

# Knowledge, attitudes, anxiety, and preventive behaviors towards COVID-19 among health care providers in Yemen: an online cross-sectional survey

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## Research article

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## Abstract

**Background:** The current rapid prevalence of the novel coronavirus (COVID-19) pandemic over the world is associated with a considerable level of scared, anxiety and panic among the public, in particular, healthcare providers (HCPs) as the most vulnerable group at risk for SARS-CoV-2 infection. To protect and enhance HCPs' capacity to carry out their duties in responding to COVID-19, healthcare authorities should keep them away from stress and anxiety and improve their knowledge, attitude, and practice towards COVID-19 to ensure their compliance to infection control precautions. Therefore, this study aimed to explore knowledge, attitudes, anxiety, and preventive behaviours among Yemeni HCPs towards COVID-19.

**Methods:** A descriptive, web-based-cross-sectional study was used. It was conducted among a number of 1244 Yemeni HCPs. The COVID-19 related questionnaire was designed using Google forms. The link of the survey was sent to the respondents via emails, WhatsApp messages and WhatsApp groups as well as Telegram and other social media. The data collection started on 22<sup>nd</sup> April 2020, at 6 PM and closed on 26<sup>th</sup> April 2020 at 11 AM.

**Results:** The results indicated that out of 1244 of the Yemeni HCPs participating in this study, 61.3% were male and more than (67%) were in the age group of 20 to 30 years old with a mean of  $29.25 \pm 6.75$ . Most of them (85.9%) had a bachelor degree or above and had 10 years of working experience or less (88.2%). Besides, although 57.1% of the respondents obtained their information via social and news media and 60.3% had never attended lectures/discussions about COVID-19, the results revealed that the majority of respondents had an adequate level of knowledge, an optimistic attitude, moderate anxiety and high performance in preventive behaviors (60.3%, 85.00%, 50.80 & 87.60%, respectively) toward the COVID-19 pandemic.

**Conclusion:** Although the Yemeni HCPs exhibited an adequate level of knowledge, an optimistic attitude, moderate anxiety and high performance in preventive behaviours toward the COVID-19 pandemic, the results showed gaps in some themes, particularly in their knowledge and attitude on COVID-19 pandemic which need to be updated or refreshed.

## Background

On 12 December 2019, a cluster of pneumonia cases of unknown causes was reported in Wuhan, China [1]. Among the initial 41 cases were vendors and dealers working in the Huanan Seafood Market [2]. The World Health Organization (WHO) and the Chinese authorities identified the causative agent as a novel Coronavirus (2019-nCov). The emerging disease was named coronavirus disease 2019 (COVID-19) [3]. At first, the 2019-nCov has spread within China and then dramatically spread to other countries [4]. On March 11, 2020, the WHO has declared the outbreak of Covid-19 as a worldwide pandemic [5]. As of 25 May 2020, the virus infected over 5,304,772 and caused 342,029 deaths in about 216 countries, areas and territories around the world [6].

In Yemen, the actual battle to coping COVID-19 has started on 10th April 2020, as the first confirmed case was announced in Ash Shahr, the Hadramout province southern Yemen. On 29th April 2020, five more confirmed cases were registered in Aden city, the temporary capital of Yemen. Thereafter, the cases have started increased day by day and other cities were included. As of 25 May 2020, there have been 226 confirmed cases of COVID-19 in the south of Yemen including with 43 deaths and ten cases have recovered. However, the number of COVID-19 cases anticipated to be higher, particularly with the scarcity means of tracking the virus and lack of transparency in declaring the actual number of cases in North Yemen [6].

The exact dynamic for 2019-nCov transmission has not been determined, yet, according to the WHO, the COVID-19 disease can be transmitted primarily via droplets and fomites during close unprotected contact between an infected person and a healthy person [7]. According to Centers for Disease Control and Prevention (CDC) recommendations, SARS-CoV-2 transmitted from a person to another mainly through close contact (within almost 6 feet) with an infected person via respiratory droplets during coughing or sneezing or when touching a surface or an object that is contaminated with the virus and touching one's eyes, nose or mouth [8]. In most infected patients, the SARS-CoV-2 resulting in none at all or a mild to moderate symptoms that are alleviated within a few weeks. However, it can cause severe respiratory syndrome or death, particularly in older people or patients with chronic health diseases [9].

Healthcare providers as the front line in coping with the COVID-19 pandemic are more susceptible to infection [10]. According to the WHO, the Covid-19 pandemic has infected over 22,073 of HCPs across 52 countries and regions as of 8 April 2020. This infected number of HCPs is probably underestimated because there is no systematic reporting to the WHO yet [11]. Besides, information released by the international council of nurses (ICN), stated that up to 6 May 2020, nearly 90,000 HCPs have affected, and above 260 nurses have died [12].

For the context of the current study, the ongoing six years of war and civil conflicts have destroyed Yemen's infrastructure as only 51% of the country health facilities have been fully operating [13] and only 500 ventilators and two testing centres are available for a population of nearly 30 million. Moreover, the country is suffering from a limited testing capacity, a critical shortage in health care supplies including of basic protective measures and little means of tracking the spread of SARS-CoV-2, particularly, with the similarity of symptoms of COVID-19 and other diseases that are already prevalent in Yemen [14]. All these factors make the country a uniquely dangerous environment to the catastrophic spread of the COVID-19 pandemic, which has raised the Yemeni HCPs' fear and anxiety more compared to their colleagues in other countries.

The rapid prevalence of the novel coronavirus (COVID-19) pandemic over the world was associated with a considerable level of scare, anxiety and panic among the public, in particular, HCPs as the most vulnerable group at risk for SARS-CoV-2 infection [15]. Based on the WHO, the shortage of appropriate protective measures endangers HCPs over the world and represents a major cause of their concern [16]. Accordingly, availability and correct use of personal protective equipment (PPE) are essential to protect

frontline HCPs during their coping with the COVID-19 pandemic. However, what is most important is their adherence to applying these PPE, which largely depends on their knowledge, attitudes, and practices towards COVID-19 [2]. To ensure the protection of the HCPs and safeguard Yemen of COVID-19 outbreak, there is an urgent need to understand the HCP's awareness of COVID-19. Therefore, this study aims to assess the HCPs' knowledge, attitudes, anxiety, and preventive behaviors towards COVID-19.

## Methods

### Study area, study design and study period

A descriptive, web-based cross-sectional survey was conducted among Yemeni HCPs from 22<sup>nd</sup> April 2020, 6 PM to 26<sup>th</sup> April 2020, 11 AM. All HCPs who provide direct healthcare services to patients were invited to participate in our study.

### Study instrument

The questionnaire used in this study was adapted from previously published studies based on the authors' permission [2, 17]. The questionnaire consisted of 58 items concerning the respondents' knowledge, attitude, anxiety and preventive behaviors toward COVID-19. It is contained four parts; Part (1) is concerned with socio-demographic characteristics such as age, sex, occupation, education level, years of work experience and sources of COVID-19 related knowledge. Part (2) is concerned with the respondents' knowledge (21-items). Part (3) is concerned with the respondents' attitude (10-items). Part (4) is concerned with the respondents' anxiety (17-items). Part (5) is concerned with respondents' preventive behaviors (10-items).

### Scoring of knowledge, attitude, anxiety and preventive behaviours

The scoring system used in this study was based on studies by Taghrir et al. [17] and Roy et al. [2]. The 21-items related to knowledge were assessed with "Yes" or "No" response. A score of <11 % was considered inadequate, 11-16 % moderate, and  $\geq 17$  % was considered as adequate. The 10-items concerned with respondents' attitude were evaluated with "Correct" or "Incorrect" response. A score of  $\geq 8$  was considered as a positive attitude and a 0 to 7 was considered as a negative attitude. The 17-items related to anxiety were assessed via a 5-point Likert scale, in which the score of 1 to 5 was given from never to always. A score of 68%-85% (answering for always or very often) was considered high anxiety, a score of 51 to 67 was considered moderate anxiety (answering some-times), while a score of 1 to 50 was considered as low anxiety (answering rarely and never). The 10-items related to preventive behaviours were assessed with "Yes" or "No" response. A score of < 80% was considered low performance and  $\geq 80$ % was considered as high-performance.

### Validity and reliability

Three experts in infectious disease and epidemiology (one specialist in infectious disease and two epidemiologists) have participated in the establishment of the content validity of the questionnaire items. Reliability of the questionnaire items was based on a pilot study included 40 participants and used Cronbach's alpha test. The results of the alpha were 0.79 for the knowledge part, 0.77 for the attitude part, 0.80 for anxiety part and 0.75 for the preventive behaviours part.

## **Data collection**

At the current moment, due to COVID-19 outbreak and the specific preventive precautions recommended by the Ministry of Health and Population, an electronic web-based self-reported questionnaire was designed to follow such recommendations. The link was sent to the HCPs through emails, WhatsApp, Telegram and other social media. Although participation was voluntary and the participants' information was not recorded anywhere on the questionnaire, the respondents were encouraged to forward the survey to other colleagues as possible.

## **Ethical consideration**

Approval of the Ethics Committee of Al-Razi University was obtained before conducting the study. The respondents had to confirm their willingness to participate voluntarily via answering a yes-no question before allowed to complete the online self-report questionnaire.

## **Data analysis**

Statistical Package for Social Sciences (IBMSPSS), version 22.0 was used in the management and analysis of the collected data. Descriptive analyses using the mean values and standard deviations for continuous variables and the count and percentages for the dichotomous or categorical variables were used to describe the data. The relationship between the study variables was assessed using Pearson's correlation coefficient test. A *p*-value of < 0.05 levels (two-tailed) with a 95% confidence interval was reported as significant for correlation analysis.

# **Results**

## **Healthcare providers' demographic characteristics**

Table 1 reveals the respondents' socio-demographic data. As shown in Table 1, above half (61.3%) of the HCPs were male and more than (67%) were in the age group of 20 to 30 years old and a mean of  $29.25 \pm 6.75$ . Concerning the occupation, 22.4% of the respondents were physician followed by pharmacist (17.8%), laboratory (16.3%) and nurses (16.2%). 4.5% of them had Ph.D. and only 1.8% had Board. 88.2% of the respondents had 10 years of working experience or less. Regarding COVID-19 related information sources, social media were the main source for 31.0% of the respondents and news media for 26.1% of them. Around 99.0% of the respondents heard about novel COVID-19, whereas 60.3% of them never attended lectures or discussions of novel COVID-19.

## **Healthcare providers' level of knowledge regarding COVID-19 pandemic**

Figure 1 describes the level of knowledge among healthcare providers regarding COVID-19 pandemic. A 21-items followed with “True” or “False” choices, was used to assess the respondents’ knowledge level regarding COVID-19. As shown in Figure 1, the most (69.60%) healthcare providers had an adequate knowledge level regarding COVID-19 pandemic, while 29.80% of them had moderate knowledge, and only 0.60% had inadequate knowledge about COVID-19 pandemic. The lowest percentages were related to the four statements that discussed the importance of wearing masks in the society, having to wear N95 mask only during intubation, suction, bronchoscopy and cardiopulmonary resuscitation, the possibility to treat the disease by usual antiviral drugs and antibiotics as the first-line treatment, which scored (70.0%, 68.9%, 28.4% and 27.2%), respectively.

## **Healthcare providers' attitude toward COVID-19 pandemic**

Figure 2 demonstrates the level of attitude toward COVID-19 pandemic among Yemeni healthcare providers. The level of respondents’ attitude toward COVID-19 pandemic was assessed via ten-items followed with “Yes” or “No” choices. As shown in Figure 2, the findings indicating that the majority (85.00%) of the respondents had a positive attitude, while 15.00% of them had a negative attitude toward COVID-19 pandemic. However, although the vast majority of the respondents exhibited a high level of optimistic attitude toward COVID-19 pandemic, 75.1 % of them still thought that they would not get the disease and almost 29.4% willing to move to other places within the country to be safe during the pandemic.

## **Healthcare providers' anxiety toward COVID-19 pandemic**

Figure 3 presents the level of anxiety among Yemeni healthcare providers toward COVID-19 pandemic. Level of the respondents' anxiety was assessed via 17-items about COVID-19. Answers on a 5-Likert scale were used, in which the score of 0 to 5 was given, from always to never. As shown in Figure 3, the findings indicating that nearly above half of the respondents had a moderate level of anxiety toward COVID-19 pandemic, whereas 27.70% of them had a high level and 21.50% had a low level of anxiety toward COVID-19 pandemic.

## **Healthcare providers' self-reported preventive behaviors toward COVID-19 pandemic**

A ten-items followed by “Yes” or “No” responses, was used to assess the respondents’ level of self-reported preventive behaviours towards COVID-19. Five items were to reduce public places use during daily life, one item was related to preventive behaviour when coughing/sneezing, two items were related to hand washing and surfaces disinfection frequently and one item was related to talking with family and friends regarding preventive measures of COVID-19. As shown in Figure 4, the vast majority (87.60%) of respondents exhibited sufficient preventive behaviours, while only 12.40% demonstrated low preventive behaviours. The lowest score (84.6%) was related to cancelled or postponed activities and events such as eating out, sports and meetings with colleagues.

## **Association between the respondents' socio-demographic characteristics and their Knowledge, attitude, anxiety and preventive behaviours**

Table 2 presents the association between the respondents' socio-demographic characteristics and their Knowledge, attitude, anxiety and preventive behaviours towards COVID-19 pandemic. As shown in table 2, there was only a significant positive correlation between the respondents' level of knowledge about COVID-19 and their occupation ( $p$ -value =0.012). There was no significant positive correlation between the respondents' level of attitude toward COVID-19 and their working experience years ( $p$ -value =0.238). Likewise, no significant positive association between the respondents' anxiety and their age was found ( $p$ -value =0.238). Regarding the preventive behaviours towards COVID-19, there was an only significant positive association between the respondents' level of performance and their sex and educational level at  $p$ -value (0.020 & 0.003), respectively.

### **Correlation between respondents' knowledge, attitude, anxiety and preventive behaviors scores**

Table 3 showed the correlations between healthcare providers' knowledge, attitude, anxiety and preventive behaviours scores. The correlation was divided into four levels based on the following criteria: weak = 0–0.25, fair = 0.25–0.5, good = 0.5– 0.75, and excellent = 0.75 or greater [18]. As illustrated in Table 3, there was a significant positive linear correlations between knowledge-attitude ( $r$  = 0.157,  $p$  < 0.001), knowledge-anxiety ( $r$  = 0.135,  $p$  < 0.001), knowledge-preventive behaviours ( $r$  = 0.317,  $p$  < 0.001), attitude-anxiety ( $r$  = 0.069,  $p$  < 0.014), attitude-preventive behaviours ( $r$  = 0.297,  $p$  < 0.001) and anxiety-preventive behaviours ( $r$  = 0.279,  $p$  < 0.001). The result indicates the relationship between knowledge, attitude, anxiety and preventive behaviours toward COVID-19 pandemic.

**Table 1 Healthcare providers' demographic characteristics**

<b>Demographic characteristic</b>		<b>no (%)</b>
<b>Age</b>	20-30	838(67.4)
	31-40	313(25.2)
	41-50	79(6.4)
	51-60	14(1.1)
	Mean±SD	29.25±6.75
<b>Sex</b>	Male	763(61.3)
	Female	481(38.7)
<b>Occupations</b>	Physician	279(22.4)
	Nurses	201(16.2)
	Laboratory	203(16.3)
	Anesthesia	57(4.6)
	Dentist	55(4.4)
	Medical Academicians	72(5.8)
	Pharmacist	221(17.8)
	Community	55(4.4)
	Midwifery	26(2.1)
	Physiotherapy	20(1.6)
	Nutrition	45(3.6)
	Radiology	10(0.8)
	Diploma	176(14.1)
	Bachelors	908(73.0)
	Master	82(6.6)
<b>Education Level</b>	Ph.D	56(4.5)
	Board	22(1.8)
	0-10	1097(88.2)
	11-20	125(10.0)
	>20	22(1.8)
<b>Years of working experience</b>	Mean±SD	4.23±5.57

<b>Sources of information about COVID-19</b>	News media	720(26.1)
	Social media	857(31.0)
	Ministry of health and WHO	552(20.0)
	Family and friend	307(11.1)
	Working Place	325(11.8)
<b>Heard about Novel Covid-19</b>	Yes	1231(99.0)
	No	13(1.0)
<b>Attended lectures/discussions about Covid-19</b>	Yes	494(39.7)
	No	750(60.3)

**Table 2 Association between the respondents' socio-demographic characteristics, Knowledge, attitude, anxiety and preventive behaviours**

<b>Demographic characteristic</b>		<b>Knowledge</b>	<b>Attitudes</b>	<b>Anxiety</b>	<b>Preventive behaviors</b>
<b>Sex</b>	Male	8.62±1.24	17.18±1.99	9.02±1.70	42.35±12.52
	Female	8.66±1.28	16.95±2.01	9.27±1.51	44.02±12.09
	<b>p value</b>	<b>0.540</b>	<b>0.048</b>	<b>0.008</b>	<b>0.020</b>
<b>Age (years)</b>	18-30	8.63±1.28	17.22±1.83	9.10±1.60	43.54±12.39
	31-40	8.63±1.16	16.77±2.42	9.06±1.86	42.13±13.02
	41-50	8.68±1.30	17.17±1.79	9.30±1.06	40.88±10.02
	51-60	9.07±1.20	16.57±0.75	9.85±0.36	41.64±6.60
	<b>p value</b>	<b>0.615</b>	<b>0.005</b>	<b>0.238</b>	<b>0.130</b>
<b>Occupation</b>	Physician	8.79±1.31	17.24±1.49	9.35±1.28	42.67±11.18
	Nurses	8.64±1.27	16.79±2.71	8.95±1.75	43.11±12.26
	Laboratory	8.68±1.06	17.14±2.34	8.97±1.91	44.24±13.86
	Anesthesia	8.54±0.82	17.15±2.02	9.47±0.82	44.80±11.13
	Dentist	8.58±1.43	16.47±1.90	9.58±0.78	42.38±11.89
	Academics	8.93±1.12	17.08±1.45	8.97±1.56	42.38±12.49
	Pharmacist	8.44±1.26	17.34±1.75	9.02±1.81	42.50±12.56
	Community	8.20±1.71	17.01±1.52	8.72±2.11	39.72±13.78
	Midwifery	8.42±1.39	16.46±2.33	9.34±1.06	39.73±10.83
	Physiotherapy	8.80±1.11	17.00±1.62	9.05±1.27	42.75±13.36
	Nutrition	8.82±1.09	17.00±1.39	8.97±2.05	46.22±12.46
	Radiology	8.20±1.03	18.70±1.41	9.40±1.26	45.80±10.65
	<b>p value</b>	<b>0.012</b>	<b>0.011</b>	<b>0.025</b>	<b>0.270</b>
<b>Years of working experience</b>	0-10	8.63±1.25	17.10±2.04	9.06±1.70	43.21±12.71
	11-20	8.56±1.24	16.96±1.72	9.51±0.95	41.88±9.03
	>20	9.05±1.21	17.22±1.34	9.45±1.22	38.59±11.53
	<b>p value</b>	<b>0.258</b>	<b>0.721</b>	<b>0.009</b>	<b>0.127</b>
<b>Educational Level</b>	Diploma	8.60±1.36	17.05±2.92	8.96±1.77	41.55±12.48
	Bachelors	8.66±1.22	17.18±1.70	9.11±1.61	43.49±12.40
	Master	8.64±1.07	17.22±1.39	9.62±0.76	42.56±10.70

Ph.D.	8.39±1.55	15.85±3.13	8.62±2.40	38.12±13.63
Board	8.63±1.17	16.77±1.34	9.90±0.42	48.09±8.81
p value	0.638	0.000	0.001	0.003

**Table 3 Correlation between respondents' knowledge, attitude, anxiety and preventive behaviours scores**

Variable	Correlation coefficient	P-value
Knowledge-Attitude	0.157	0.001**
Knowledge-Anxiety	0.135	0.001**
Knowledge-Preventive behaviors	0.317	0.001**
Attitude-Anxiety	0.069	0.014*
Attitude-Preventive behaviors	0.297	0.001**
Anxiety-Preventive behaviors	0.279	0.001**

\*\*. Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).

## Discussion

Since the first confirmed case has been announced in Yemen on 10th April 2020, in Ash Shihr, which is a port city in the Hadhramout province southern Yemen, extreme fear and anxiety extended to the other provinces from the possibility of COVID-19 outbreak. The HCPs as a front line, are the most vulnerable to catch COVID-19 than other people, particularly with a critical shortage in PPE due to the current war and civil conflict in the country [14]. At this critical moment, it is crucial to understand the HCPs' preparedness to cope with COVID-19 outbreak. Accordingly, the current study aimed to explore the level of knowledge, attitudes, anxiety, and preventive behaviors among the Yemeni HCPs towards the COVID-19 pandemic.

Based on the findings, although the majority (60.3%) of respondents had never attended training courses of COVID-19, most (69.60%) of them had an adequate level of knowledge about COVID-19. However, these four statements on the importance of wearing masks in the society, having to wear N95 mask only during intubation, suction, bronchoscopy and cardiopulmonary resuscitation, the possibility to treat the disease by usual antiviral drugs and antibiotics as the first-line treatment scored the lowest correct answers (70.0%, 68.9%, 28.4% and 27.2%), respectively. This result probably highlights the need to focus more on some parts in future educational courses related to COVID-19. The adequate level of knowledge among the respondents could be attributed to their educational level as most of them (85.9%) had a

bachelor degree or higher like Master Degrees. Such an educated professional group could act to obtain knowledge about COVID-19 from different sources of information. In this regard, the result showed that only (20.0%) of HCPs obtained their information about COVID-19 from the official websites of the Ministry of Public Health and Population and the WHO. This indicates that health authorities should pay more attention to encourage HCPs to use official websites as an essential and credible source of information. Likewise, 57.1% of the HCPs appeared to use social media and news media as the main source of their information, which is a considerable concern. This is because using such media can misguide the HCPs by spreading numerous fabricate and unverified information.

It is worth noting that there was only a statistically significant difference between the respondents' level of knowledge and their occupation, while no significant differences related to other socio-demographic characteristics such as age, sex, years of experience and level of education were found in this study. Our results are consistent with the findings of Giao et al. [9], who found that the majority of healthcare workers in Vietnam had a good level of knowledge about the COVID-19 pandemic. The result is also in line with the findings of Nemati, Ebrahimi, and Nemati [19]. Their findings indicated that above half of Iranian nurses had a good level of knowledge related to the COVID-19 outbreak. Similarly, another study conducted by Zhong et al. [20] on knowledge, attitudes, and practices among Chinese residents towards COVID-19 revealed that most respondents had a high level of knowledge about COVID-19.

Regarding the respondents' attitude, the result showed that 85.00% of the respondents had optimistic attitudes towards COVID-19. Unfortunately, the findings showed that 75.1% of them think that they will not get infected by the virus, and almost 29.4% of them are willing to move to other places inside the homeland to protect himself from the COVID-19 outbreak. This result means that most of the respondents are either confident to protect themselves or are not aware that COVID-19 is very contagious. Likewise, one-third of the respondents probably leave their work and go to other places for fear of infection, which resulted in extra healthcare providers' shortage and made the situation more serious. Accordingly, this information should be corrected as soon as possible via holding training courses about COVID-19 or disseminating such information through official websites. The high optimistic attitude in the current study could be explained by the limited cases reported in Yemen so far and the adequate level of knowledge that they obtained since the outbreak has started until this study was conducted. The result of Roy et al. [2] indicated that adequate awareness often leads to optimistic attitudes, which could positively affect the preparedness of the HCPs to meet pandemic issues. In addition, our study result showed a positive correlation between the respondents' knowledge and their attitude, which could support this speculation. Our findings are consistent with a study by Giao et al. [9], who found that healthcare workers had a high level of knowledge and a positive attitude towards the COVID-19 pandemic. These findings are also in line with the result of a cross-sectional study conducted among Saudi health college students [21]. The results revealed that more than half of the students had a positive attitude toward MERS-CoV.

Concerning the respondents' anxiety, the result indicated that nearly half (50.80%) of the respondents had a moderate level of anxiety and 27.70% of them had a high level of anxiety about the COVID-19 outbreak. According to Roy et al. [2], fear and anxiety among a given population are usually expected because of

the intense impact of the pandemic, which could affect the mental well-being and influence their behavior in the community. In this study, only 27.7% of the respondents exhibited a high level of anxiety about COVID-19. The low level of anxiety among the respondents could be attributed to the knowledge level that they have and because they are still in the first stage of the battle against the COVID-19 pandemic. Our result showed lower anxiety reported in studies conducted during the COVID-19 outbreak by Huang and Zhao [22] on Chinese healthcare workers and Nemati et al. [19] on Iranian nurses. Their results showed that the anxiety among healthcare workers was higher than that in other people. The high anxiety among the HCPs could be attributed to the uncontrolled nature of the pandemic and worries about being infected, particularly with the shortage of healthcare institutions and PPE.

Concerning the self-reported preventive behaviors, it was found that the majority (87.60%) of the respondents had a high-performance level of preventive behaviors toward COVID-19. Such high-proactive behavior toward COVID-19 could be attributed to the adequate level of knowledge among the respondents towards the COVID-19 outbreak. As shown by a previous study, those who had adequate knowledge exhibited optimistic attitudes and appropriate proactive practice toward COVID-19 [20]. Another study demonstrated that the level of good knowledge in a given population about COVID-19 is significantly reflected in their behavior and attitude [2]. Our finding seems to be relatively lower than a study conducted during COVID-19 by Taghrir et al. [17] on Iranians' medical students as the researchers found that 94.2% of respondents had high performance in preventive behaviors toward COVID-19. According to the results of this study, it was found that females exhibited a higher-performance-level in preventive behaviors as compared to males. This probably indicates that the women in this study were more compliance in preventive behaviors toward COVID-19. This result is consistent with result of Taghrir et al. [17], that female demonstrated more precautionary behaviors than males.

Another key result was the positive linear correlation between knowledge-attitude, knowledge-anxiety, knowledge-preventive behaviors, attitude-anxiety, attitude-preventive behaviors and anxiety-preventive behaviors. This result reaffirms the relationship between respondents' level of knowledge and their anxiety, attitude and preventive measures toward COVID-19 pandemic. It could be concluded that adequate knowledge can lead to an optimistic attitude, less anxiety, and eventually resulting in a good level of preventive behaviors towards the COVID-19 pandemic. The findings are in line with the results by Zhong et al. [20] who found that those with good knowledge about COVID-19 had an optimistic attitude and proper practices towards COVID-19. However, our result is in contrast to the results of the study conducted by Nemati et al. [19] who found that most Iranian nurses exhibited their anxiety about themselves and their family toward COVID-19, although they had sufficient knowledge about COVID-19.

The current study had several limitations that should be addressed for future research. First, the data was collected through a web-based survey because it was not possible to conduct a face-to-face survey among the Yemeni healthcare providers during this exceptional period. Therefore, the data obtained might less reliable, since there are less accountability and a lack of a trained interviewer. In addition, the data collection was challenging owing to limited respondent availability and cooperation. Another limitation of this study was its exclusiveness to healthcare providers. Therefore, further research should

involve different community-population, and when possible used a community-based studies design are recommended.

## Abbreviations

COVID-19: Coronavirus Disease 2019; SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2; HCPs: Healthcare providers; WHO: World Health Organization; CDC: Centers for Disease Control and Prevention; IBMSPSS: Statistical Package for Social Sciences.

## Declarations

### Ethical approval and consent to participate

This study has obtained ethical approval from the Ethics Committee for Research of Al-Razi University. The participants gave their consent to participate voluntarily via answering a yes-no question in the online consent form before they allowed to complete the questionnaire.

### Consent to publish

Not applicable

### Availability of data and material

Data are available from the corresponding author on reasonable request.

### Competing interests

The authors declare that they have no competing interests.

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### Authors' contributions

GGA, TAHA and MSAA were involved in the idea and the study design. TAHA and MSAA were responsible for data collection. GGA supervised and TAHA performed data analysis. GGA has written up the manuscript the manuscript. All the authors contributed to the data interpretation, reviewing and drafting the manuscript and approved the final manuscript.

### Acknowledgement

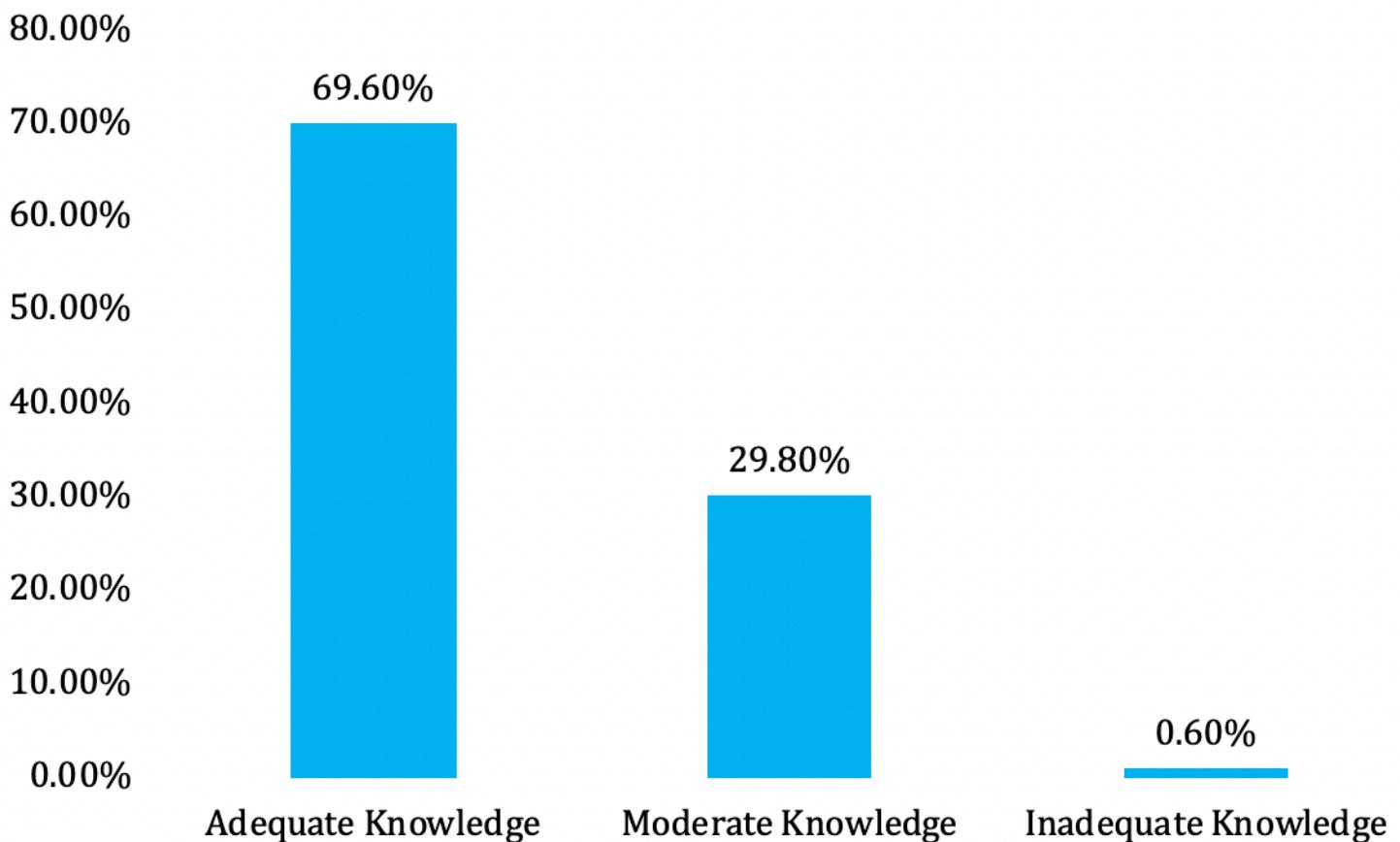
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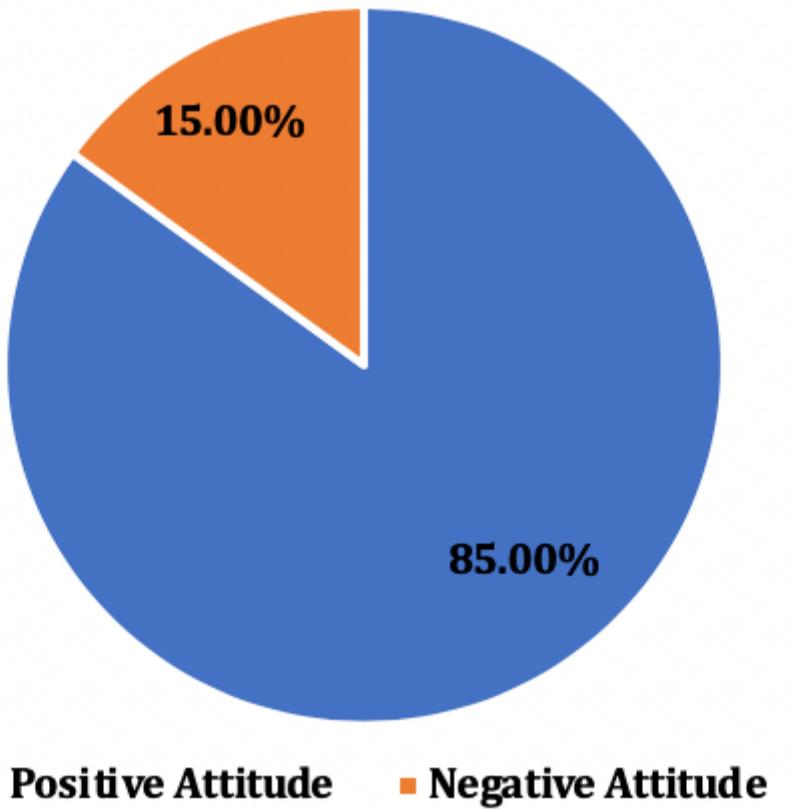
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## Figures



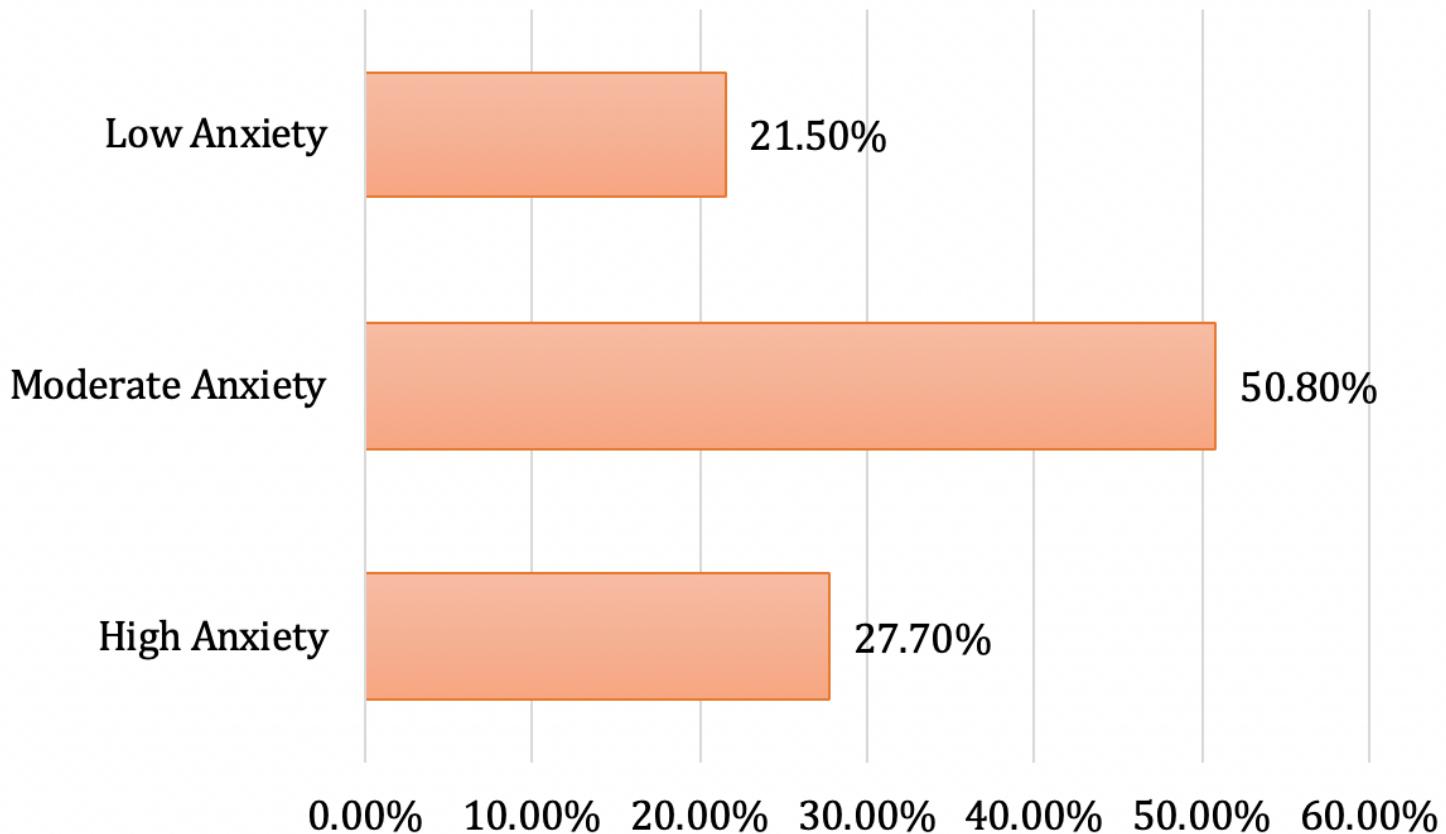
**Figure 1**

Healthcare providers' level of knowledge on COVID-19 pandemic



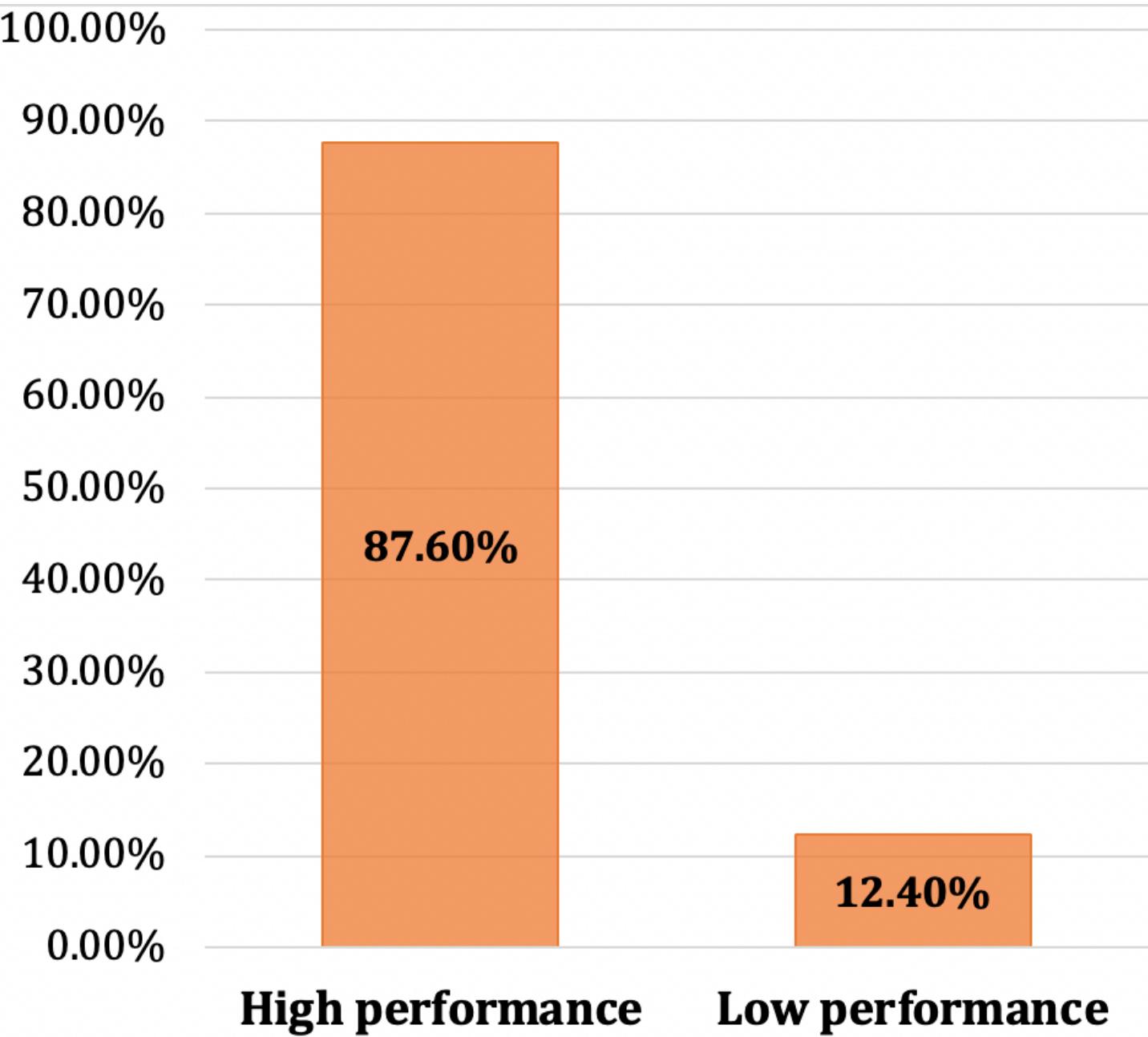
**Figure 2**

Healthcare providers' attitude toward COVID-19 pandemic



**Figure 3**

Healthcare providers' anxiety of COVID-19 pandemic



**Figure 4**

Healthcare providers' preventive behaviours toward COVID-19 pandemic