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Knowledge, Attitudes, and Willingness to Vaccinate for Mpox among Healthcare Workers in Kurdistan Region of Iraq: A Nationwide Cross-Sectional Study

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Abstract: Educating healthcare workers (HCWs) to take action against monkeypox (mpox) is an important part of public health prevention efforts. The study aimed to assess the knowledge, attitudes, and willingness to vaccinate against mpox among HCWs in the Kurdistan Region of Iraq. This study utilized an online cross-sectional survey that was disseminated via Google Forms between November, 1, 2022 and January, 15, 2023, employing a convenience sampling method. The researchers utilized logistic regression to ascertain the factors associated with knowledge, attitude and willingness to vaccinate. A total of 637 HCWs were included in the analysis (ages ranged between 21 and 51 years old). The mean overall score and standard deviation of the knowledge, attitude, and willingness assessment on mpox were 8.18±3.37 out of (0–16), 3.40±1.37 out of (0–5), 2.41±1.25 out of (0–5), respectively. The multivariate logistic regression analysis showed that HCWs who heard about mpox before 2022 had a higher level of knowledge (AOR: 4.85; 95% CI: 2.81-8.36; $p < 0.001$). In addition, those who had less than 1 year of practice had a positive attitude about mpox (AOR: 0.35; 95% CI: 0.20-0.59; $p < 0.01$). Finally, none of the variable groups had the capacity to predict willingness to be vaccinated against mpox. The research revealed that HCWs exhibit a relatively low level of knowledge and attitude towards mpox, as well as a low level of willingness to receive mpox vaccinations. Further, there is an urgent need to increase their knowledge and attitude, as the success of efforts to control the global epidemic depends on them.

Keywords: monkeypox virus; mpox; knowledge; attitude; vaccine acceptance; vaccine hesitancy; healthcare workers; doctors; nurses; pharmacists

1. Introduction

Beginning in early 2020, the globe was shocked by the COVID-19 pandemic, which has yet not ended, we are dealing with yet another epidemic that has the potential to decimate the humans. In 1958, researchers in Denmark discovered the first incidence of monkeypox virus (MPXV) in a group of monkeys [1]. After that, in 1970, the MPXV, an orthopox DNA virus that is zoonotic, was first discovered in humans in the Democratic Republic of the Congo (formerly Zaire) [2]. Subsequently, the disease emerged endemic throughout West and Central Africa [3–5]. Since then, in 2003, the first case of monkeypox (mpox) infection was recorded from endemic to non-endemic nations, caused by an imported rodent from Ghana [3,4,6,7]. Then, the confirmed of mpox cases in the United Kingdom, Israel, and Singapore in 2018 and 2019 was recorded [8–10]. In May, 2022, a significant number of

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cases were reported from nations with no known history of mpox transmission [11]. On 23 July, 2022, the World Health Organization (WHO) declared mpox infection as public health emergency of international concern (PHEIC) [12]. As of July 5, 2023, there have been 88,122 cases confirmed by laboratories, with 148 deaths reported across 112 countries [13]. The mpox outbreak that occurred in 2022 was sporadic in comparison to its prior presentations such as prolonged incubation period (up to 21 days), infection even when outside of an endemic region, prevalence in males, sexual transmission, anogenital lesions, and younger patients [1,2,14–20].

Humans can contract mpox by direct contact with infected animals, humans, and contaminated surfaces and raw meat [21–24]. Furthermore, it is possible that squirrels, prairie dogs, and rodents contribute to the spread of MPXV to humans [22,25]. The recent discovery of MPXV transmission from humans to dogs underscores the importance of researching the dynamics of mpox dissemination in depth [26,27]. Although everyone in close contact with infected cases is susceptible to contracting the virus, the present instances seem to be concentrated among men who engage in sexual activity with other men (MSM) [2,18,28]. Despite this, incidences have been observed in females and children [29–32]. The overwhelming majority of reported cases of mpox in recent studies conducted in the UK and Spain were found to be among MSM [14,18]. Since MSM community are disproportionately affected by mpox, we must pay close attention to the problems of stigma and discrimination, which can be just as devastating as the virus itself [33,34]. However, little is known about the potential risk factors for transmission and infection, zoonotic hosts, and vectors [17,35]. A number of circumstances, including close contact between humans and infected animals, the cessation of smallpox vaccination, and increasing international travel, will make this disease a global public health threat in the future [7,36].

The mpox is a self-limiting disease with a case fatality rate between 1% and 10% [37]. Despite this, there were only a very low number of fatalities during the ongoing outbreak [38]. Symptoms include fever, headache, back pain, myalgia, fatigue, lymphadenopathy, and a variety of skin lesions (including papules, pustules, and ulcers) on the face and body [11,39,40]. The progression of this skin eruption includes the appearance of macules, papules, pustules, vesicles, and finally scabs [41]. Lymphadenopathy appears to be one of the primary features distinguishing monkeypox from smallpox [36]. There are numerous complications associated with mpox, such as keratitis, Paraphimosis, encephalitis, pneumonitis, myocarditis, conjunctivitis and secondary bacterial infections [2,42–48]. Children, pregnant woman and immunosuppressed individuals, particularly HIV-positive people, are at elevated risk of severe outcomes [49–52], but whether effective HIV antiretroviral treatment (ART) reduces this risk is uncertain [53].

There is currently not an MPXV-specific vaccine and drugs available for use. Nevertheless, antiviral medications such as Cidofovir, Tecovirimat (TPOXX), Brincidofovir and Vaccinia Immune Globulin Intravenous (VIGIV) have proven to be effective [54–56]. The mpox infection cannot be cured with antibiotics, however they can be used to stop and control secondary bacterial infections [45]. The smallpox vaccine, however, offered cross-protection against MPXV [3]. In the fight against the smallpox virus, there have been three different generations of vaccinations used [57]. Up until 2008, the first-generation vaccination was the only one available for protection against smallpox [58,59]. This vaccination was extremely successful at preventing smallpox and played a crucial role in the worldwide elimination of the disease [59]. Some populations considered to be at high risk of contracting orthopoxvirus have benefited from the use of a live attenuated vaccination (second-generation). Third-generation vaccine modified vaccinia Ankara-Bavarian Nordic (MVA-BN) is currently licensed for use in humans in both Europe and Canada [60,61]. Despite the fact that vaccines are crucial for eradicating infectious diseases like monkeypox [62]. Recent reports have indicated that some people are hesitant to be vaccinated in response to the current mpox outbreak [63–71]. There are numerous reasons for vaccine hesitancy, including fear of their negative side effects, disinformation and its influence, and distrust of medical staff or the medical system [72,73]. However, healthcare workers' lack of knowledge and unsuitable attitudes might have a negative effect on HCWs' choices, infection prevention, early identification, and prompt intervention [74,75].

When a new infectious disease is discovered, it can be helpful to examine the healthcare workers' current levels of knowledge, attitude, and vaccine hesitancy. This fits with previous findings showing that misinformation about the dangers of new infectious agents can increase anxiety, worry, and even the possibility of conspiratorial thinking [64,76]. In addition, bridging knowledge gaps might be

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considered a crucial component of an mpox epidemic management [77]. Healthcare workers' knowledge, attitudes and willingness to mpox vaccinate are crucial to the development and implementation of an effective infection control strategy. To this day, there have been relatively few studies carried out on the degree of knowledge and attitudes towards mpox among HCWs, college students, and the general public [38,58,83–92,59,93,94,63,64,78–82]. As far as we are aware, no studies have assessed the level of knowledge of HCWs regarding of mpox in Iraq. Since the mpox epidemic spread quickly, more study is required, particularly among health professionals because of their pivotal role in responding to epidemics [95–97].

The Kurdistan Region of Iraq has a population of around 6,000,000 and is located in the Middle East. Despite the fact that mpox has not been recorded in the Kurdistan Region of Iraq as of yet, the rapid growth of cases worldwide and the detection of mpox in other Middle Eastern nations demands for careful planning and response measures [98,99]. Taking into account the major role of healthcare workers in response to the current mpox epidemic [100,101]. The present study aimed to assess the knowledge, attitudes, and willingness to vaccinate for mpox among HCWs in the Kurdistan Region of Iraq.

2. Methods

2.1. Study Design and Setting

This was an analytical cross-sectional study conducted among healthcare workers in Kurdistan-region of Iraq between November, 1, 2022 and January, 15, 2023. This study included Iraqi Kurdistan-registered healthcare workers. These healthcare workers practices in many cities across the region and have different medical specialties.

2.2. Sample Size and Participants

We determined the appropriate size of the sample by utilizing the Raosoft calculator. We established the size of the sample based on the most recent statistics, estimating that there are 30,000 healthcare workers working in the medical field across the Kurdistan region of Iraq [102]. Considering there have been no prior studies in the KRG examining healthcare workers' knowledge of monkeypox, a 50% conservative estimate was used. A minimum of 380 samples were required to achieve a 5% margin of error in a 95% confidence interval. There were 637 total respondents whose data were used for analysis. Our target group comprised doctors, registered nurses, dentists, pharmacists, and medical technicians (MTs), aged 20 or older, willing to participate voluntarily, and residing in the Kurdistan Region of Iraq during the period of the study.

To recruit participants, convenience sampling was utilized. Google Forms were used to create the survey, and participants were recruited using various social media channels (WhatsApp, Telegram, Twitter, Instagram and Facebook). Each respondent was required to provide their informed consent by clicking on the agreement statement before starting to fill out the answers. All of the questions needed to be answered for the submission to be considered valid. For submitting the questionnaires, participants received no benefits or rewards. Moreover, participation was totally on a voluntary basis. To ensure confidentiality, participants' identities were not collected. The entire process of filling out the questionnaire required a total of ten minutes.

2.3. Study Tools

The researchers used a structured questionnaire with 34 items, including sociodemographic. The research questionnaire was developed based on the previously published studies addressing mpox knowledge, attitude, and willingness to mpox vaccinate [70,71,88,90,93,103]. The questionnaire was drafted in English and Kurdish (the local language). The questionnaire was translated to Kurdish language by different experts (Virologists, epidemiologists). A forward-backwards translation from English to Kurdish ensured precise results. There were four main parts to the questionnaire, as outlined below:

The first part included 8-items about sociodemographic data such as age, gender, marital status, highest educational level (undergraduate and postgraduate), duration of practice (in years), occupational category (Doctor, Dentist, Pharmacist, Nurse or other medical technicians), place of residence (the capital and outside the capital) and one “Yes” and “No” question about hearing mpox before 2022.

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The second part included 16-items about mpox knowledge related to transmission of mpox, prevention, treatment and vaccination. The third part included 5-items about attitudes toward of mpox. The fourth part included 5-items related willingness to mpox vaccination.

On October 29, 2022, among 44 participants pilot study was conducted to assess the questionnaire's reliability (the results were excluded from final analysis). For the purpose of determining whether or not the items have a consistent internal structure, Cronbach's alpha was utilized. Cronbach's alpha was 0.77 for the knowledge scale, 0.74 for the attitude scale, and 0.75 for the willingness to mpox vaccinate scale. The overall Cronbach's alpha for the full questionnaire was 0.75, which demonstrates an appropriate level of internal consistency [104].

2.4. Study Variables

There were 16 questions on the knowledge part, and the choices were "Correct", "Incorrect," and "Don't Know". The score of 1 represented a "correct" response, and 0 represented an "Incorrect" or "Don't Know" response. Responses to inverted questions were assigned points in reverse (Correct = 0 and Incorrect = 1). Therefore, the overall score ranged from 0-16, with a higher score (12–16) indicating good knowledge and a score below 12 indicating poor knowledge about mpox disease.

The attitude part included 5-itmes, and the response of each item was measured on a 3-point Likert scale. The score 1 represented “Agree”, and 0 represented “Undecided”, or “Disagree”. The overall score ranged from 0-5, with a higher score (4-5) indicating positive attitude and score below 4 indicating a negative attitude toward of mpox disease.

The willingness to mpox vaccinate part included 5-itmes, and the response of each item was measured on a 3-point Likert scale. The score 1 represented “Agree”, and 0 represented “Undecided”, or “Disagree”. The overall score ranged from 0-5, with a higher score (4-5) represent “willing” to receive the mpox vaccine if made available, score below 4 represent “unwilling” to receive the mpox vaccine.

2.5. Ethical Consideration

The ethical approval was granted by the Research Ethics Committee at University of Raparin, College of basic education, department of kindergarten with reference number 78/2023. This research followed the principles outlined in the Declaration of Helsinki. The confidentiality and anonymity of the participants' responses were also guaranteed. The electronic inform consent was obtained from all participants involved the study.

2.6. Data Analysis

All data analysis were performed using IBM SPSS Statistics version 25 (IBM Corporation, Armonk, NY, USA). Categorical variables and sociodemographic characteristics were given as frequencies and percentages. Then, for determining the normality distribution of the data, the Shapiro-Wilk and histogram were applied, and all the variables followed the normal distribution. The standard error of the skewness coefficient and the standard error of the kurtosis coefficient were also utilized in this study to assess the normality of the data. Additionally, the chi square test was used to find out the association between baseline sociodemographic characteristics and scores of knowledge, attitude, and willingness to get vaccinated against mpox. The univariate binary logistic regression analysis was applied, and factors with a p value of <0.25 were selected for the multivariate binary logistic regression analysis. From the binary logistic regression, variables with a significance level of p-value <0.05 and an odds ratio of 95% CI were taken as statistically significant factors that were independently associated with good knowledge, a positive attitude, and willing to receive the vaccination against mpox.

3. Results

3.1. Baseline Characteristics and Demographic Data

A total of 637 participants were analyzed. All of the survey questions had to be answered for it to be submitted successfully. No one of the participants was excluded. The ages ranged between 21 and 51 years old. There were 49.9% males and 50.1% females, and 49.3% of them were single. 96.7% of the participants were undergraduates (diploma or BSc degree). Also, 42.5% of the participants had 1–5 years of experience. The majority of participants (35.6%) were nurses. Whereas 73.9% of the

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participants were from outside the capital (Erbil). Finally, 60% of the participants reported they heard about mpox before the 2022 outbreak (Table 1).

Table 1. Sociodemographic characteristics of healthcare workers (n= 637).

Variables	Items	Frequency	Percentage
Age	21-30	401	63.0
	31-40	173	27.2
	41+	63	9.8
Gender	Male	318	49.9
	Female	319	50.1
Marital status	Single	314	49.3
	Married	304	47.7
	Widow/er	19	3
Level of education	Undergraduate (diploma or BSc degree)	616	96.7
	Postgraduate (MSc, PhD or its equivalent)	21	3.3
Work experience	Less than 1 year	168	26.4
	1-5 years	271	42.5
	More than 5 years	198	31.1
Occupational category	Medical technicians	130	20.4
	Nurse	227	35.6
	Pharmacist	121	19.0
	Dentist	65	10.2
	Physician	94	14.8
Residence area	The capital (Erbil)	166	26.1
	Outside the capital	471	73.9
Heard about human Monkeypox before 2022		**Yes**	**No**
		382 (60%)	255 (40%)

3.2. Knowledge, Attitude and Willingness to Mpox Vaccinate among HCWs

Table 2 showed that; 74% of the participants answered the question that mpox is a viral disease and 69.5% the question that mpox is a bacterial disease correctly. 68.3% answered the question that mpox is transmitted from one person to another and 69.4% answered the question mpox is transmitted to humans through direct contact from infected animals, correctly. About 59% of the participants reported that mpox infection is associated with typical skin lesions which is correct. Finally, 60.4% replied correctly the question that antivirals are required in the management of human mpox patients.

Table 2. Knowledge of healthcare workers towards monkeypox (n = 637).

Knowledge items	Correct answers	Incorrect answers

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	n (%)	n (%)
Q1. Mpox is a new infection that appeared this year 2022.	324 (50.9)	313 (49.1)
Q2. Mpox is a viral disease infection.	476 (74.7)	161 (25.3)
Q3. Mpox is a bacterial disease infection.	443 (69.5)	193 (30.3)
Q4. Mpox is prevalent in middle eastern countries.	283 (44.4)	354 (55.6)
Q5. Mpox is prevalent in Western and Central Africa.	334 (52.4)	303 (47.6)
Q6. There are many human Mpox cases in Iraq.	328 (51.5)	309 (48.5)
Q7. Mpox is transmitted from one person to another.	435 (68.3)	202 (31.7)
Q8. Mpox is transmitted to humans through direct contact from infected animals.	442 (69.4)	195 (30.6)
Q9. Mpox is spread by droplets (coughing and sneezing).	320 (50.2)	317 (49.8)
Q10. Mpox and smallpox have similar signs and symptoms.	176 (27.6)	461 (72.4)
Q11. Mpox infection is associated with typical skin lesions.	377 (59.2)	260 (40.8)
Q12. Lymphadenopathy (swollen lymph nodes) is one clinical sign or symptom that could be used to differentiate Mpox and smallpox cases.	275 (43.2)	362 (56.8)
Q13. There is a specific vaccine for Mpox.	195 (30.6)	442 (69.4)
Q14. There is a smallpox vaccine that can be used for Mpox.	197 (30.9)	440 (69.1)
Q15. There is a specific treatment for Mpox.	224 (35.2)	413 (64.8)
Q16. Antivirals are required in the management of human Mpox patients.	385 (60.4)	252 (39.6)

As shown in the Table 3 the results showed the distribution of the participants response in frequencies and percentage to the variables of attitude and willingness to get the mpox vaccination, 63.4% of the participants reported that they are confident that the world's population can control the mpox worldwide, 76% of the participants showed their interest in learning more about mpox, 66.2% of the participants reported they think that mass media coverage about mpox may have influence on its worldwide prevention, whereas 62.8% of the participants revealed they think that mass media coverage about mpox may have influence on its worldwide prevention, finally, 72.8% of the participants said they think that it is dangerous to travel to the countries epidemic with mpox. For the variables of willingness to get the vaccination for mpox, 62% of the participants reported that they were considering a smallpox vaccine to prevent mpox infection, while 52.3% of the participants said that the recommendation for the vaccination against mpox infection by doctors, the community, and other professionals has a great influence on them.

The mean scores and standard deviation for knowledge, attitude, and willingness were 8.18±3.37, 3.40±1.37, and 2.41±1.25 respectively. Consequently, 116 participants (18.2%) attained a good level of knowledge based on a 75% cutoff [105] (i.e., 12 questions answered correctly), while 319 participants (50.1%) demonstrated a positive attitude toward mpox. Nonetheless, 112 participants (17.6%) willing to receive mpox vaccine if it were provided. (Figure 1).

Table 3. Attitude toward of mpox and willingness to vaccinate among HCWs (n = 637).

Questions No.	Questions	Agree No. (%)	Disagree & Undecided

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				No. (%)
Attitude toward of mpox				
	A1	I am confident that the world's population can control the Mpox worldwide	404 (63.4)	233 (36.6)
	A2	I am interested in learning more about Mpox	484 (76)	153 (24.0)
	A3	I think that Mpox can add new burden on healthcare system of the affected countries	422 (66.2)	215 (33.8)
	A4	I think that mass media coverage about Mpox may have influence on its worldwide prevention	400 (62.8)	237 (37.2)
	A5	I think that it is dangerous to travel to the countries epidemic with Mpox	460 (72.2)	177 (27.8)
Willingness of HCWs to mpox vaccination				
	W1	I'm considering getting the smallpox vaccine to prevent Mpox viral infection	395 (62)	242 (38.0)
	W2	The monkeypox infection has been alleviated, and there is no need to be vaccinated against Mpox infection.	177 (27.8)	460 (72.2)
	W3	I am worried about the possible side effects of vaccination against Mpox infection	307 (48.2)	330 (58.1)
	W4	The recommendation for the vaccination against Mpox infection by doctors, the community and other professionals has a great influence on me.	333 (52.3)	188 (29.5)

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	W5	If the country provides the vaccination against Mpox infection for free, I am willing to be vaccinated.	327 (51.3)	304 (47.7)

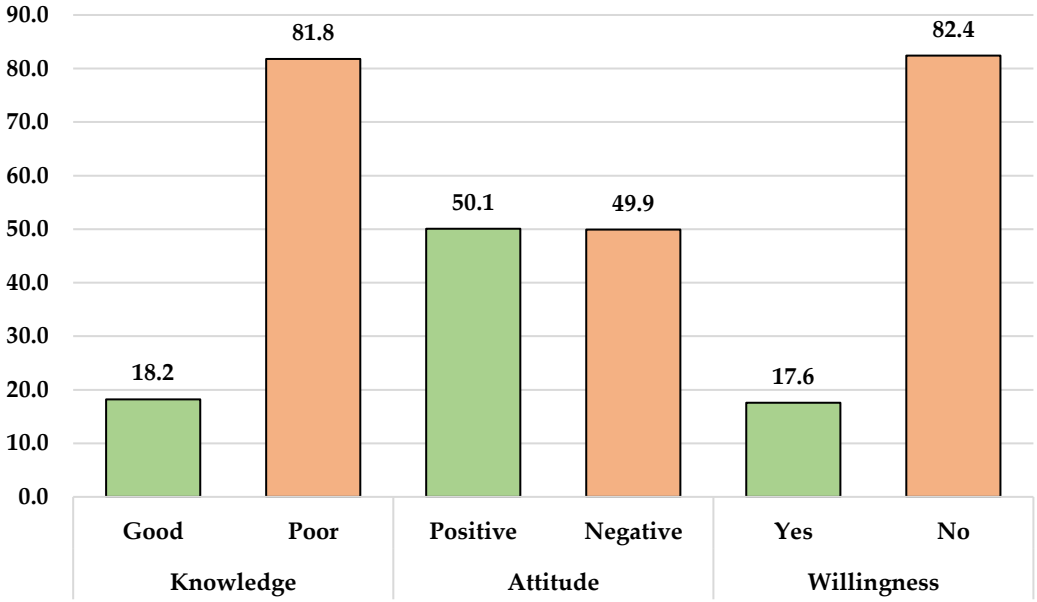

Figure 1. Percentage distributions of knowledge (good and poor), attitude (positive and negative), and vaccination willingness (yes and no) for pox among health care workers in Kurdistan Region, northern Iraq.

3.3. Relationships between Baseline Sociodemographic Characteristics and Knowledge, Attitude and Willingness Scores Toward Mpox

Table 4 shows the association between participants' sociodemographic characteristics and their knowledge, attitude toward mpox, and willingness to get the vaccine against mpox. A good knowledge of participants was associated with hearing about mpox before 2022 ($p < 0.01$). A positive attitude among participants was associated with age groups ($p = 0.01$), marital status ($p < 0.01$), duration of practice ($p < 0.01$), and place of residence ($p = 0.03$). High attitude scores were common among 31-41 years old participants (56.1%), more than 41 years old (66.9%), males (74%), married (58.9%) and widow/er participants (63.2%), for under graduated both level of attitude were equal (50.0%), whereas for graduated group the positive attitude was high (52.4%), also, high attitude scores were common among nurses (52.9%), physician (54.3%), capital city "Erbil" (57.2%), finally, the participants that heard about mpox before 2022 had high attitude scores (51.3%). Chi square results showed that a willingness toward getting mpox vaccination were not associated with any of the baseline sociodemographic characteristics.

Table 4. Association between baseline sociodemographic characteristics and knowledge, attitude and willingness scores toward mpox (n = 637).

Variables		Knowledge				Attitude				Willingness			
		Good	Poor	X^2	*p*-value	Positive	Negative	X^2	*p*-value	Yes	No	X^2	*p*-value
Age (years)	21-30	73 (18.2)	328 (81.8)	0.03	0.98	183 (45.6)	218 (54.4)	9.17	0.01	63 (15.7)	338 (84.3)	2.61	0.27
	31-40	32 (18.5)	141 (81.5)			97 (56.1)	76 (43.9)			36 (20.8)	137 (79.2)		
	41+	11 (17.5)	52 (82.5)			39 (61.9)	24 (38.1)			13 (20.6)	50 (79.4)		
Gender	Male	54 (16.9)	265 (83.1)	0.70	0.40	162 (74.0)	157 (26.0)	0.12	0.72	50 (15.7)	269 (84.3)	1.60	0.20
	Female	62 (19.5)	256 (80.5)			157 (49.4)	161 (50.6)			62 (19.5)	256 (80.5)		
Marital status	Single	55 (17.5)	259 (82.5)	2.71	0.25	128 (40.8)	186 (59.2)	21.6	<0.01	57 (18.2)	257 (81.8)	0.16	0.92
	Married	60 (19.7)	244 (80.3)			179 (58.9)	125 (41.1)			52 (17.1)	252 (82.9)		
	Widow\er	1 (5.3)	18 (94.7)			12 (63.2)	7 (36.8)			3 (15.8)	16 (84.2)		
Level of education	Under graduated	115 (18.7)	501 (81.3)	2.63	0.10	308 (50.0)	308 (50.0)	0.04	0.83	109 (17.7)	507 (82.3)	0.16	0.68
	Graduated	1 (4.8)	20 (95.2)			11 (52.4)	10 (47.6)			3 (14.3)	18 (85.7)		
Duration of practice	Less than 1 year	31 (18.5)	137 (81.5)	1.54	0.46	52 (31.0)	116 (69.0)	37.0	<0.01	31 (18.5)	137 (81.5)	0.31	0.85
	1-5 years	44 (16.2)	227 (83.8)			144 (53.1)	127 (46.9)			45 (16.6)	226 (83.4)		

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	More than 5 years	41 (20.7)	157 (79.3)			123 (62.1)	75 (37.9)			36 (18.2)	162 (81.8)		
Occupation	Medical technician	18 (13.8)	112 (86.2)	5.77	0.21	57 (43.8)	73 (56.2)	3.48	0.48	14 (10.8)	116 (89.2)	7.63	0.10
	Nurse	44 (19.4)	183 (80.6)			120 (52.9)	107 (47.1)			42 (18.5)	185 (81.5)		
	Pharmacist	29 (24.0)	92 (76.0)			59 (48.8)	62 (51.2)			22 (18.2)	99 (81.8)		
	Dentist	12 (18.5)	53 (81.5)			32 (49.2)	33 (50.8)			17 (26.2)	48 (73.8)		
	Physician	13 (13.8)	81 (86.2)			51 (54.3)	43 (45.7)			17 (18.1)	77 (81.9)		
Place of residence	Outside the capital	91 (19.3)	380 (80.7)	1.49	0.21	224 (47.6)	247 (52.4)	4.59	0.03	86 (18.3)	385 (81.7)	0.57	0.45
	The Capital (Erbil)	25 (15.1)	141 (84.9)			95 (57.2)	71 (42.8)			26 (15.7)	140 (84.3)		
Heard about human Monkeypox before 2022	Yes	98 (25.7)	284 (74.3)	35.5	<0.01	196 (51.3)	186 (48.7)	0.57	0.44	65 (17.0)	317 (83.0)	0.21	0.64
	No	18 (7.1)	237 (92.9)			123 (48.2)	132 (51.8)			47 (18.4)	208 (81.6)		

X^2 = Chi square.

3.4. Univariate Binary Logistic Regression Analysis of Knowledge, Attitude and Willingness to Mpox Vaccination

Table 5, shows the univariate binary logistic regression analysis results and revealed that the only factor which was significantly associated with good knowledge about mpox, was: participants who heard about mpox before 2022 compared with participants who didn't hear about mpox before 2022 (OR: 4.54; 95% CI: 2.67-7.73; $p < 0.01$). Also, results showed that factors that were significantly associated with a positive attitude toward mpox were: 21-30 years old participants compared to the participants 31-40 years old (OR:0.51; 95% CI: 0.29-0.89; $p = 0.018$), participants with less than 1 year of practice compared to the participants who had 1-5 years of practice (OR:27; 95% CI: 0.17-0.42; $p < 0.01$), and participants who lived outside the capital compared to the participants from the capital city Erbil (OR: 0.67; 95% CI: 0.47-0.96; $p = 0.033$). Finally, none of the factors was significantly associated with the willingness to be vaccinated against mpox.

Table 5. Univariate binary logistic regression analysis to evaluate the predictive factors associated high knowledge, attitude and willingness scores on mpox (n= 637).

	Knowledge				Attitude				Willingness			
Items	OR	95% CI		*P*	OR	95% CI		*P*	OR	95% CI		*P*
Age (41+ as ref.)												
21-30 years	1.05	0.52	2.11	0.887	0.51	0.29	0.89	0.018	0.71	0.36	1.39	0.328
31-40 years	1.07	0.50	2.28	0.855	0.78	0.43	1.41	0.423	1.01	0.49	2.06	0.977
Gender (Female as ref.)												
Male	0.84	0.56	1.25	0.401	1.05	0.77	1.44	0.721	0.76	0.50	1.15	0.206
Marital status (Widow\er as ref.)												
Single	3.82	0.50	29.23	0.196	0.40	0.15	1.04	0.062	1.18	0.33	4.19	0.795
Married	4.42	0.57	33.81	0.152	0.83	0.32	2.18	0.713	1.10	0.30	3.91	0.882
Educational level (Post graduate as ref.)												
Undergraduate	0.21	0.02	1.64	0.139	0.90	0.38	2.17	0.830	1.29	0.37	4.45	0.687
Duration of practice (More than 5 years as ref.)												
Less than 1 year	0.86	0.51	1.45	0.589	0.27	0.17	0.42	< 0.01	1.01	0.59	1.73	0.947
Between 1-5 years	0.74	0.46	1.18	0.215	0.69	0.47	1.00	0.053	0.89	0.55	1.45	0.656
Occupation (Physician as ref.)												
Medical technical	1.00	0.46	2.16	0.997	0.65	0.38	1.12	0.125	0.54	0.25	1.17	0.121
Nurse	1.49	0.76	2.93	0.238	0.94	0.58	1.53	0.820	1.02	0.55	1.91	0.930

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Pharmacist	1.96	0.95	4.03	0.066	0.80	0.46	1.37	0.424	1.00	0.50	2.02	0.985
Dentist	1.41	0.59	3.32	0.432	0.81	0.43	1.54	0.533	1.60	0.74	3.44	0.225
Residence (The Capital "Erbil" as ref.)												
Outside the capital	1.35	0.83	2.18	0.223	0.67	0.47	0.96	0.033	1.20	0.74	1.94	0.450
Heard about mpox before 2022 (No as ref.)												
Yes	4.54	2.67	7.73	< 0.01	1.13	0.82	1.55	0.447	0.90	0.60	1.37	0.64

OR= odds ratio, CI= confidence interval, P= p-value.

3.5:. Multivariate Binary Logistic Regression Analysis of Knowledge, Attitude and Willingness to Mpox Vaccination

In the Table 6 results of the multivariate binary logistic regression analysis showed that participants who heard about mpox before 2022 were more likely to have good knowledge about mpox compared to the participants who didn't hear about Mpox before 2022 (AOR:4.85; 95% CI: 2.81-8.36; $p < 0.001$). Also, results showed that participants with less than 1 year of practice were more likely to have positive attitude about mpox compared to participant who had 1-5 years of practice (AOR: 0.35; 95% CI: 0.20-0.59; $p < 0.01$). Finally, results showed that none of the variable groups had the capacity to predict willingness to be vaccinated against mpox.

Table 6. Multivariate binary logistic regression analysis to evaluate the predictive factors associated high knowledge, attitude and willingness scores on mpox (n= 637).

Items	Knowledge				Attitude				Willingness			
	AOR	95% CI		*P*	AOR	95% CI		*P*	AOR	95% CI		*P*
Age (41+ as ref.)												
21-30 years	-	-	-	-	0.95	0.51	1.77	0.887	-	-	-	-
31-40 years	-	-	-	-	0.91	0.49	1.68	0.778	-	-	-	-
Gender (Female as ref.)												
Male	-	-	-	-	-	-	-	-	0.78	0.51	1.20	0.268
Marital status (Widow\er as ref.)												
Single	2.99	0.37	23.90	0.302	0.48	0.17	1.32	0.158	-	-	-	-
Married	3.42	0.42	27.37	0.246	0.70	0.26	1.88	0.481	-	-	-	-
Educational level (Post graduate as ref.)												
Undergraduate	4.45	0.56	35.15	0.156	-	-	-	-	-	-	-	-
Duration of practice (More than 5 years as ref.)												
Less than 1 year	0.95	0.50	1.79	0.875	0.35	0.20	0.59	< 0.01	-	-	-	-
Between 1-5 years	0.75	0.44	1.28	0.299	0.79	0.51	1.22	0.294	-	-	-	-
Occupation (Physician as ref.)												
Medical technical	1.19	0.53	2.68	0.664	0.74	0.42	1.31	0.314	0.56	0.26	1.20	0.139
Nurse	1.82	0.89	3.72	0.099	1.07	0.64	1.79	0.787	1.03	0.55	1.93	0.916
Pharmacist	1.81	0.85	3.86	0.122	0.83	0.47	1.46	0.529	0.96	0.47	1.94	0.918
Dentist	1.51	0.62	3.70	0.360	0.83	0.42	1.61	0.586	1.62	0.75	3.47	0.215
Residence (The Capital "Erbil" as ref.)												
Outside the capital	1.38	0.82	2.31	0.215	0.81	0.55	1.19	0.294	-	-	-	-
Heard about mpox before 2022 (No as ref.)												
Yes	4.85	2.81	8.36	<0.001	-	-	-	-	-	-	-	-

AOR: adjusted odds ratio; ref.: reference; CI: confidence interval, P= p-value.

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4. Discussion

This study represents the first attempt to assess the knowledge, attitudes, and willingness of healthcare workers (HCWs) in the Kurdistan Region of Iraq with respect to human mpox and the associated vaccination, as well as the factors that influence their knowledge, attitudes, and willingness to be vaccinated.

The international healthcare system has faced one of the most significant challenges in recent decades with the outbreak of COVID-19. The pandemic not only overwhelmed healthcare systems worldwide but also put immense strain on healthcare workers who had to provide care for both COVID-19 patients and non-COVID-19 patients [106]. The recovery phase of the COVID-19 pandemic brought hope as vaccination campaigns were initiated to control the spread of the virus. However, just as the healthcare system was starting to regain its footing, the re-emergence of mpox presented a new challenge. The resurgence of mpox during the resolution phase of the COVID-19 pandemic has further strained the healthcare system, especially considering that many infection prevention measures implemented during the COVID-19 pandemic were gradually relaxed or abandoned. This unexpected alert highlights the importance of maintaining a vigilant approach to infectious disease prevention and control measures in healthcare settings [107]. Investigating healthcare workers' knowledge and attitudes related to monkeypox also allows for targeted educational interventions. Identifying knowledge gaps or misconceptions can help develop tailored training programs to enhance their understanding of the disease. By addressing these gaps, healthcare workers can improve their ability to recognize mpox cases accurately, provide appropriate care, and educate patients and the community about preventive measures [108].

Our study has shown that 50.1% of HCW were female, 49.3% of them were single, and 96.7% of the participants were undergraduates (diploma or BSc degree) with 1–5 years of experience.

Also, we found that 60% of HCWs heard about mpox before the 2022 outbreak, which can be attributed to their medical education and training, engagement in professional development activities, and exposure to research and publications. These factors contribute to their overall awareness and knowledge of various infectious diseases.

In this study, gaps in mpox knowledge were most conspicuous for transmitting from one person to another, how to differentiate between mpox and smallpox clinical features, specific vaccines and treatment for mpox. Less than 40% of the HCWs correctly answered these questions. Overall, of HCWs from different categories who participated in this study, more than 80% had poor knowledge. Along the same line, recent studies that assessed HCWs' knowledge in a Middle Eastern country [88] reported a low level of mpox knowledge among HCWs. In another hand a previous study conducted on HCWs in Saudi Arabia found that overall knowledge about mpox relatively good [109].

The significance of this result is that training HCWs on infectious diseases like mpox enables them to implement effective prevention and control measures, and HCWs trained in mpox are better equipped to recognize the signs and symptoms of the disease. Early detection is vital for initiating appropriate isolation measures and implementing supportive care promptly. Additionally, differentiate monkeypox from other similar conditions, ensuring accurate diagnosis and appropriate management.

In our data analysis, it was found that only 50% of HCWs displayed a positive attitude toward mpox, and 82.4% were not willing to be vaccinated against monkeypox. The attitude of HCWs plays a critical role in the management and control of mpox, HCWs with a positive attitude are more likely to be attentive and proactive in identifying potential cases of monkeypox and will also be an effective communicator with patients and family [108].

The finding of a mpox vaccine acceptance rate of only 17.6% in the study mentioned is significantly lower compared to the pooled estimate from a recent meta-analysis. This meta-analysis involved HCWs plotted in four different studies, which reported an acceptance rate of 63% [110]. The difference in acceptance rates between the study and the meta-analysis raises important considerations regarding mpox vaccination hesitancy among health professionals. It is worth noting that the acceptance rate reported among HCWs in the meta-analysis is higher than the rates reported among the general public worldwide. Lounis and Riad conducted a recent review that highlighted the issue of possible mpox vaccination hesitancy among health professionals despite their relatively higher rates of vaccine acceptance compared to the general public [111]. Furthermore, another recent study among medical workers in China described a majority of participants supporting the

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promotion of mpox vaccination, mainly among health practitioners and immune-deficient populations [112]. A study conducted on adults in the United States revealed that knowledge levels regarding mpox vaccination were low, and only 46% expressed intentions to get vaccinated if the vaccine was recommended. This suggests a lack of awareness and understanding about the importance and benefits of mpox vaccination [113].

In contrast, the recent study conducted among Pakistani university students aimed to assess their knowledge, attitudes, and willingness to vaccinate against mpox. The findings of the study revealed that there is a relatively high level of willingness among the students to receive mpox vaccination, with 68% expressing their willingness. Additionally, 35% of the participants were willing to pay for the vaccine [114]. Additional study among HCWs in China showed high willingness to get mpox vaccination at a rate of 90%.

Vaccine hesitancy refers to the delay in acceptance or refusal of vaccines, regardless of their availability. It is an intricate phenomenon influenced by various factors such as individual beliefs, attitudes, knowledge, and social influences. Thoughtful vaccine hesitancy among HCWs is crucial, as they play a dynamic role in promoting vaccination and ensuring public health. The organizational aspects within healthcare settings that can affect vaccine acceptance among HCWs, such as vaccine availability, accessibility, and convenience, can impact thier willingness to be vaccinated. Financial barriers can also be addressed by exploring options for making the vaccine more accessible and affordable. This could involve negotiating with vaccine manufacturers for reduced prices or seeking funding from the government or non-governmental organizations to subsidize the cost of vaccination.

Complacency towards mpox vaccination may arise due to a perception that the disease is not a significant threat in certain regions. Another factor contributing to vaccine reluctance could be misinformation or misconceptions about mpox and its vaccine. Misinformation can spread through various channels, including social media platforms, websites, and word-of-mouth [112].

Furthermore, cultural and religious beliefs can also play a role in vaccine reluctance. Some individuals may have concerns about the use of vaccines due to religious or cultural beliefs that discourage medical interventions. These beliefs can vary across different communities and may influence an individual's decision regarding vaccination [105].

Additionally, mistrust in healthcare systems or government authorities can contribute to vaccine hesitancy. If individuals have doubts about the transparency or effectiveness of vaccination campaigns, they may be less likely to trust and comply with recommended immunization practices. Building trust through transparent communication, providing accurate information, and addressing concerns can help mitigate vaccine hesitancy [109]. It is crucial to keep in mind that vaccine reluctance is a complex issue that depends on a variety of factors, some of which can vary across populations and regions. Understanding the specific reasons behind vaccine hesitancy in a particular context is crucial for designing targeted interventions to address these concerns effectively [115].

In this study, we found that good knowledge of HCWs was associated with hearing about mpox before 2022. This suggests that individuals who had prior awareness of mpox were more likely to possess a higher level of knowledge regarding the disease.

Additionally, a positive attitude towards mpox was linked with HCWs age groups 31-41 years old, which showed an even higher percentage (66.9%) of positive attitudes. Marital status was also found to be significantly associated with a positive attitude ($p < 0.01$). Furthermore, HCWs with longer durations of practice were more likely to have positive attitudes towards mpox.

When considering educational background, the study found that among under graduates, both levels of attitude (positive and negative) were equal, with 50% exhibiting high attitude scores. However, among the graduated group, a higher percentage displayed positive attitudes, at 52.4%. In terms of professional backgrounds, nurses had a relatively high prevalence of positive attitudes, with 52.9% scoring high on attitude measures. Physicians also showed a significant proportion of positive attitudes at 54.3%. Lastly, we found that geographically, the capital city (Erbil) had a relatively higher percentage of participants with positive attitudes at 57.2%.

In the current survey, a multivariate logistic regression analysis was conducted to identify additional determinants that have a significant influence on the different outcomes of interest. Specifically, the analysis revealed that the number of years of working activity in the healthcare profession and gender were predictive factors for knowledge and attitude among the sampled

 doi:10.20944/preprints202308.1737.v2

healthcare workers (HCWs). One possible explanation for less experienced HCWs being more active in acquiring information, reading scientific journals, and participating in recent proper training and education compared to those with more years of activity is their higher level of enthusiasm and motivation. Additionally, less experienced HCWs may have a stronger desire to establish themselves professionally and build a solid foundation of knowledge and skills. Furthermore, younger HCWs who are just starting their careers may be more comfortable with technology and digital platforms, which can facilitate access to scientific journals, online courses, webinars, and other educational resources. They may be more adept at utilizing these tools for self-directed learning compared to their more experienced counterparts, who may have been trained in a different era.

Attitudes and willingness to be vaccinated can vary based on the type of vaccine and the population of interest. This study emphasizes the need for special attention to the intricate details surrounding this topic. It acknowledges that previous evidence suggests that vaccine mandates may not always be effective due to the divided opinion among the general public and healthcare workers (HCWs), who can play a crucial role in advocating for such strategies [116,117].

5. Strengths and Limitations

A major strength of this study lies in its ability to collect data from a representative sample of different hospitals inside the Kurdistan region, to provide overview of knowledge gaps, attitudes and mpox vaccine willingness among HCWs. These gaps and attitudes can significantly impact the effectiveness of public health interventions and the overall control of the outbreak.

This study's limitations included, firstly, the cross-sectional design of the survey, which is a significant limitation. A cross-sectional study collects data at a single point in time, providing a snapshot of a population or phenomenon. While this design allows for the examination of associations between variables, it does not establish causality. Additionally, one potential limitation of using self-administered questionnaires is that participants may feel pressured to present themselves in a positive light or conform to societal norms. This can result in respondents providing answers that they believe are more socially acceptable rather than reflecting their true thoughts, feelings, or behaviors.

6. Conclusion

A gab of knowledge levels was found among HCWs toward mpox; one of the primary challenges in identifying and managing mpox cases is the lack of awareness among healthcare professionals and the general public. Without adequate knowledge about the signs, symptoms, and transmission of mpox, it becomes difficult to recognize and respond to potential cases effectively. This can lead to delays in diagnosis, treatment, and containment measures, allowing the pathogen to spread further. This can be achieved through the implementation of proper and timely awareness campaigns, educational courses, workshops, and alerts and equipping HCWs with a comprehensive understanding of mpox, and enhancing their ability to provide high-quality and safe patient care. Furthermore, it is essential to establish vigorous surveillance systems that enable early detection of mpox cases. These systems should involve close collaboration between healthcare facilities, laboratories, public health agencies, and other relevant stakeholders. By implementing real-time monitoring and reporting mechanisms, potential mpox cases can be identified promptly, allowing for timely intervention and containment measures.

One of the key actions that can be taken to combat the negative impact of endorsing vaccination hesitancy is education and awareness regarding the vaccine components, effects and, importance for both HCWs and the general population. Moreover, social media platforms should collaborate with public health organizations to ensure that accurate and up-to-date information is readily available to users, through partnerships that involve sharing verified information, promoting official health guidelines, and providing resources for users.

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