [148/171 (86.5%)] reported they have planned to receive a COVID-19 vaccine (either the 1st dose or completed the 2 doses prior to participation, or would be vaccinated on scheduled time). There was not a difference between HCWs in the vaccine acceptance level (p= 0.62), (table 4). Likewise, the majority [135 (78.9%)] showed vaccine confidence, and they did not differ with this regard (p= 0.36).

Out of 36 vaccine hesitant HCWs (18 "unconfident", 18 "unsure") 23 (63.9%) were among those the vaccine acceptance group and out of 148 who accepted the vaccine, 135 (91.2%) were vaccine confident, while only 23 (8.8%) were not so. The frequency of vaccine acceptance was significantly associated with the confidence level [$\chi^2(1) = 44.6$, p<0.001], (table 4). A linear regression model to predict the variability in vaccine response score yielded the equation: *P| Vaccine response| = 20.6 + 4.5 (Sex) + 1.1 (Occupation) + 2.9 (H/O COVID-19 infection) + 0.23 (Score section 2);* (age and nationality were non-significant); i.e., being a "physician", "male", "having previous COVID-19 infection", and section 2 score can be used to calculate the overall vaccine response score. The model was significant [ANOVA: F (7,163,170) =18.1, p<0.001] and could explain 41.1% of the change in vaccination acceptance score (R^2 = 0.413), (table 4 footnote).

Table 4 COVID-19 vaccine response*: acceptance and vaccine confidence ** (N = 171)

Profession	*Vaccination acceptance*											
	Received/Planning/			Unsure/Hesitant/			Did not plan/refused					
	n	% row	% total	n	% row	% total	n	% row	% total	*Total*	% total	Statistic, sig.
Physician	65	9 1.5	38.0	3	4.2	1.8	3	4.2	1.8	71	41.5	χ^2 (2) = 0.9, p= 0.62
"All other HCWs"	83	83.0	48.5	10	10.0	5.8	7	7.0	4.1	100	58.5	
Total	48**	86.5	86.5	13	7.6	7.6	10	5.8	5.8	171	100.0	
	Vaccine confidence											
	Confident			Unsure			Unconfident					
	n	% row	% total	n	% row	% total	n	% row	% total	*Total*	% total	Statistic, sig.
Physician	59	83.1	34.5	6	8.4	3.5	6	8.4	3.5	71	41.5	χ^2 (2) = 2.0, p= 0.36
"All other HCWs"	76	76.0	44.4	13	13.0	7.6	12	12.0	7.0	100	58.5	
Total	135	78.9	78.9	18	10.5	10.5	18	10.5	10.5	171	100.0	
	COVID-19 vaccine attitude: Vaccine acceptance vs. vaccine confidence											
Vaccine confidence	Accepted			Unaccepted			*Total*	Statistic		Sig.		
	n	% column	% total	n	% column	% total						
Confident	135	91.2	78.9	0	0.0	0.0	135	χ^2 (1) = 44.6		p<0.001		
Unconfident	36	8.8	21.0	23	100.0	100.0	59					
Total	148	100.0	86.5	23	100.0	100.0	171					

*Vaccine overall response rate all HCWs: Favorable 69 (40.3%), unfavorable 101 (59.1%), p=0.04.

1-sample t-test: Overall vaccine response (section 5): Mean score 28.1/52 vs. cutoff 36.4/52 (70%): t (170) = –15.2, p<0.001.

**OLS: P |Response|: 20.6+4.5(Male) +1.1(Physician) +2.9 (Q 33) +0.23 (Section2); R^2 0.413; ANOVA: F (7,163,170)18.1; p<0.001]

4. DISCUSSION

The study started April 2021, a midst an upsurge of the pandemic, time when mutant virus strains (CDC, 2021) with unprecedented transmissibility have emerged. A study focus involved important COVID-19 aspects, as well as knowledge and perception about exposure prevention and source control. The initial Covid-19 vaccine launches under the emergency authorization umbrella, (WHO, 2020d) extended our focus to address vaccine acceptance as a specific research inquiry. The predominant participation of our physicians over other HCW staff reflects an interest to take a leading part in the efforts to unveil the plenty of uncertainties around SARS-Cov-2 on scientific evidence basis. A fair questionnaire response rate (60.47%) has been achieved. Since the pandemic, a state of "survey fatigue" characterized by decreased response rates has been proposed due to a surge in a COVID-19 related survey-based activity, exaggerated by a restriction of other data collection methods (deKoning et al., 2021).

Overall questionnaire response

An overall 62.3% of questionnaire performance generally reflects a modest knowledge and perception response trend to our HCWs to COVID-19 competencies in question. The number of infections among HCWs in this pandemic is worrisome both at the professional and societal levels. On our part, we set a COVID-19 safety reference level as high as 70% to assure highest level of protection against such healthcare acquired virus transmission. Often, HCWs CPVID-19 surveys adopt lower response cutoff, e.g., 50% as the favorable response limit for the HCWs' studied (n=147) (Agarwal et al., 20210). The overall response of a Vietnamese HCWs group to COVID-19 pandemic was "good", (Huynh, et al., 2020); (no reference score was given, too). Not uncommonly, too, other studies, such as that from Ugandan recorded a sufficient overall COVID-19 surveying response (83.9%) (Kamacooko, et al., 2021); age (>35 years), but not profession, was a significant predictor for the overall performance, while profession (physician) but

not age was so in our study. A head-to -head comparison in such researches are not feasible, due to the plenty of factors related to study settings and socio-demographic variations. For instance, having a health research experience was a selected predictor for the variability of COVID-19 epidemiological and clinical knowledge level in the Uganda; the same factor was not selected as a predictor in pours'- and the Vietnamese-study. The difference between studies could also be attributed to an ongoing the "infodemic" phenomenon that has led to a misinformation campaign and anecdotal evidence that is widespread even among HCWs (Hua & Shaw, 2021).

COVID-19 knowledge response

The HCWs' COVID-19 epidemiological and clinical knowledge level was particularly sufficient (69.4%). Being either a physician or a nurse was associated with such favorable knowledge. In Uganda, (Kamacooko, et al., 2021) too, being a clinical HCW was a predictor for COVID-19 knowledge sufficiency; likewise in our study. Our HCWs' COVID-19 knowledge performance was also comparable to what had been found in Greece where a significantly "good" level (score ≥80%) of Covid-19 knowledge had mostly been reported (Papagiannis et al., 2021).

COVID-19 control knowledge response

The knowledge level (57.1%) regarding our Covid-19 IPC and PPE guidelines did not live up to the required standard. A study on a cohort of 311 Japanese HCWs (stratified as physician/non-physician), of a preventive Covid-19 focus (e.g., IPC measures, patient isolation, PPE utilization), reported a significantly insufficient knowledge level with this regard (Kadoya et al., 2020).

"All-COVID-19 knowledge" awareness

Our HCWs' performance on "all COVID-19 knowledge" was rather insufficient (62.7%). A study from UAE (Abdel Aziz et al., 2021) about the knowledge and attitude of 176 HCWs (27.3% physicians, 72.7%, nurses, 85.2% non-Emiratis; compared to 38.6% physicians, 41.5% nurses; 18.1% non-Saudis, respectively in our study) also found that only 57.4% of recruits had sufficient COVID-19 knowledge. On the other hand, the UAE's study (Abdel Aziz et al., 2021) generally tended to report a satisfactory level of COVID-19 epidemiological/clinical knowledge (e.g., virus origin, infectiousness, IP, symptoms), likewise ours'. Further, less than 65% of the UAE workers exhibited a satisfactory knowledge level regarding COVID-19 protection practices (e.g., isolation of contacts with positive cases), compared to 33.3% of our HCWs; with a scoring profile significantly lower than the expected.

General IPC guidelines perception

The perception to protection guiltiness amid the pandemic by 70.8% of the participants was beyond the desired standard (i.e., score 76.1%), particularly among physicians and nurses who behaved equivocally, but more favorably than other allied health workers. (Pharmacists were as frequently committed to these guidelines as nurses). The behavioral study of Vietnam (Huynh et al., 2020) also agrees that pharmacists were as equivalently positive toward these measures as physicians and the nursing staff. Conversely, only 50.6% of UAE HCWs studied (Abdulaziz et al., 2021) had a sufficiently positive protective attitude on items addressing concerns about personally acquiring the infection, (such as the subjectivity to nosocomial COVID-19), compared to 70.8% rate of confidence in the utilized protective measures in the study on hand.

Responses to specific IPC precautions

There is a scarcity of addressing AGP as one of the important source control in studies analyzing HCWs' COVID-19 knowledge and behavior responses (Huynh et al., 2020; Bhagavathula et al., 2020; Papagiannis et al., 2021; Saad et al., 2020). Our participants' response to AGP precautions caring for suspected COVID-19 cases was not up to the expected level. In Japan, (Kadoya et al., 2020) the HCWs' awareness about AGP precautions, dealing with COVID-19 cases was also inadequate. Physicians and non-non-physicians reacted equivocally inadequately in the two studies.

Knowledge sources preferences

Although KASH staff, whether physicians or non-physicians, tended to resort to evidence-based sources for gaining information about COVID-19 more frequently, this tendency (61.4%) did not meet the level set for this inquiry. In COVID-19 knowledge and attitude literature, a tendency for relying on less-scientific sources has frequently been noted. For instance, over 70% of a Nigerian HCWs derived their COVID-19 information from the social media and the television. Moreover, 91.1% of Vietnamese counterparts (Huynh et al., 2020), including physicians, were predominately using social media as a main source of COVID-19 information. In

UAE the situation was somewhat different, where 91.5% of participants used official health organizations as the primary source of information, but only 38.1% reported using scientific journals as one of the sources (Abdel Aziz et al., 2021).

Vaccine response

The time of this study, 86.5% (148/171) of our HCWs positively accepted a COVID-19 vaccine, and only 13.5% disagreed to take it. Being a male was one of our HCWs' vaccine acceptance correlates. Comparatively, 75% of male HCWs in USA have planned on being vaccinated (within 30 days) vs. 60% of female peers (Ciardi et al., 2021). In UAE, (Abdel Aziz et al., 2021) a higher proportion [40.9% (72/176)] of the health workers expressed some hesitancy to take the vaccine (once available), who were predominantly females (90.0%) and nurses (72.7%), (the majority of the latter was also female nursing staff). A comparatively high vaccine acceptance rate (77.8%, n=298) among HCWs in different KSA regions has been reported (Alhofaian et al., 2021). It has been shown that the concern about the productive ability could have been a predictor for such women's hesitancy about the vaccine (Ciardi et al., 2021). However, further analysis by age did not suggest that women of childbearing age differed from the overall female population. Other predictors for vaccine acceptance included age, role in hospital, and personal risk perception (Ciardi et al., 2021; Ahmed et al., 2021).

We found that the majority (63.9%) of those who were vaccine skeptical opted to receive a COVID-19 vaccine, regardless their concerns. This indicates that their "personal risk perception" could be motive to get a vaccine with a side effect profile yet to be understood rather than getting the infection the complications of which can be devastating, especially those in direct contact with the patients. The current coronavirus COVID-19 pandemic is yet to be reassuring. With the beginning of winter of 2021, there has been an increasing trend in new global COVID-19 cases and mortality with escalating weekly rates. As of 14 November, over 252 million confirmed cases and over 5 million deaths have been reported (WHO, 2021a). The Americas, the European and the Western Pacific Regions all reported increases in new weekly cases, while other regions reported less invasive trend. Any easiness in enforcing strict protective and preventive measures impacts virus transmission in all communities, especially between the frontline personnel. On the other hand, in circumstances where prescribed IPC protocols were strictly watched, reports of new HCAI of COVID-19 significantly declined. That in mind, the need for utmost vigilance to enhance the health workers' community protection against the virus is mandatory.

Limitations

The study provides an insight on the awareness and perception of KASH health professionals regarding the clinical and protection trends congruent with COVID-19. A rather limited response questionnaire rate may limit the study's generalizability. Not uncommonly, low participation rate, as well as honesty responding to questionnaires by healthcare audience would be a concern, e.g., probably due to job security fear, and the like, in spite of the utmost confidentiality and the anonymity we aimed to provide to all invited workers. However, the interest in stratifying most of the analyses, e.g., by profession, helped control the confounding effect of demographic traits upon the results. The use of aOR, where appropriate, was another way to minimize confounding. The change role of the new virus patterns and parallel change in the conclusions about it and the methods to mitigate, limited our ability to incorporate some updated policies such as the need for a booster dose of the vaccine, in the questionnaire material.

5. CONCLUSION

Enjoying an adequate COVID-19 knowledge, a favorable infection control perception, and a high vaccination acceptance helps develop training programs to raise the staff's preventive skills; provide favorable environment for a most efficient COVID-19 control strategy. Adopting future research to resolve the debate about questionable vaccine issues helps lessens residual hesitance about COVID-19 immunization.

Authors' contributions

Author R.M.A. handled study guarantor role, set the study design, methodology, study instrument, statistical analysis plan, data display, discussion outlines; write up, supervised publication process. Author M. Kh. A. Founded study idea, shared in study design, preparing the study proposal, study instrument, study approvals; supervised study progress. Author B. A. defined intellectual content, set clinical and diagnostic criteria, clinical literature evidencing, designed and supervised pilot study, assured study questions answered. Author A.S. set the infection control guidelines, shared in data analysis, discussion, literature evidencing, manuscript editing. Author S. A. A. supervised study approvals, resources allocation, shared in data acquisition, monitored study integrity, discussion outlining, manuscript preparation, recommendations. Author M. A. supervised data

collection, shared in preparing logistics, data entry; participants' education. Author F.A. shared in literature review, data entry, results data formatting; referencing, final manuscript review, publication follow-up. All authors read and approved the final manuscript.

Ethical approval

An institutional review board was granted by Directorate of Health Affairs - Taif Research and Studies Department) to conduct the study (IRB Registration: HAP-02-T-067; Approval # 512; Feb. 11, 2021). A hospital management's approval to commence data collection and proceed with publishing the work was obtained.

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Conflict of interests

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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