Hesitancy of Arab Healthcare Workers Towards COVID-19 Vaccination: A Large-Scale Multinational Study

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Abstract

Background: Health Care Workers (HCWs) are at increased risk of acquiring and transmitting COVID-19 infection. Also, they present role models for communities with regards to attitudes towards COVID-19 vaccination. Hence, hesitancy of HCWs towards vaccination can crucially affect the efforts aiming to contain the pandemic. Previously published studies paid little attention to HCWs in Arab countries, which has a population of over 440 million. **Objectives:** to assess the rates of COVID-19 vaccine hesitancy in Arabic-speaking HCWs residing in and outside the Arab countries, and their perceived barriers towards vaccination. **Methods:** a cross-sectional study based on an online survey was conducted from 14-Jan 2021 to 29-Jan 2021, targeting Arabic-speaking HCWs from all around the world. **Results:** the survey recruited 5,708 eligible participants (55.6% males, 44.4% females, age 30.6±10 years) from 21 Arab countries (87.5%) and 54 other countries (12.5%). Our analysis shows a significant rate of vaccine hesitancy among Arabic-speaking HCWs residing in and outside Arab countries (25.8% and 32.8%, respectively). The highest rates of hesitancy were among participants from the west region of the Arab world (Egypt, Morocco, Tunisia, and Algeria). The most cited reasons for hesitancy were concerns about side effects and distrust in vaccine expedited production and healthcare policies. Factors associated with higher hesitancy included age of 30-59, previous or current suspected or confirmed COVID-

19, female gender, not knowing the vaccine type authorized in the participant's country, and not regularly receiving the influenza vaccine. **Conclusion:** this is the first large-scale, multinational, post-vaccine-availability study on COVID-19 vaccine hesitancy among HCWs. It reveals high rates of hesitancy among Arab-speaking HCWs. Unless addressed properly, this hesitancy can impede the efforts for achieving widespread vaccination and collective immunity.

Key Words: COVID-19 Vaccines, Vaccine Hesitancy, Healthcare workers, Vaccine Acceptance, Vaccination, Vaccines, Arab Healthcare workers.

Introduction

Health care workers (HCWs) are at high risk for occupational SARS-CoV-2 exposure and transmission, which prioritizes them for early COVID-19 vaccination. In addition, the different communities take HCWs as role models in their attitudes towards vaccination and refer to them for vaccine information [1]. For this reason, vaccine hesitancy among HCWs can impede the widespread of vaccination and contradict the efforts for circumventing the ongoing COVID-19 pandemic; so, assessing the size of hesitancy in addition to addressing its root causes is important.

A limited number of studies have assessed vaccine attitudes in HCWs before the vaccine availability and uptake [1-8], with several of them reporting high rates of hesitancy. The HCWs were found to be more inclined to take the vaccine than non-HCWs [5, 6]. The most common barriers towards vaccination among HCWs included concerns about efficacy, safety, and the conceivably rushed vaccine production process.

In the last few months, several Arab countries announced more coronavirus infections and fatalities [9], raising the total numbers from the start of the pandemic to about 4.5 million and 76 thousand, respectively, until Mid-March, 2021. In a previous work [10], we have shown a high rate of vaccine hesitancy in Arab countries post vaccine availability. Up to our knowledge, only two studies assessed vaccine hesitancy among HCWs in Arab countries; in Saudi Arabia [3] (n=673), where about a quarter intended to have the vaccine once available, and Egypt [4] (n=496), where 46% of HCWs somewhat/totally agreed to receive the vaccine. Therefore, an update of the status of vaccine hesitancy among HCWs in general, and among Arabic-speaking HCWs in particular is highly required.

The aim of this study is to address vaccine attitudes among Arabic-speaking HCWs in and out of the Arab countries post vaccine limited availability, through a large-scale online survey. The study includes a comparison with the attitudes of non-HCWs, vaccine acceptance and hesitancy indicators by demographic groups, barriers to vaccination among HCWs, and their attitudes towards vaccine mandating policies.

Methods

We conducted a cross sectional study through an online survey to assess the attitude of Arab-speaking people toward COVID-19 vaccination. Survey data were collected from 14-Jan 2021 to 29-Jan, 2021 using the online platform www.surveyplanet.com, in which unique IP addresses were allowed to participate once to ensure that each participant was real and unique. Social media platforms were used to conduct a digital campaign targeting a convenience sample of Arabic-speaking HCWs from all around the world. Data were collected anonymously, and no personally

identifiable information was collected or stored. Consent to participate was obtained for each participant before answering the questions of the survey. All questions were written and validated in the Arabic language. An English translation of the survey can be found on Supplementary Document 1. This study was approved by the institutional review board (IRB) at King Hussein Cancer center (Approval No. 21 KHCC 0.34).

The survey consisted of 17 questions, to capture the following data for each participant: demographics, health status, influenza vaccination, type(s) of approved COVID-19 vaccine(s) in the participant's country, whether he/she already received a COVID-19 vaccine and the appearance of any side effects thereof, self-perceived need for COVID-19 vaccination and mandating policies, intention of the participant to uptake the vaccine in case he did not yet, and a detailed list of barriers towards vaccination to choose from. Participants who had already taken the COVID-19 vaccine were not allowed to answer the question about the intention to uptake it.

The independent demographic variables collected included age, gender, country of residence, academic education, and being a HCW or not. Only the data for HCWs were analyzed for the purpose of this study while the gross data were reported elsewhere [10].

Data for age were collected through open-text fields, and age was then coded into age categories: below 30, 30-39, 40-49, 50-59, 60 years or older. Academic education levels were categorized as lower (less than high school diploma, high school diploma, and Some education with no degree yet) and higher (university degree or diploma and postgraduate degree).

Participants were also subcategorized according to the country of residence. Arab countries with less than 25 participants (Bahrain, Mauritania, Somalia) were grouped together in one category and labeled "Other Arab countries". The non-Arab countries where the Arabic speaking participants resided were classified into groups: European countries (n=25), North American countries (the United States and Canada), Turkey and the rest of non-Arab countries as others (n=26).

The survey data were analyzed and graphs generated using R programming language (R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/)- v.4.0.2. The primary outcome of the survey was whether participants were willing to take the COVID-19 vaccine or not, which was assessed by the question "Do you intend to take the vaccine if the option is available to you?". The responses allowed for graded stances (Yes, Depends on the type of vaccine, No, Not sure, I will wait and see its effects on others). The first two of these choices were used to define vaccine acceptance, since those who chose 'Depends on the type of vaccine' did not have objection to the vaccine in principle, while the last three were labeled as 'Vaccine Hesitancy'.

The distribution of the responses against this question were analyzed for the entire dataset and further differences by country were examined. To analyze the association between vaccine acceptance and participant characteristics, binary logistic regression was used.

Responses to the question of the barriers to acceptance were compared for gender, age, country of residence, having chronic diseases, and academic education using Chi-Square. The acquisition and analysis of the results followed the guidelines of the CHERRIES checklist22.

The COVID19 package- v2.3.2 was used for updated data on COVID-19 cases and deaths. The results of the survey can be found on the project's website at https://mainapp.shinyapps.io/CVHAA.

Results:

Demographics

The survey recruited 6,043 HCWs who consented to participate, of whom 335 reported that they already took the vaccine. Data analysis was performed for the remaining 5,708 participants for the sake of this study.

The participants cover all the Arab countries and territories (n=4996, 87.5%) except Djibouti and Comoros, and Arabs who live in 54 other countries outside the Arab region (n= 712, 12.5%). Participants from countries out of the Arab region were clustered into four groups: Europe (n=397, 7.0%), North America (n=89, 1.6%), Turkey (n=168, 2.9%) and others (n=58, 1.0%).

The mean age of the participants was 30.6 years (±10), and more females (n=3171, 55.6%) participated than males (n=2,537, 44.4%)- Supplementary Fig. 1. Chronic diseases were reported by 800 participants (14.0%). In response to the question (Do you take the flu vaccine yearly), only 321 (5.6%) participants chose (Yes, every year) while 3994 (70.0%) reported never receiving it. Having or previously having suspected or confirmed COVID-19 infection was reported by 1270 (22.2%) participants; while 1859 (32.6%) participants were not sure if they had contracted the virus. From the 912 participants who reported testing for COVID-19, 337 had positive test results (37.0% positivity). Two thirds (n=3,875, 67.9%) of the participants had a bachelor's degree or higher.

When asked about the type of COVID-19 vaccine authorized in their countries, 1,851 (32.4%) did not know the type. More HCWs in Arab countries reported that they do not know the types of vaccines officially approved in their countries (34.3%) compared with HCWs out of Arab countries (19.0%). Those who knew the vaccine type(s) reported authorizing the American vaccine from Pfizer/BioNTech or Moderna (n= 2,291, 40.1%), the Chinese vaccine from Sinopharm or Sinovac (n= 2,190, 38.4%), the European vaccine from Oxford-AstraZeneca (n= 623, 10.9%), the Russian Vaccine Sputnik V (n= 541, 9.5%), and the Indian vaccine (n= 55, 1%). Detailed participant characteristics are shown in Supplementary Table 1 and compared with those of the non-HCW that we reported in a previous study [10].

COVID-19 Vaccination Acceptance and related factors

The overall COVID-19 vaccine acceptance rate in this study was 26.7%. The rate of vaccine acceptance among HCWs in Arab countries (25.8%) was lower than among their counterparts outside the Arab world (32.8%) [Fig 1 A-C, Table 1]. Participants from Kuwait showed the highest vaccine acceptance (50.9%), while those from the west region (Egypt, Morocco, Tunisia, Algeria) showed the lowest vaccine acceptance (Fig 1 D). As for the HCWs residing outside the Arab region, those living in North America showed more vaccine acceptance than those in the other three clusters (Fig 1 E).

Variations in responses to the question of vaccine acceptance (Table 2) were analyzed using participant characteristics as covariates (Fig 2). A binomial logistic regression model was used to examine the correlation of these participant characteristics with vaccine acceptance (Fig 3, Table 3). Univariate and multivariate analyses revealed several predictors for vaccine hesitancy, with Odds ratio showing the stronger effect of the following factors on participants' hesitance: Never (OR, 4.30) or rarely (OR, 2.87) receiving the influenza vaccine, female gender (OR, 2.04), not knowing the vaccine type authorized in the participant's country (OR, 1.69), and having or previously having suspected or confirmed COVID-19 infection (OR, 1.34).
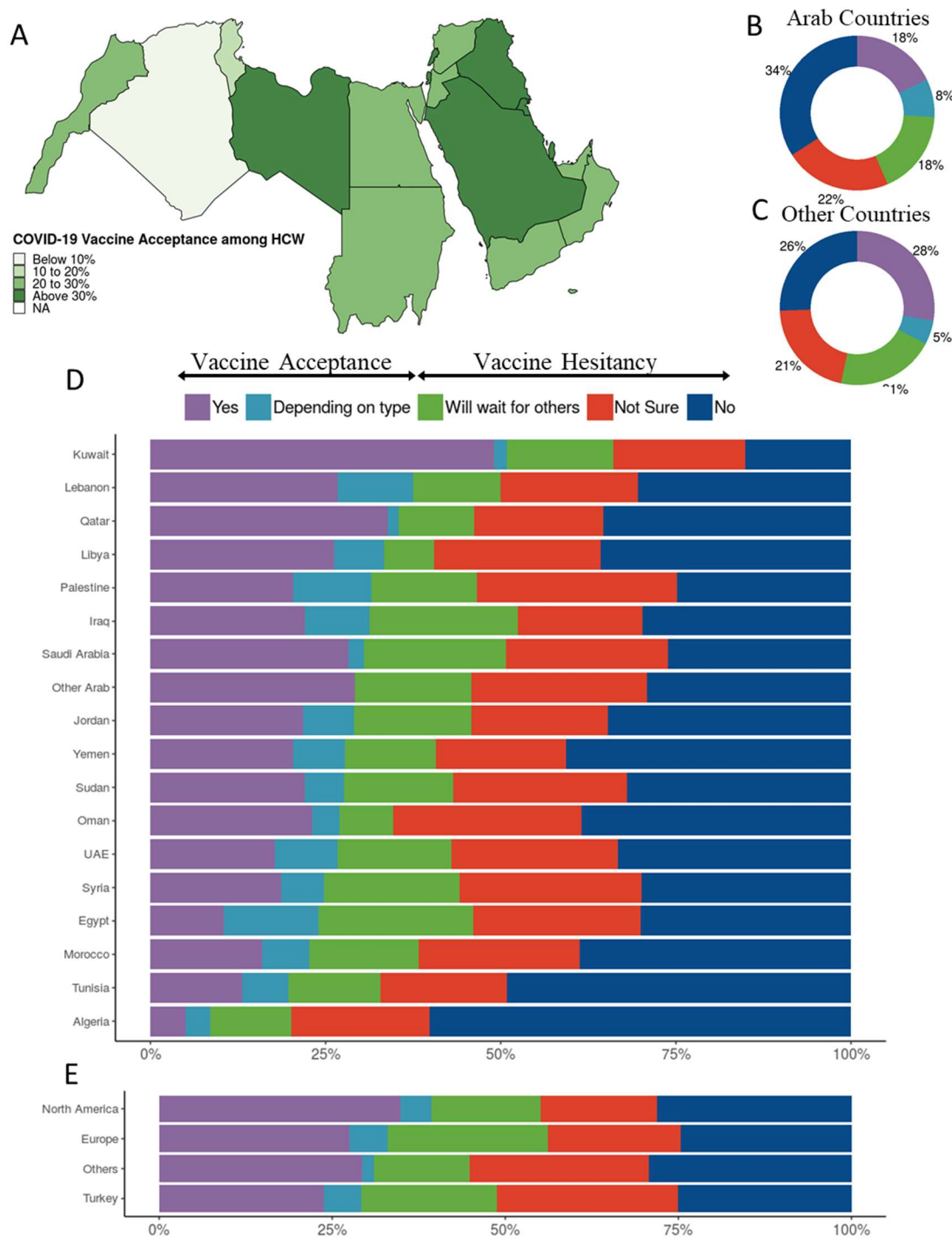
Figure 1. COVID-19 Vaccination attitudes among 5,708 HCW participants. A) Vaccine acceptance in the per-country in the Arab region, B) Vaccination attitudes reported by HCWs from the Arab countries and territories, C) Vaccination attitudes reported by HCWs from countries other than Arab countries and territories, D) Vaccination attitudes reported by HCWs per Arab country/territory, and E) Vaccination attitudes reported by HCWs from countries other than Arab countries and territories clustered by residency region.
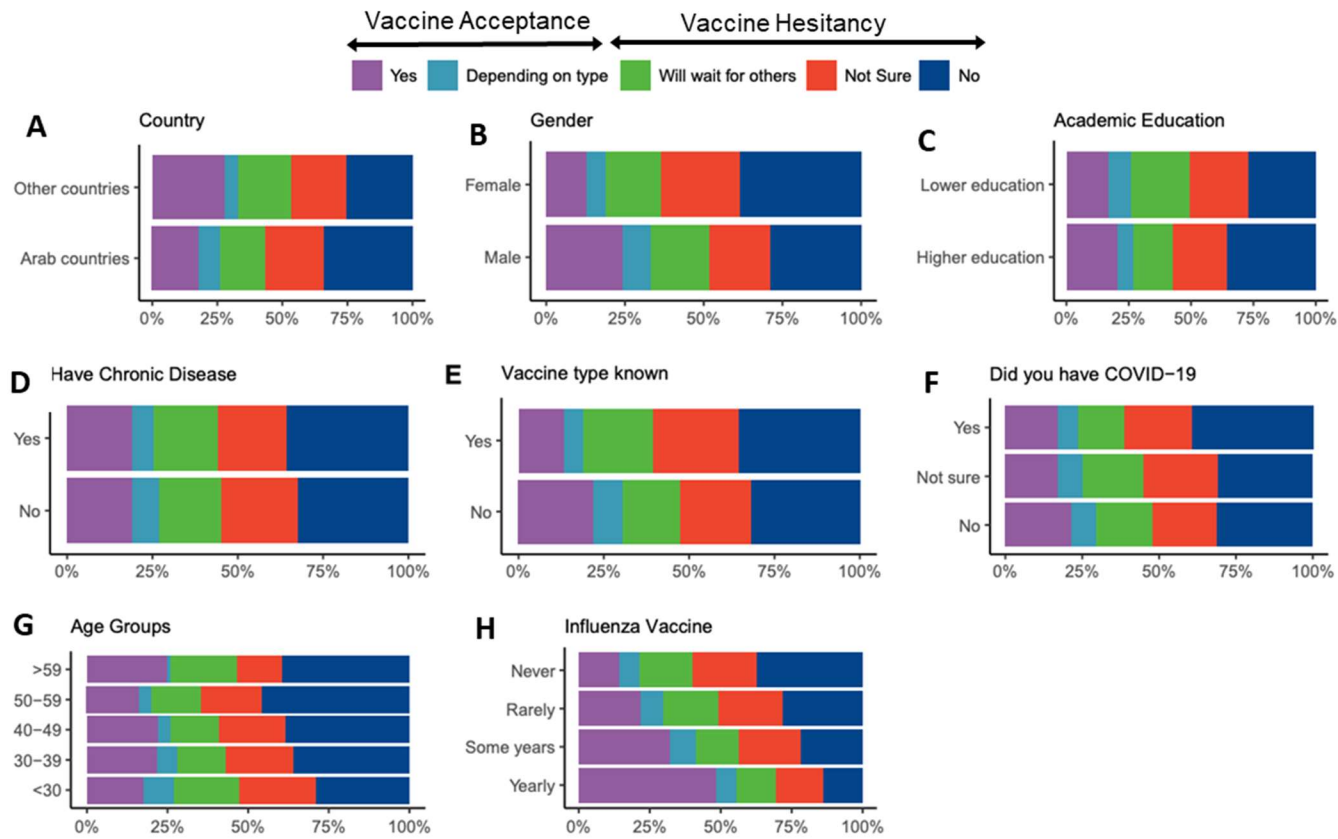
Figure 2. Differences in COVID-19 Vaccination attitudes among HCWs according to (A) country of residence, (B) gender, (C) level of academic education, (D) having a chronic illness, (E) knowing the vaccine type available in participant's country, (F) having a previous or current COVID-19 infection, (G) age and (H) receiving annual influenza vaccine.
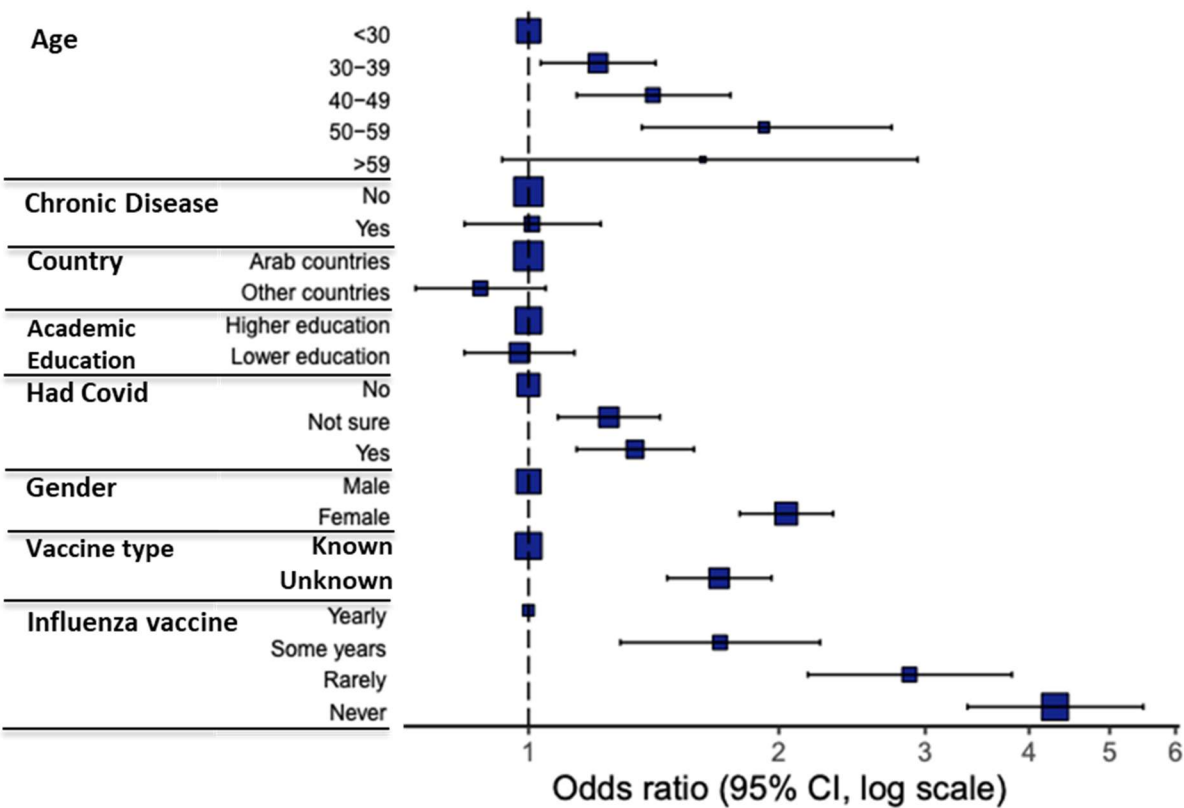
Figure 3. Multivariate analysis results of COVID-19 vaccine acceptance/hesitancy stratified according to different factors; odds ratio (OR) and 95% confidence intervals (CI) are shown; the size of the box represents the number of participants in each level.

Table 1. Acceptance and Hesitancy Rates by Country

Country	No		Not Sure		Will wait for others		Depending on type		Yes		Total
	N	%	N	%	N	%	N	%	N	%	
Algeria	287	(60.2%)	94	(19.7%)	55	(11.5%)	17	(3.6%)	24	(5.0%)	477
Egypt	376	(30.1%)	298	(23.8%)	276	(22.1%)	169	(13.5%)	131	(10.5%)	1250
Europe	98	(24.7%)	76	(19.1%)	92	(23.2%)	22	(5.5%)	109	(27.5%)	397
Iraq	42	(29.8%)	25	(17.7%)	30	(21.3%)	13	(9.2%)	31	(22.0%)	141
Jordan	379	(34.7%)	212	(19.4%)	184	(16.8%)	79	(7.2%)	238	(21.8%)	1092
Kuwait	8	(15.1%)	10	(18.9%)	8	(15.1%)	1	(1.9%)	26	(49.1%)	53
Lebanon	17	(30.4%)	11	(19.6%)	7	(12.5%)	6	(10.7%)	15	(26.8%)	56
Libya	15	(35.7%)	10	(23.8%)	3	(7.1%)	3	(7.1%)	11	(26.2%)	42
Morocco	87	(38.7%)	52	(23.1%)	35	(15.6%)	15	(6.7%)	36	(16.0%)	225
North America	25	(28.1%)	15	(16.9%)	14	(15.7%)	4	(4.5%)	31	(34.8%)	89
Oman	10	(38.5%)	7	(26.9%)	2	(7.7%)	1	(3.8%)	6	(23.1%)	26
Other Arab	7	(29.2%)	6	(25.0%)	4	(16.7%)	0	(0.0%)	7	(29.2%)	24
Others	17	(29.3%)	15	(25.9%)	8	(13.8%)	1	(1.7%)	17	(29.3%)	58
Palestine	66	(24.8%)	76	(28.6%)	40	(15.0%)	30	(11.3%)	54	(20.3%)	266
Qatar	23	(35.4%)	12	(18.5%)	7	(10.8%)	1	(1.5%)	22	(33.8%)	65
Saudi Arabia	142	(26.1%)	126	(23.2%)	110	(20.2%)	12	(2.2%)	154	(28.3%)	544
Sudan	45	(31.9%)	35	(24.8%)	22	(15.6%)	8	(5.7%)	31	(22.0%)	141
Syria	103	(29.9%)	89	(25.9%)	67	(19.5%)	21	(6.1%)	64	(18.6%)	344
Tunisia	30	(49.2%)	11	(18.0%)	8	(13.1%)	4	(6.6%)	8	(13.1%)	61
Turkey	42	(25.0%)	44	(26.2%)	33	(19.6%)	9	(5.4%)	40	(23.8%)	168
UAE	45	(33.3%)	32	(23.7%)	22	(16.3%)	12	(8.9%)	24	(17.8%)	135
Yemen	22	(40.7%)	10	(18.5%)	7	(13.0%)	4	(7.4%)	11	(20.4%)	54

Table 2. Characteristics of HCWs with Distribution of COVID-19 Vaccine Willingness

Label	levels	No		Not Sure		Will wait for others		Depending on type		Yes	
		N	%	N	%	N	%	N	%	N	%
Age	<30	876	(28.9%)	720	(23.7%)	624	(20.6%)	290	(9.6%)	523	(17.2%)
	30-39	595	(36.1%)	345	(20.9%)	249	(15.1%)	105	(6.4%)	355	(21.5%)
	40-49	266	(38.4%)	142	(20.5%)	106	(15.3%)	26	(3.8%)	152	(22.0%)
	50-59	120	(46.0%)	49	(18.8%)	40	(15.3%)	10	(3.8%)	42	(16.1%)
	>59	29	(39.7%)	10	(13.7%)	15	(20.5%)	1	(1.4%)	18	(24.7%)
Chronic Diseases	No	1600	(32.6%)	1104	(22.5%)	883	(18.0%)	384	(7.8%)	937	(19.1%)
	Yes	286	(35.8%)	162	(20.3%)	151	(18.9%)	48	(6.0%)	153	(19.1%)
Country	Arab countries	1704	(34.1%)	1116	(22.3%)	887	(17.8%)	396	(7.9%)	893	(17.9%)
	Other countries	182	(25.6%)	150	(21.1%)	147	(20.6%)	36	(5.1%)	197	(27.7%)
Academic Education	Higher education	1388	(35.8%)	835	(21.5%)	607	(15.7%)	260	(6.7%)	785	(20.3%)
	Lower education	498	(27.2%)	431	(23.5%)	427	(23.3%)	172	(9.4%)	305	(16.6%)
Had Covid	No	809	(31.4%)	535	(20.7%)	481	(18.7%)	202	(7.8%)	552	(21.4%)
	Not sure	578	(31.1%)	451	(24.3%)	362	(19.5%)	148	(8.0%)	320	(17.2%)
	Yes	499	(39.3%)	280	(22.0%)	191	(15.0%)	82	(6.5%)	218	(17.2%)
Job	HCW	1886	(33.0%)	1266	(22.2%)	1034	(18.1%)	432	(7.6%)	1090	(19.1%)
Gender	Male	911	(28.7%)	623	(19.6%)	588	(18.5%)	285	(9.0%)	764	(24.1%)
	Female	975	(38.4%)	643	(25.3%)	446	(17.6%)	147	(5.8%)	326	(12.8%)
Influenza Vaccine	Yearly	45	(14.0%)	53	(16.5%)	45	(14.0%)	23	(7.2%)	155	(48.3%)
	Some years	149	(21.9%)	148	(21.7%)	105	(15.4%)	61	(9.0%)	218	(32.0%)
	Rarely	201	(28.2%)	160	(22.5%)	141	(19.8%)	57	(8.0%)	153	(21.5%)
	Never	1491	(37.3%)	905	(22.7%)	743	(18.6%)	291	(7.3%)	564	(14.1%)
Vaccine type unknown	No	1228	(31.8%)	800	(20.7%)	656	(17.0%)	326	(8.5%)	847	(22.0%)
	Yes	658	(35.5%)	466	(25.2%)	378	(20.4%)	106	(5.7%)	243	(13.1%)

Table 3. Univariate and Multivariate Analyses of Factors Affecting Hesitancy

Variable	Levels	Acceptance	Hesitance	OR (Univariable)	OR (Multivariable)
Age	<30	813 (26.8)	2220 (73.2)	-	-
	30-39	460 (27.9)	1189 (72.1)	0.95 (0.83-1.08)	1.21 (1.03-1.42)
	40-49	178 (25.7)	514 (74.3)	1.06 (0.88-1.28)	1.41 (1.14-1.75)
	50-59	52 (19.9)	209 (80.1)	1.47 (1.08-2.03)	1.92 (1.37-2.73)
	>59	19 (26.0)	54 (74.0)	1.04 (0.62-1.81)	1.62 (0.93-2.94)
Chronic Diseases	No	1321 (26.9)	3587 (73.1)	-	-
	Yes	201 (25.1)	599 (74.9)	1.10 (0.93-1.31)	1.01 (0.84-1.22)
Country	Arab countries	1289 (25.8)	3707 (74.2)	-	-
	Other countries	233 (32.7)	479 (67.3)	0.71 (0.60-0.85)	0.87 (0.73-1.05)
Academic Education	Higher education	1045 (27.0)	2830 (73.0)	-	-
	Lower education	477 (26.0)	1356 (74.0)	1.05 (0.93-1.19)	0.97 (0.84-1.14)
Had Covid	No	754 (29.2)	1825 (70.8)	-	-
	Not sure	468 (25.2)	1391 (74.8)	1.23 (1.07-1.41)	1.25 (1.08-1.44)
	Yes	300 (23.6)	970 (76.4)	1.34 (1.15-1.56)	1.34 (1.14-1.58)
Gender	Male	1049 (33.1)	2122 (66.9)	-	-
	Female	473 (18.6)	2064 (81.4)	2.16 (1.91-2.44)	2.04 (1.79-2.32)
Vaccine Type Unknown	No	1173 (30.4)	2684 (69.6)	-	-
	Yes	349 (18.9)	1502 (81.1)	1.88 (1.64-2.16)	1.69 (1.47-1.96)
Influenza Vaccine	Yearly	178 (55.5)	143 (44.5)	-	-
	Some years	279 (41.0)	402 (59.0)	1.79 (1.37-2.35)	1.70 (1.29-2.24)
	Rarely	210 (29.5)	502 (70.5)	2.98 (2.27-3.91)	2.87 (2.17-3.81)
	Never	855 (21.4)	3139 (78.6)	4.57 (3.62-5.77)	4.30 (3.37-5.49)

Barriers to acceptance

The most common barriers among HCWs towards COVID-19 vaccination are shown in Fig. 4. More than half of the participant chose "I am afraid side effects of the vaccine will develop, other than what has been disclosed"- 3313 (58.0%), "Not enough time has passed to verify the vaccine's safety"- 3252 (57.0%), "The vaccine production has been rushed, making me doubt the credibility of the producing company"- 2505 (43.9%), and "I do not trust the healthcare policies applied in my country"- 2133 (39.1%). Most of the barriers were reported more frequently by HCWs in Arab countries compared with their counterparts outside (Fig. 5 A), and by female HCWs compared with male counterparts (Fig. 5 B). Notably, 41.0 % of HCWs in Arab countries chose "I do not trust the healthcare policies applied in my country" versus 11.9% who chose the same barrier among their counterparts residing outside.

We compared the barriers chosen by HCWs in this study with those chosen by non-HCWs that we reported in a separate study [10] (Table 4). The barriers that differ significantly ($p < 0.001$) with

more than 5% difference are shown in Fig. 6. Notably, the choices "The vaccine might lose its efficacy against the new viral strains" and "I believe/I fear that the immunity gained from the vaccine does not last long" were chosen more frequently by HCWs than non-HCWs.
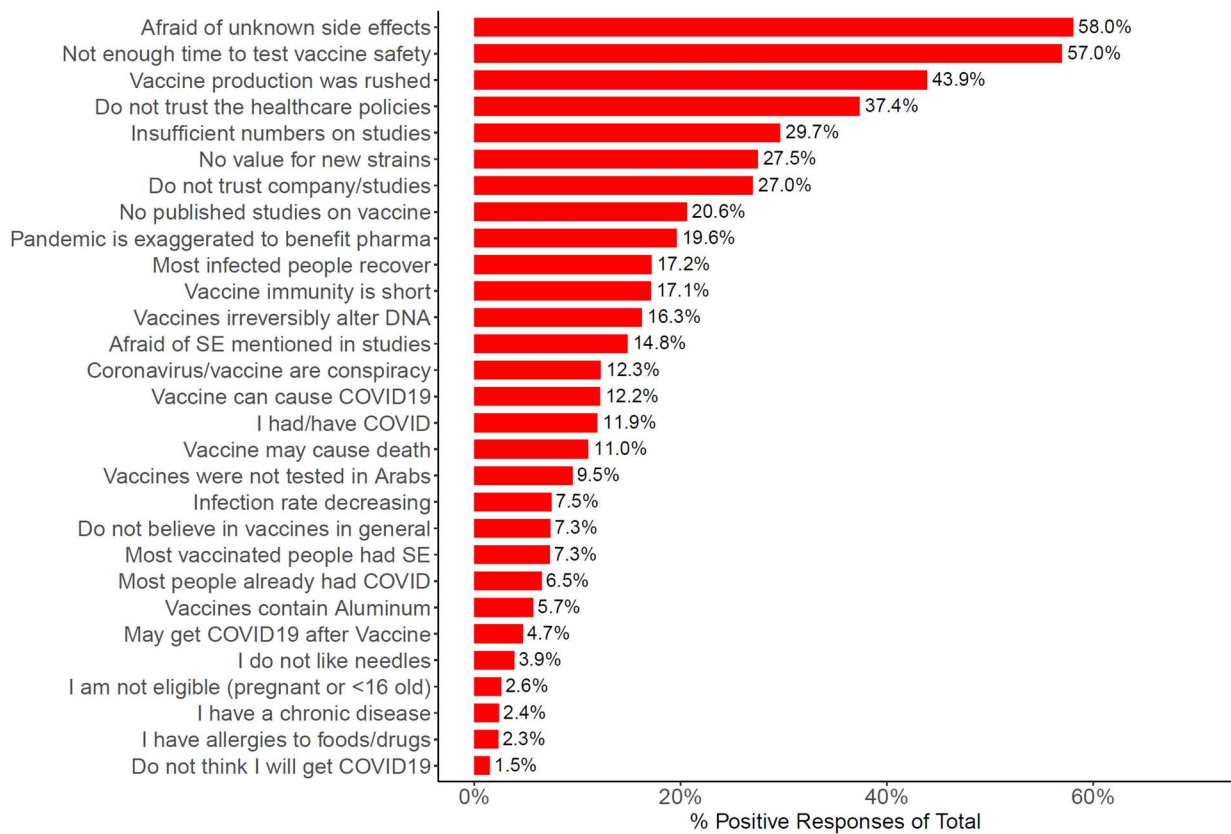
Figure 4. Barplot showing percentages of participants (N=5,708) who selected the shown barriers.
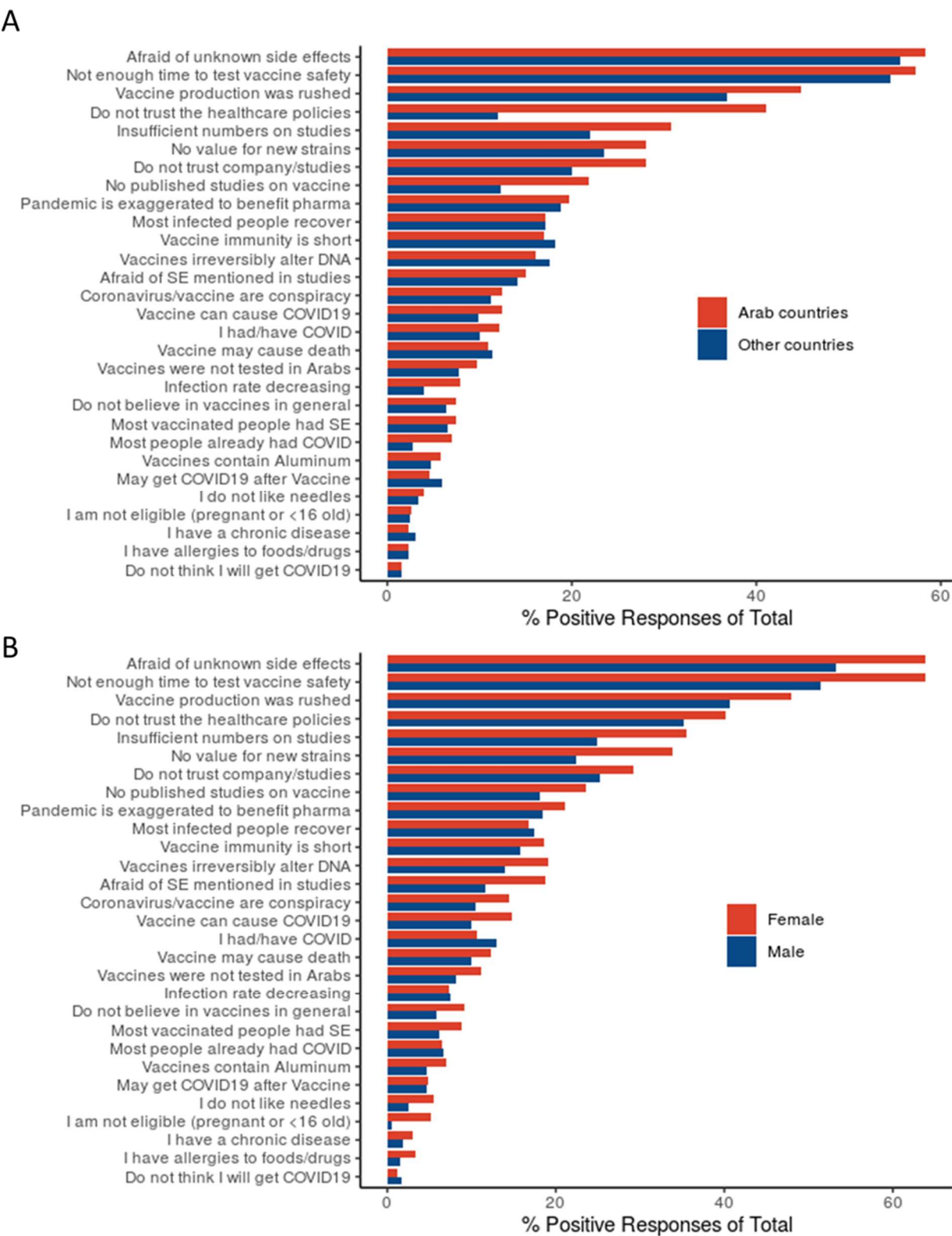
Figure 5. Barplot comparing barriers of HCWs in Arab countries with their counterparts outside (panel A), and barriers of female HCWs with male counterparts (panel B).
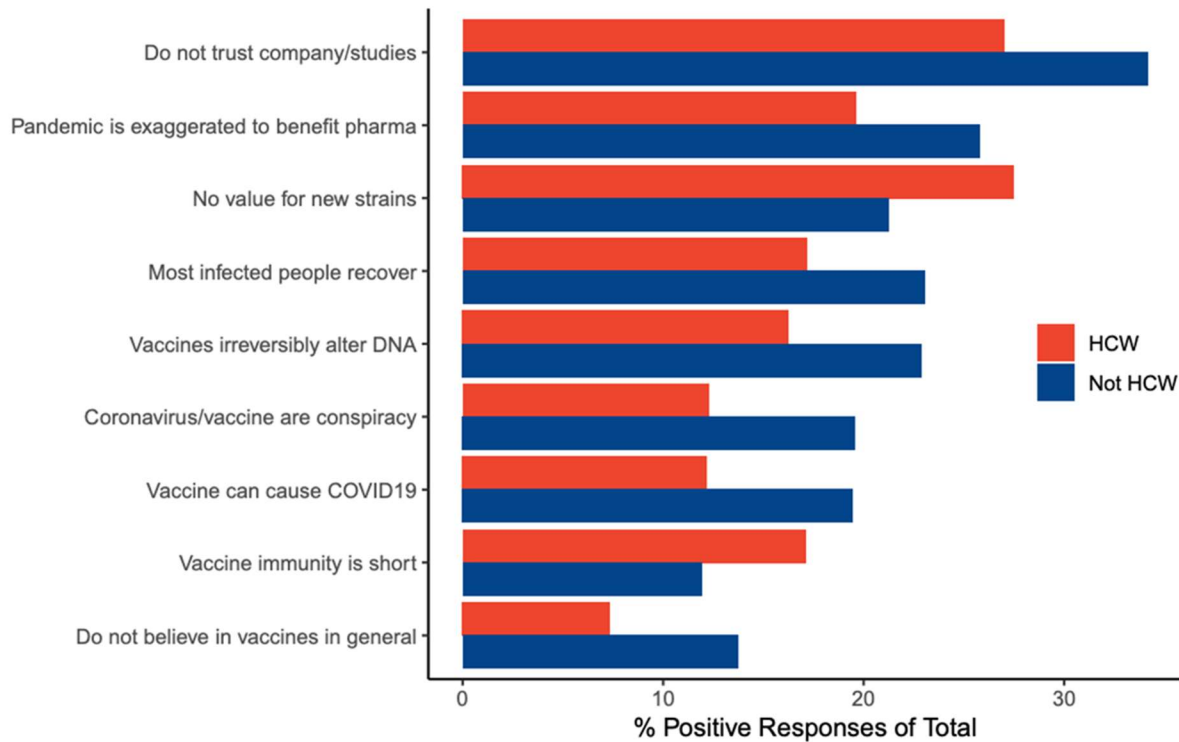
Figure 6. Barplot showing the barriers with more than 5% difference between HCWs and non-HCWs (*p*<0.001 for all).

Table 4. Barriers among HCW and non-HCW participants

Barriers	HCW		Not HCW	
	N	(%)	N	(%)
Afraid of unknown side effects	3313	(58.0%)	18922	(62.0%)
Not enough time to test vaccine safety	3252	(57.0%)	16920	(55.5%)
Vaccine production was rushed	2505	(43.9%)	14193	(46.5%)
Do not trust the healthcare policies	2133	(37.4%)	12018	(39.4%)
Insufficient numbers on studies	1693	(29.7%)	8208	(26.9%)
No value for new strains	1569	(27.5%)	6475	(21.2%)
Do not trust company/studies	1541	(27.0%)	10427	(34.2%)
No published studies on vaccine	1175	(20.6%)	5911	(19.4%)
Pandemic is exaggerated to benefit pharma	1119	(19.6%)	7868	(25.8%)
Most infected people recover	979	(17.2%)	7036	(23.1%)
Vaccine immunity is short	976	(17.1%)	3637	(11.9%)
Vaccines irreversibly alter DNA	928	(16.3%)	6985	(22.9%)
Afraid of SE mentioned in studies	847	(14.8%)	5695	(18.7%)
Coronavirus/vaccine are conspiracy	700	(12.3%)	5972	(19.6%)
Vaccine can cause COVID19	695	(12.2%)	5939	(19.5%)
I had/have COVID	681	(11.9%)	2875	(9.4%)
Vaccine may cause death	630	(11.0%)	4257	(14.0%)
Vaccines were not tested in Arabs	543	(9.5%)	2209	(7.2%)

Infection rate decreasing	426	(7.5%)	3056	(10.0%)
Do not believe in vaccines in general	419	(7.3%)	4186	(13.7%)
Most vaccinated people had SE	416	(7.3%)	2608	(8.5%)
Most people already had COVID	373	(6.5%)	1898	(6.2%)
Vaccines contain Aluminum	326	(5.7%)	2896	(9.5%)
May get COVID19 after Vaccine	267	(4.7%)	1370	(4.5%)
I do not like needles	220	(3.9%)	1750	(5.7%)
I am not eligible (pregnant or <16 old)	147	(2.6%)	965	(3.2%)
I have a chronic disease	136	(2.4%)	1266	(4.1%)
I have allergies to foods/drugs	132	(2.3%)	716	(2.3%)
Do not think I will get COVID19	86	(1.5%)	674	(2.2%)

Stances of HCWs on vaccination policies and need

When asked "In your opinion, what is the best way to deal with the vaccine in your country?", more than half of the HCWs (56.7%) chose "To let people choose if they want to take it or not". Only 16.2% of HCWs supported mandating the vaccine on some groups of people (Fig. 7 A). When asked "In your opinion, to what extent do others in your country need the vaccine?", about half of the HCWs (48.3%) chose "It is needed for whomever the vaccine was proven to be effective and safe as per clinical studies" (Fig. 7 B).
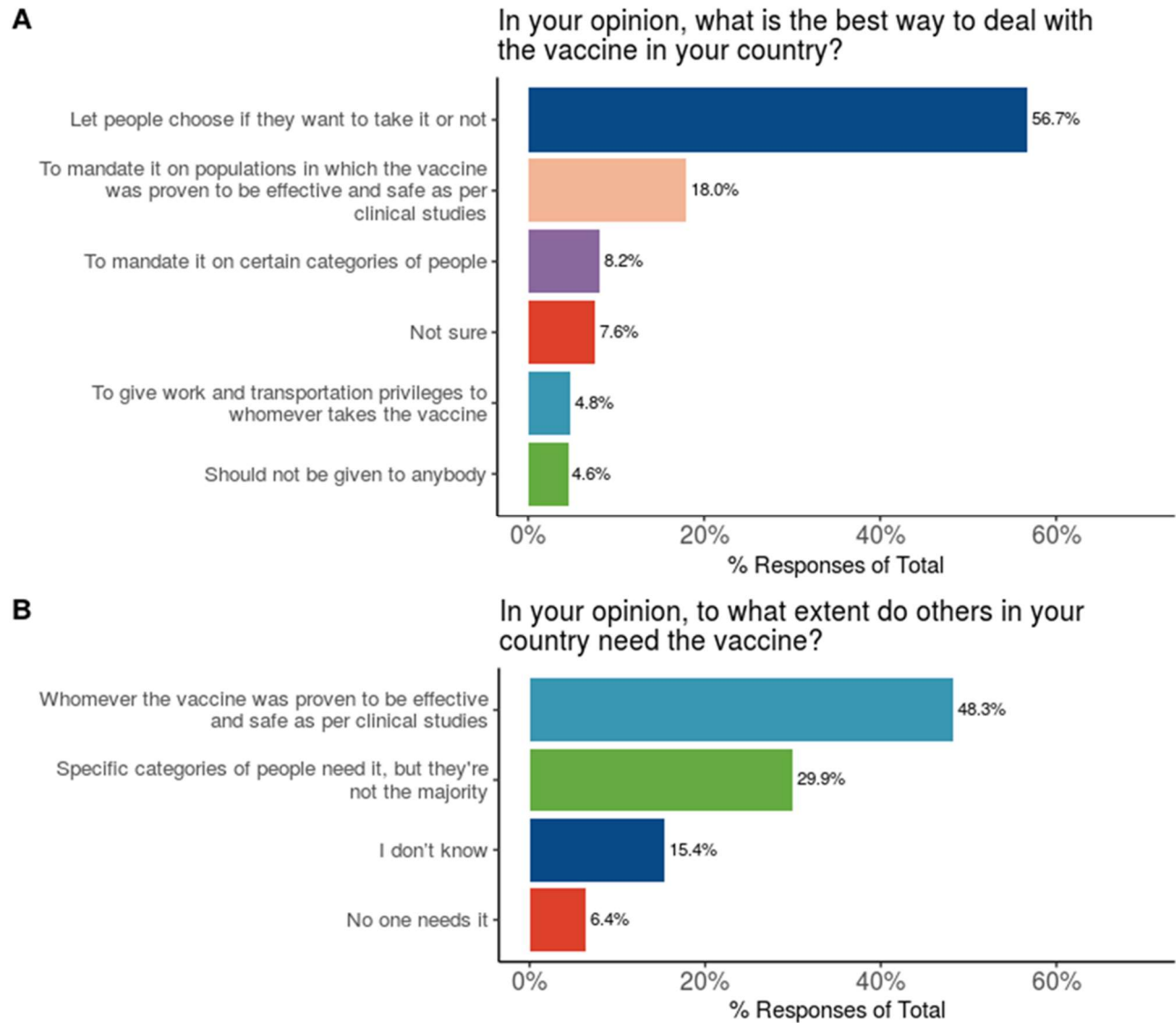
Figure 7. Participants' attitudes towards COVID-19 vaccination in regards to (A) national health policies and (B) selecting individuals who should be vaccinated.

Discussion:

This study fills an important knowledge gap, being the first multinational survey, and the first post vaccine limited availability, on the attitudes of HCWs towards COVID-19 vaccines, with the largest number of participants up to the time of writing the manuscript. In addition, it covers the large geographical area of the Arab countries which have been affected badly by the pandemic. Comparing the answers of the HCW respondents residing in and outside the Arab world gives an insight into the effect of cultural, socioeconomic, political & health policy differences on their reported attitudes and barriers to vaccine acceptance.

The study shows a low rate of vaccine acceptance (26.7%) among Arab-speaking HCWs. This is consistent with previous studies on Saudi HCWs (n=673) in which only about a quarter intended

to have the vaccine as soon as it becomes available in the country while another quarter would delay until the vaccine safety is confirmed [3]. Similar results were shown by Egyptian HCWs (n=496), of whom 13.5% totally agreed to receive the vaccine, and 32.4% somewhat agreed [4]. In our study, 30.5% of Saudi HCWs and 24% of Egyptian HCWs were willing to receive vaccination. These low rates of acceptance are also consistent with other studies on HCWs in the USA (n=3479) in which only 36% of respondents were willing to take the vaccine as soon as it became available [1]. Similarly, in a study conducted on Los Angeles HCWs (n=540), most participants (65.5%) indicated they would delay vaccination once coronavirus vaccines became available for distribution [2]. Also, about a quarter of Congolese HCWs (n=613) reported intent to take the vaccine [7].

The HCWs residing in the Arab world were more hesitant than their counterparts residing outside [Fig. 1 B & C], with a hesitancy rate of about three quarters versus two thirds, respectively. One reason can be the significantly higher percentage of HCWs in Arab countries who do not know the types of vaccines officially approved in their countries (34.3% compared with 19.0% for HCWs out of Arab countries). Among the barriers reported towards vaccination, distrust in healthcare policies in the country of residence seems to be an important reason for this discrepancy. The HCWs residing in the Arab countries chose this barrier about more than three times those residing outside (41.0 % vs 11.9%, respectively) [Fig. 6].

Vaccine acceptance varied widely among the different Arab countries, from 8.6% among HCWs of Algeria to 50.9% among HCWs of Kuwait [Fig. 1]. Again, not knowing the vaccine type (29.1% vs. 11.3% in Algeria and Kuwait, respectively), and distrust in healthcare policies in the country of residence (48.4% vs. 9.4% in Algeria and Kuwait, respectively) seem to be important contributors to this variation. In addition, this variation is in clear correlation with the number of COVID-19 cases and deaths per million in the different countries, which was as low as 2.5 thousand cases and 68 deaths per million in Algeria, and as high as 40 thousands and 232 per million in Kuwait.

The rates of vaccine acceptance in HCWs (26.7%) were higher than those for non-HCWs (15.2%), for whom we reported the rates of acceptance in a previous paper [10]. This is consistent with previous studies [5, 6], and is expected given the higher health, pandemic, and vaccine literacy among HCWs.

Predictors of vaccine hesitancy among HCWs included age of 30-59, previous or current suspected or confirmed COVID-19 infection, being a female, not knowing the vaccine type, and never, rarely, or intermittently receiving the influenza vaccine (as compared to regular influenza vaccination) [Fig. 3 and 4]. Similarly, previous studies reported higher intention to vaccinate in male HCWs[1, 4, 8,], and HCWs who received influenza vaccine during previous season[8].

The most frequently chosen barriers to vaccine acceptance in this study were "I am afraid side effects of the vaccine will develop, other than what has been disclosed" (58.0%), "Not enough time has passed to verify the vaccine's safety" (57.0%), and "The vaccine production has been rushed, making me doubt the credibility of the producing company" (43.9%). This is consistent with a study on the United States HCWs (n=3479) in which safety (69%), effectiveness (69%), and speed of development/approval (74%) were noted as the most common concerns regarding COVID-19 vaccination [1]. In addition, a study on Los Angeles HCWs (n=540) showed that

respondents were most heavily influenced by the fast-tracked development timeline (83.5%) in shaping their vaccination intent [2]. There were noticeable disparities in reported barriers to vaccination between participants in and out of the Arab world [Fig. 6]. All the top 23 barriers to vaccination were higher among HCWs in Arab countries compared with their counterparts outside.

On the other hand, several barriers were significantly more frequent among HCWs compared with non-HCWs [Fig. 6]. These included concerns about the vaccine effectiveness against the new viral strains and short-lived immunity, which is a likely observation given the medical and paramedical background of HCWs. However, unexpectedly, more HCWs chose "The vaccine has not been tested on a large enough number of people, just tens or hundreds". This could be due to the fact that Arab countries were first to approve the Chinese vaccines despite lack of affirmative data [9], which can further be affirmed by the observation that significantly more HCWs in Arab countries chose this barrier compared with HCW outside [Fig. 6].

As for the attitudes towards mandating the vaccine, the majority of HCWs believed that choice should be given for people to take the vaccine or not [Fig. 8 A]. In a study on HCWs in the United States [1], 48% of the participants believed the vaccine should be voluntary and 17% were not sure. In our study, about half of the HCWs chose that the vaccine is needed for whomever it was proven to be effective and safe as per clinical studies [Fig. 8 B], which is about double those who intend to uptake the vaccine. This is consistent with a previous study on HCWs in Los Angeles [2], were participants overwhelmingly acknowledged the importance and utility of general vaccination to public health practice but were widely hesitant about partaking in COVID-19 vaccination in trial or postmarket settings.

Conclusion: this study highlights the alarmingly high rate of COVID-19 vaccine hesitancy among HCWs post vaccine limited availability. Given the crucial role of HCWs, this is expected to significantly affect the ongoing efforts for achieving widespread vaccination and collective immunity. The barriers to vaccination and demographic correlations were detailed to help properly address this phenomenon, with the aim of contribution in containing the pandemic.

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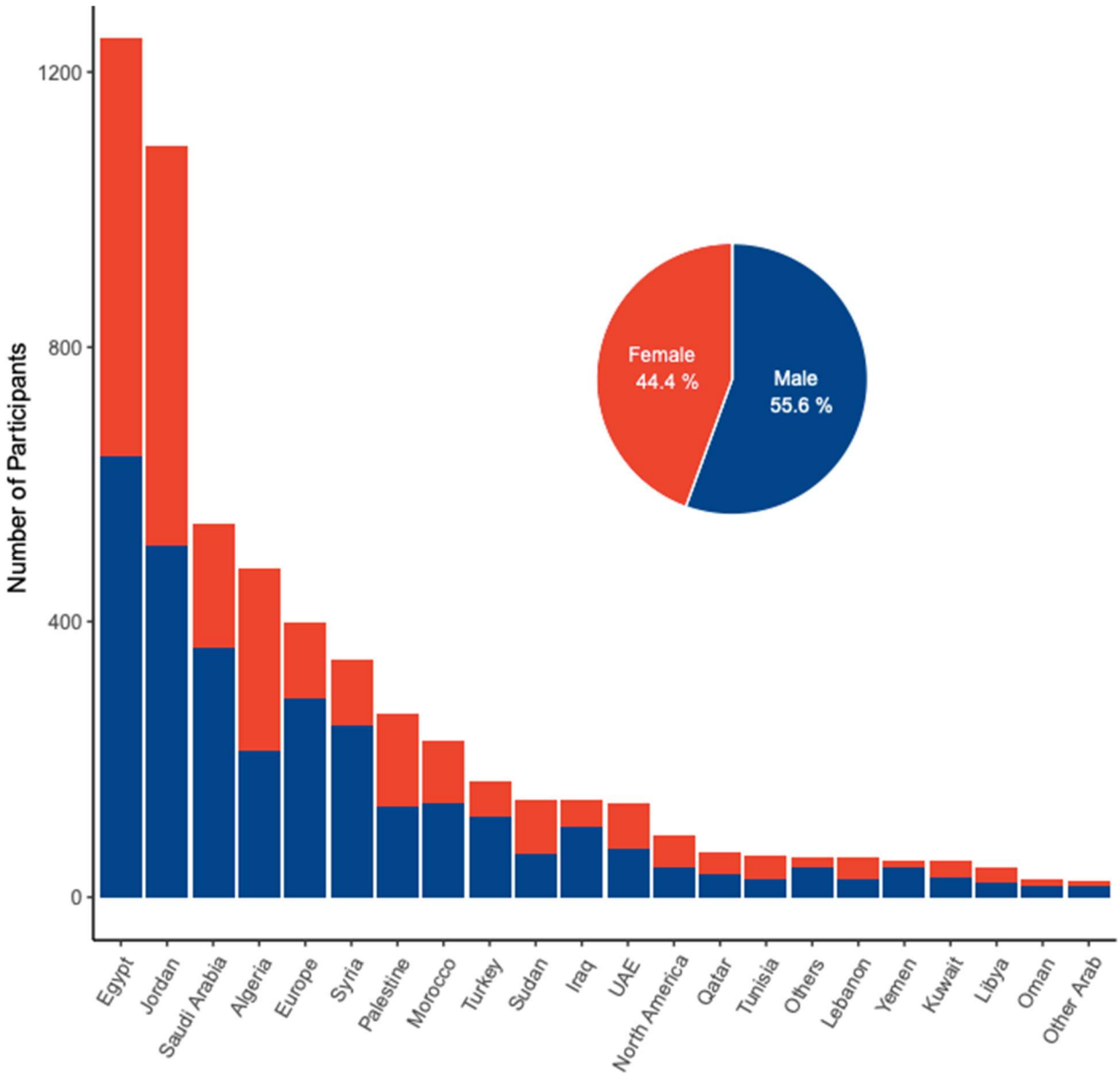
Conflicts of Interest: the authors declare that there is no conflict of interest.

Institutional Review Board Approval: this study was approved by the institutional review board (IRB) at King Hussein Cancer center (Approval No. 21 KHCC 0.34).

Informed Consent: informed consent was obtained from all subjects involved in the study.

Supplementary Figure 1. A bar plot and a pie chart showing distribution of participants according to country of residence and gender.

Supplementary Table 1. Comparison between HCW and non-HCW participants

Label	levels	HCW		Not HCW		Total	
		N	%	N	%	N	%
Age	Below 30	3033	53.1%	12738	41.7%	15771	43.5%
	30-39	1649	28.9%	9916	32.5%	11565	31.9%
	40-49	692	12.1%	5227	17.1%	5919	16.3%
	50-59	261	4.6%	2040	6.7%	2301	6.4%
	Over 59	73	1.3%	591	1.9%	664	1.8%
Chronic Diseases	No	4908	86.0%	25473	83.5%	30381	83.9%
	Yes	800	14.0%	5039	16.5%	5839	16.1%
Country	Arab countries	4996	87.5%	25204	82.6%	30200	83.4%
	Other countries	712	12.5%	5308	17.4%	6020	16.6%
Academic Education	Higher education	3875	67.9%	18361	60.2%	22236	61.4%
	Lower education	1833	32.1%	12151	39.8%	13984	38.6%
Had Covid	No	2579	45.2%	15546	51.0%	18125	50.0%
	Not sure	1859	32.6%	9599	31.5%	11458	31.6%
	Yes	1270	22.2%	5367	17.6%	6637	18.3%
Gender	Male	3171	55.6%	18869	61.8%	22040	60.9%
	Female	2537	44.4%	11643	38.2%	14180	39.1%
Vaccine Type Unknown	No	3857	67.6%	17306	56.7%	21163	58.4%
	Yes	1851	32.4%	13206	43.3%	15057	41.6%
Influenza Vaccine	Yearly	321	5.6%	587	1.9%	908	2.5%
	Some years	681	11.9%	2230	7.3%	2911	8.0%
	Rarely	712	12.5%	3649	12.0%	4361	12.0%
	Never	3994	70.0%	24046	78.8%	28040	77.4%
Vaccine Hesitancy	Acceptance	1522	26.7%	4641	15.2%	6163	17.0%
	Hesitance	4186	73.3%	25871	84.8%	30057	83.0%
		5708	100.0%	30512	100.0%	36220	100.0%

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