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Original Article

Knowledge of mpox and its determinants among the healthcare personnel in Arabic regions: A multi-country cross-sectional study

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ABSTRACT

Background & aim: The monkeypox virus (MPXV), an Orthopoxvirus family member, is the zoonotic agent that causes mpox (formerly known as monkeypox). The ongoing mpox pandemic has caused cases across continents involving 110 countries. This study aimed to assess mpox knowledge and its determinants among healthcare personnel.

Methods: This cross-sectional study was conducted from June 6 to June 25, 2022, among 17 Arab countries. The self-administered questionnaire consists of 53 questions assessing the knowledge about the monkeypox virus.

Results: In total, 5874 medical students and clinical doctors from 17 Arab countries participated in this study. Only 13.8% (n = 812) of respondents have ever received information about mpox during their studies in medicine. The mean knowledge score was 13.84, and the median score was 15 (range 1–34). More than half (51.3%, n = 3012) have heard about mpox before. A low proportion of the participants had a good level of knowledge on mpox. Only 11.7% of respondents had correctly identified the natural host and the incubation period of mpox. More than half (58.9%) were aware of the signs and symptoms of mpox. Few respondents (28%) believed that mpox and smallpox have similar signs and symptoms. Specialist doctors had higher knowledge of mpox (AOR = 2.96, 95% CI = 2.24–3.92, p < 0.001) than other cadres.

Conclusion: Mpox awareness among Arabic medical students and practitioners is low; hence immediate action in creating awareness among arab healthcare professionals is the need of the hour. This is crucial in the mpox early detection and prevention of its spread.

1. Background

Mpox (formerly known as mpox) is a zoonotic disease considered a member of the poxviridae family, chordopoxvirinae subfamily, orthopoxvirus genus, and Monkeypox (MPXV) virus species. The MPXV is an encapsulated, double-stranded DNA virus, and it is most prevalent in central and western Africa and the Democratic Republic of the Congo [1,2].

The mpox virus was identified for the first time in 1958 when two cases of a pox-like disease appeared in colonies of monkeys in Copenhagen after being packaged from Singapore. The first human mpox was documented in 1970 in the Democratic Republic of the Congo (DRC) during an intensification effort to eradicate smallpox, and the disease persists in the region [3–5].

The incubation period may be between 5 and 21 days, while symptoms and indications can last between 2 and 5 weeks. Before rashes occur, vague symptoms such as fever, chills, headaches, fatigue, asthenia, lymph node swellings, back pain, and myalgia (muscle aching) may manifest, beginning with a fever. Within one to five days following the beginning of the fever, various-sized rashes occur, initially on the face, then the rest of the body, arms, legs, and feet. The rash progresses through various phases, beginning with macules, papules, vesicles (fluid-filled blisters), and pustules and ending with crusts and scabs that fall off upon recovery. Around isolated lesions, erythema and hyperpigmentation are often seen. Sometimes removed scabs are much smaller than the initial lesion. The pharyngeal, conjunctival, and vaginal mucosae may also be inflammation [4,6].

Mortality rates in epidemics have ranged from 1% to 10%, with the majority of fatalities occurring in young people and children [2,6]. In 1987, it was shown that severe lymphadenopathy was the sole diagnostic symptom differentiating mpox from smallpox and chickenpox (varicella) [7,8].

According to retrospective research, outbreaks happened from 1970 to 1971 in Ivory Coast, Liberia, Nigeria, and Sierra Leone. During the epidemic, 72 confirmed mpox cases were recorded in six states, including Illinois, Indiana, Kansas, Missouri, Ohio, and Wisconsin, which were all affected. In September 2018, three mpox cases in the UK attracted the interest of international media, lawmakers, and scientists. As a consequence of the most recent trip to Nigeria, 52 of the first two passengers got symptoms when travelling back to the United States. A health care worker caring for one of the first two mpox patients in the United Kingdom was diagnosed with the disease [2,6]. According to the Nigeria Center for Disease Control (NCDC), 113 cases of mpox have been recorded, and 45 of them were verified between January and December 2019 in nine states: Oyo; Bayelsa; Lagos; Delta; Rivers; Enugu; Akwa Ibom; Anambra; and Cross River [9].

A previous design of the Surveillance, Outbreak Response Management and Analysis System (SORMAS) was effectively initiated in Nigeria in 2015. NCDC decided to use it on an as-needed basis in October 2017 after using a traditional monitoring system early in the outbreak. NCDC then declared to use SORMAS [10].

Enhancing the ability of healthcare professionals to detect instances and improve patient treatment is one of the essential features of the monitoring system [11]. Since May 13, 2022, and June 2, 2022, 780 laboratory-confirmed cases of mpox have been recorded or verified by the WHO from 27 Member States across four non-endemic WHO areas. Many confirmed patients with a travel history reported visiting Europe and North America, as opposed to West or Central Africa, where mpox is endemic [12].

A study conducted in Indonesia revealed that general practitioners, like other nations, particularly Lower and Middle-Income Countries (LAMICs), had minimal understanding of the mpox virus. These low levels of knowledge may be explained by the fact that these countries have never seen an actual epidemic of this illness. Due to this, medical schools do not effectively train students to deal with an outbreak by educating them about the disease and how to treat it during an epidemic's peak phase [13]. The World Health Organization has declared that one of the largest challenges created by the pandemic is the lack of knowledge about mpox in certain countries, particularly those impacted by the illness. This shows that improved prevention and control methods for mpox will be made possible by enhanced knowledge in these areas [14]. Hence, country and region-specific studies on the healthcare professionals' (HCPs) knowledge on mpox and its potential determinants are required. This will enable us to assess the need for awareness generation and specific target groups among the HCPs, before they may be employed in an endemic situation. Environmental concerns require further study to identify the reservoir hosts and focus on educational programs to assist the most susceptible [4,15,16].

In light of the above background, the present study was conducted to evaluate mpox knowledge and its determinants among medical students, general practitioners (GPs), residents, and specialists of the Arab countries.

2. Methods

2.1. Study design and setting

A cross-sectional online study was conducted from June 6 to June 25, 2022 in the Arab countries. Participants included medical students, general practitioners, residents, and specialists from Arabic countries,

including Syria, Lebanon, Palestine, Kuwait, Qatar, Iraq, Jordon, Yemen, Saudi Arabia, the United Arab Emirates, Sudan, Somalia, Egypt, Libya, and Algeria. The multi-centric study improved the generalizability of our results to all the included Arabic countries. All participants were informed of the objectives of the study, as well as the identity of the research group, their right to withdraw from the study, their right to privacy and data protection, and the fact that only fully registered data will be analyzed. The questionnaire was created using data from the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC) of the United States, and cross-sectional research from Indonesia [15]. It was then translated into Arabic. We utilized convenience and snowball strategies to enroll participants in the study. A Google form questionnaire was developed and distributed to respondents via social media, including Facebook, WhatsApp, and Telegram. Participants were also permitted to post the link to the survey through social media. Calculator.net based on Cochran formula, was used to compute the sample size (https://www.calculator.net/sample-size-calculator.html). We conducted a statistical power analysis to determine the appropriate sample size using the following parameters: a population percentage of 50%, a margin of error of 0.02, and a confidence level of 98%. According to the website Statista, the Arabic population was estimated at 436.08 million people in 2020, and the acceptable sample size was 4161. The study design involved recruiting a sample size larger than the minimum requirement to account for potential non-responses or did not match the inclusion criteria. Through google forms, 5905 people were asked to participate in this survey; however, 31 respondents declined, lowering the sample size to 5874.

2.2. Measures

The survey consists of 53 questions divided into three sections. Section one was on the socio-demographic characteristics of the participants, and sections two and three were about general and specific knowledge on the mpox epidemiology. On the first page is a question about willingness to engage in this study.

2.2.1. Socio-demographic variables and work-related characteristics

This section includes 14 questions about the participant's age, gender, marital status, place of residence, chronic disease, country of origin, the academic year for medical students, and speciality of resident doctors and specialists. In addition, they were questioned about their years of experience (more than or less than five years), whether they are a specialist or general practitioner, and if they had attended a conference in their country or abroad. In addition, participants were asked whether they had studied anything about mpox in their medical curriculum, if they had heard of mpox previously, and if they had heard about mpox, then when did they first hear about it (month, week, days, among others). Participants were asked where they first learned about this virus (Internet, social media, television, medical lectures, medical seminars, healthcare workers, and TV).

2.2.2. General knowledge about the mpox virus

This section contains 13 questions about the general information about the mpox virus. This included its natural host (squirrels, dogs, monkeys, rats, and cows), the incubation period (1–7 days, 7–14 days, or 24–28 days), the age group most susceptible to infection, and how the infection is transmitted (human to human, animal to human, fecal-oral route, sharing the clothes of the infected person, respiratory secretions, and from the pregnant mother to the fetus). This section also includes questions about the disease's signs and symptoms, duration (1 week, 2–4 weeks, 4–6 weeks, 6–8 weeks, and do not know), diagnostic tools (including PCR test, Clinical diagnosis, microscopic diagnosis, and do not know), examination sample type (blood, urine, stool, blood, and skin lesions fluid), high-risk complications that may occur (skin rash, respiratory or digestive complications, neurological, delayed growth, and death), treatment (supportive treatment, antibiotics, antiviral, antimalarial drugs, antifungals, and do not know), and prevention methods (vaccination, avoidance of exposure, isolate infected patients, avoid contact with animals that may harbour the virus, and do not know). (1%, 10%, 20%, more than 20%). The score for the correct response was one, while the score for the incorrect answer and “don't know” was zero.

2.2.2. Specific knowledge about the monkeypox virus

This section consists of 21 questions designed to assess the knowledge about the mpox virus, including the prevalence of the mpox virus in Asia countries, Western and Central Africa, and the prevalence in the participant's country. In addition, this section investigates whether this disease is viral or bacterial and the similarity between the symptoms of mpox and smallpox. Also, it covers questions about the symptoms of mpox, such as rashes and lymphadenopathy; this section also has questions regarding treatment options for this illness.

For all the items in the scale, the correct answer received a score of one, while the incorrect response and “don't know” received a score of zero. As a result, the score to evaluate the clinical doctors and medical student's knowledge of mpox ranged from 0 to 34 (21 + 13).

2.3. Pilot study

Before beginning the data collection, we piloted this online questionnaire among 50 Arabic participants (medical students and clinicians) to demonstrate its suitability, readability and comprehensibility of all

Table 1A
Unadjusted and multivariable logistic regression analysis showing predictors of knowledge (using a cut-off of 70%) about human monkeypox infection among healthcare professionals in Arabic Countries (good vs. poor) (n = 5874).

Variables	n (%)	Good knowledge n (%)	Unadjusted	
			OR (95% CI)	P-value
Location				
Algeria	96 (1.6)	8 (8.33)	Ref.	
Egypt	617 (10.5)	21 (3.40)	0.39 (0.17–0.91)	0.03
Iraq	296 (5.0)	14 (4.73)	0.55 (0.22–1.35)	0.19
Jordan	382 (6.5)	27 (14.13)	0.84 (0.37–1.92)	0.69
Kuwait	92 (1.6)	13 (5.34)	1.83 (0.72–4.64)	0.20
Lebanon	32 (5.0)	1 (3.13)	0.35 (0.04–2.98)	0.34
Libya	131 (2.2)	7 (5.34)	0.62 (0.22–1.79)	0.38
Morocco	4 (0.1)	0 (0.0)	–	–
Palestine	55 (0.9)	8 (14.55)	1.89 (0.66–5.36)	0.23
Qatar	94 (1.6)	21 (22.34)	3.20 (1.33–7.64)	0.09
Saudi Arabia	138 (2.3)	37 (26.81)	4.07 (1.80–9.21)	0.01
Somalia	31 (0.5)	3 (9.68)	1.19 (0.29–4.80)	0.80
Sudan	907 (15.4)	107 (11.80)	1.48 (0.70–3.15)	0.30
Sultanate of Oman	8 (0.1)	1 (12.50)	1.58 (0.17–14.58)	0.68
Syria	1758 (29.9)	129 (7.34)	0.88 (0.41–1.85)	0.74
United Arab Emirates	50 (0.9)	8 (16.00)	2.11 (0.74–6.03)	0.16
Yemen	1183 (20.1)	126 (10.65)	1.32 (0.62–2.79)	0.45

OR, Odd Ratio; 95% CI, 95% Confidence Interval; Ref., reference value; Bold are significant values.
*Significant at 0.05 level; ** Significant at 0.01 level ***Significant at 0.001 level.

questions. Then, we made modifications based on participant feedback. Then, employing 50 participants, we conducted a pilot test to assess the online questionnaire's reliability. Cronbach's alpha ratings for the areas varied from 0.712 to 0.861, showing that the instrument maintained a high level of internal consistency. The questionnaire was finalized after the pilot study. The responses used for assessing the clarity and Cronbach's alpha value of the instrument were not included in the main data for the data analysis.

2.4. Ethical consideration

The Institute Review Board (IRB) approval for the study was obtained from the Ethical Society for Scientific Research in Syria (IRB = 784–21). In addition, ethical approval was obtained from the Arabic nations that contributed to the study, where there was a responsible collaborator to get the ethical approval from each included country. The Public Authority verified each country's ethical approval. Participants were given a URL to access the online survey on Google. Before starting the questionnaire, they are sent to a website page containing comprehensive information on the research. The first page of the questionnaire contained a question on whether they agreed to complete it. The time required to complete the online survey ranged from 5 to 12 min. All responses were saved in a protected online database.

2.5. Statistical analysis

The statistical analysis of the data was performed using the IBM SPSS V. 28.0 package program (IBM Corporation, Armonk, NY, USA). A p-value less than 0.05 were considered for statistical significance. Categorical variables on the socio-demographic characteristics of the participants were expressed using descriptive statistics and frequencies. For the statistical analysis, we categorized the levels of knowledge into good and poor based on two modified Bloom's cut-off criteria: 70% and 80% of the total score (i.e., if a participant answered 24 and 27 of the total 34 questions correctly, respectively). A univariate analysis using unadjusted logistic regression was performed to determine factors influencing the knowledge level of participants. Then, a multivariate logistic regression analysis was conducted for the variables with significance ($p < 0.05$) in the univariate analysis to evaluate the odds ratios of the factors determining the knowledge level of participants. The study was conducted following the guidelines of STORSS SECTIONAL criteria, 2019 [16].

3. Results

3.1. Demographic characteristic

The demographic features of the respondents are summarized in Tables 1A–1D. A total of 5874 healthcare professionals from 17 Arabic countries participated in this study. Most participants were from Syria (n = 1758, 29.9%) (Table 1A). More than half of the participants were female (58.20%, n = 3419). Most participants were aged 30 years or below (91.7%, n = 5389), and the majority were single (83.2%, n = 4889). Nearly 84% (n = 4921) lived in the city area. A significant proportion of participants (47.8%, n = 2806) had a moderate level of economic status, while 38.6% (n = 2266) had a good economic condition. Most of the respondents (87.1%, n = 5117) had no history of chronic disease (Table 1B). By occupation types, most were medical students (67.7%, n = 3975), followed by general doctors (16.7%, n = 981), resident doctors (9.5%, n = 559), and specialist doctors (6.1%, n = 359). Of total medical students, about 20% (n = 783) were in the fourth year of their medical education, followed by the fifth year (19.39%, n = 771), sixth year (18.31%, n = 728), third year (16.35%, n = 650), second year (14.81%, n = 589) and first year (11.42%, n = 454) of medical education. Regarding medical speciality, 347 (18.27%) respondents were internal medicine specialists (Table 1C). Most general practitioners (80.18%, n = 1663) had less than five years of work experience. Nearly 38% (n = 2240) of respondents attended a national conference, while 40% (n = 2355) attended a local conference, and only 9.7% (n = 570) attended an international conference. Only 13.8% (n = 812) of respondents have ever received information about mpox during studies in medicine. More than half (51.3%, n = 3012) have heard about mpox before. About 51.7% of respondents reported that they had heard about mpox a few days ago for the first time, while 41.7% (n = 2448) heard it a month ago (Table 1D).

Table 1B
Unadjusted and multivariable logistic regression analysis showing predictors of knowledge (using a cut-off of 70%) about human monkeypox infection among healthcare professionals in Arabic Countries (good vs. poor) (n = 5874).

Variables	n (%)	Good knowledge n (%)	Unadjusted		Multivariable	
			OR (95% CI)	P-value	OR (95% CI)	P-value
Gender						
Male	2455 (41.8)	271 (11.04)	Ref.		Ref.	
Female	3419 (58.2)	260 (7.60)	1.50 (1.26–1.80)	0.000	0.75 (0.56–1.01)	0.060
Age (year)						
30 or less	5389 (91.7)	444 (8.24)	Ref.		Ref.	
More than 30	485 (8.3)	87 (17.94)	2.43 (1.89–3.13)	0.000	0.67 (0.40–1.13)	0.137
Social status						
Single	4889 (83.2)	385 (7.87)	Ref.		Ref.	
Married	935 (15.9)	136 (14.55)	1.99 (1.61–2.45)	0.000	1.26 (0.88–1.79)	0.200
Divorced	38 (0.6)	6 (15.79)	2.19 (0.91–5.27)	0.080	1.39 (0.48–4.04)	0.541
Widower	12 (0.2)	4 (33.33)	5.84 (1.75–19.51)	0.004	1.61 (0.36–7.12)	0.528
Residence						
City	4921 (83.8)	453 (9.21)	Ref.			
Country	953 (16.2)	78 (8.18)	1.13 (0.88–1.46)	0.315		
Economic status						
Bad	277 (4.7)	49 (17.69)	Ref.		Ref.	
Moderate	2806 (47.8)	226 (8.05)	0.40 (0.29–0.57)	0.000	0.69 (0.39–1.23)	0.211
Good	2266 (38.6)	199 (8.78)	0.44 (0.31–0.63)	0.000	0.63 (0.35–1.15)	0.140
Excellent	525 (8.9)	57 (10.86)	0.57 (0.37–0.85)	0.007	0.48 (0.24–0.95)	0.037*
Chronic disease						
No	5117 (87.1)	437 (8.54)	Ref.		Ref.	
Yes	757 (12.9)	94 (12.42)	1.51 (1.19–1.92)	0.001	1.15 (0.80–1.64)	0.442

OR, Odd Ratio; 95% CI, 95% Confidence Interval; Ref., reference value; Bold are significant values.
*Significant at 0.05 level; ** Significant at 0.01 level ***Significant at 0.001 level.

3.2. Knowledge and associated determinants

The mean and median knowledge scores were 13.84 and 15, respectively. Using a threshold score of 80%, only 36 (0.6%) of 5874 respondents had a good knowledge of mpox (Supplementary Table 1). When the threshold was lowered to 70%, 9% (531/5874) of participants had accurate knowledge (Table 1). Thus, most participants did not have a good understanding of mpox. Only 11.7% of respondents had correctly identified the natural host and the incubation period of mpox. Only 9.7% of respondents had correctly answered about the transmission route of mpox. More than half (58.9%) correctly answered about the sign and symptoms of mpox. Nearly 75% of respondents correctly identified the duration of illness due to mpox. The questions on the diagnostic tool use, sample type examination, treatment process, preventive measures, and signs of complications were correctly answered by 26%, 30.7%, 30.8%, 42.7%, and 70.5% of respondents, respectively (Supplementary Table 2).

About 56% of respondents answered correctly regarding the psychological effect of mpox. Nearly 39% of respondents answered correctly about the mortality rate of mpox. Of the total, only 8.4% believed that a virus causes mpox. Most respondents (87.3%) believed that mpox is easily transmitted from human to human, while 63% thought it might be transmitted through a bite of an infected monkey. Nearly 41% of respondents reported that travellers from the American continent were the primary source of imported cases of mpox. Few respondents (28%) believed that mpox and smallpox have similar signs and symptoms. About 53% of respondents stated that paracetamol could be a management option for mpox. In addition to symptomatic treatment, 41.3% of respondents claimed that an antiviral is necessary to manage mpox. In comparison, 38.4% reported that an antibiotic is required to manage human mpox (Supplementary Table 2).

The association between the explanatory variables and knowledge (good vs poor) was determined using two different knowledge domain cut-off criteria (i.e., 70% and 80% out of 34 questions). Using an 80% score threshold, we found no significant association between the explanatory factors and knowledge. However, a multivariate analysis revealed that bad economic status, general practitioner experience (more than five years), attendance at a national conference, receiving information about mpox during the studies at medical school, heard of mpox previously, and the time of first hearing about mpox were significantly associated with good knowledge level about mpox (at a lower threshold score of 70%) (Tables 1A–1D).

3.3. Information sources

Most respondents (89.9%) reported getting mpox-related information from social media such as Facebook, Twitter, and Telegram etc. Around 83% of respondents used the popular internet search websites such as Google, and Chrome for mpox information. More than half of respondents (53%) received information from their friends, while 38% used TV for information. Nearly 34% of respondents relied on health sector workers for information. Only 13% of participants used medical seminars as one of the means for receiving mpox information. The respondents who received information from the medical seminar had the highest proportion (23.15%) of good knowledge, followed by health sector workers, television, friends, the internet, and social media (Table 2).

4. Discussion

Public health professionals are alarmed by the unexpected worldwide spread of monkeypox cases, which were previously thought to be mostly limited to endemic nations in West and Central Africa. The world nowadays faces an outbreak due to the monkeypox virus, which requires cooperation between all agencies, including national and international health foundations. Both government and healthcare staff must collaborate to tackle it. The role of the government is to enhance the health facilities while healthcare workers are responsible for diagnosing and managing the detected cases. So, all medical field workers, including medical students, GPs, resident doctors, and specialists, must have adequate knowledge of this disease to see and manage cases properly.

The present study conducted in 17 Arabic countries found that the knowledge concerning mpox is very low. According to knowledge assessment, only about 0.61% of GPs, 0.36% of residents, 1.67% of specialists, and 0.55% of medical students have adequate knowledge about mpox. The ignorance of mpox is expected as mpox is a reappearing infection, and previously there was no history of similar cases in such countries. Experience with actual cases might have raised their knowledge of such conditions in medical practice [17]. Other studies have also reported that Indonesian healthcare providers lack sufficient knowledge about this infectious virus because no cases have been reported there [18]. This has an adverse implication, as shown by another Asian study which reported that GPs in Indonesia have low confidence in detecting

Table 1C
Unadjusted and multivariable logistic regression analysis showing predictors of knowledge (using a cut-off of 70%) about human monkeypox infection among healthcare professionals in Arabic Countries (good vs. poor) (n = 5874).

Variables	n (%)	Good knowledge n (%)	Unadjusted	
			OR (95% CI)	P-value
Occupation				
Medical student	3975 (67.7)	320 (8.05)	Ref.	
General practitioner	981 (16.7)	79 (8.05)	1.00 (0.77–1.29)	0.998
Resident	559 (9.5)	58 (10.38)	1.32 (0.98–1.77)	0.063
Specialist	359 (6.1)	74 (20.61)	2.96 (2.24–3.92)	0.000
Academic year (student)				
First	454 (11.42)	30 (6.61)	Ref.	
Second	589 (14.81)	35 (5.94)	0.89 (0.53–1.47)	0.553
Third	650 (16.35)	31 (4.77)	0.70 (0.42–1.18)	0.187
Fourth	783 (19.69)	63 (8.05))	1.23 (0.78–1.93)	0.361
Fifth	771 (19.39)	60 (7.78)	1.19 (0.75–1.87)	0.453
Sixth	728 (18.31)	101 (13.87)	2.27 (1.48–3.47)	0.000
Medical specialty				
Anesthesia and resuscitation	39 (2.05)	7 (17.95)	Ref.	
Dermatology	65 (3.42)	13 (20.00)	1.14 (0.41–3.16)	0.797
Family medicine	55 (2.90)	10 (18.18)	1.01 (0.35–2.95)	0.977
Internal medicine	347 (18.27)	80 (23.05)	1.37 (0.58–3.22)	0.471
Laboratory medicine specialty	56 (2.95)	3 (5.36)	0.25 (0.06–1.07)	0.062
Obstetrics and Gynecology	119 (6.27)	18 (15.13)	0.81 (0.31–2.12)	0.675
Ophthalmology	83 (4.37)	12 (14.46)	0.77 (0.27–2.14)	0.621
Pediatric	115 (6.06)	14 (12.17)	0.63 (0.23–1.70)	0.367
Psychiatry	20 (1.05)	5 (25.00)	1.52 (0.41–5.59)	0.526
Surgery	196 (10.32)	29 (14.80)	0.79 (0.32–1.96)	0.618
Others	965 (50.82)	74 (7.67)	0.38 (0.16–0.89)	0.026

OR, Odd Ratio; 95% CI, 95% Confidence Interval; Ref., reference value; Bold are significant values.
*Significant at 0.05 level; ** Significant at 0.01 level ***Significant at 0.001 level.

Table 1D
Unadjusted and multivariable logistic regression analysis showing predictors of knowledge (using a cut-off of 70%) about human monkeypox infection among healthcare professionals in Arabic Countries (good vs. poor) (n = 5874).

Variables	n (%)	Good knowledge n (%)	Unadjusted		Multivariable	
			OR (95% CI)	P-value	OR (95% CI)	P-value
Experience of general practitioner						
Less than five years	1663 (80.18)	189 (11.37)	Ref.		Ref.	
More than five years	411 (19.82)	90 (21.90)	0.45 (0.34–0.60)	0.000	1.80 (1.13–2.85)	0.012*
Attend national conference						
No	3634 (61.9)	221 (6.08)	Ref.		Ref.	
Yes	2240 (38.1)	310 (13.84)	2.48 (2.06–2.97)	0.000	1.80 (1.20–2.71)	0.004*
Attend local conference						
No	3519 (59.9)	228 (6.48)	Ref.		Ref.	
Yes	2355 (40.1)	303 (12.87	2.13 (1.77–2.55)	0.000	1.43 (0.97–2.13)	0.070
Attend international conference						
No	5304 (90.3)	419 (7.90)	Ref.		Ref.	
Yes	570 (9.7)	112 (19.65)	2.85 (2.26–3.58)	0.000	1.15 (0.82–1.63)	0.404
Have you ever received information about monkeypox during your studies in medicine?						
No	5062 (86.2)	347 (6.85)	Ref.		Ref.	
Yes	812 (13.8)	184 (22.66)	3.98 (3.26–4.84)	0.000	3.26 (2.35–4.52)	0.000***
Have you ever heard of monkeypox before?						
No	2862 (48.7)	179 (6.25)	Ref.		Ref.	
Yes	3012 (51.3)	352 (11.69)	1.98 (1.64–2.39)	0.000	1.48 (1.09–2.01)	0.011*
When did you first hear about monkeypox?						
I never heard of it	387 (6.6)	5 (1.29)	Ref.		Ref.	
A few days or weeks ago	3039 (51.7)	234 (7.70)	6.37 (2.61–15.55)	0.000	3.88 (1.35–11.18)	0.012*
A month or so ago	2448 (41.7)	292 (11.93)	10.34 (4.24–25.21)	0.000	3.32 (1.15–9.75)	0.026*

OR, Odd Ratio; 95% CI, 95% Confidence Interval; Ref., reference value; Bold are significant values.
*Significant at 0.05 level; ** Significant at 0.01 level ***Significant at 0.001 level.

and managing mpox cases due to their lack of knowledge [19]. However, compared to the COVID-19 infection, a Lebanese study showed that physicians had adequate knowledge and awareness regarding this pandemic [20]. Another study in Saudi Arabia also reported a high awareness of COVID-19 among medical professionals. That may be explained by exposure to actual cases in raising perception and cognition toward COVID-19 infection in medical settings [21].

When the cut-off point was reduced to 70%, we can see that the level of awareness about mpox was still low; however, the level of knowledge among specialists was the highest (20.61%), while the lowest level of knowledge was seen among medical students (8.05%) and GPs (8.05%). That can be explained by the fact that older doctors rely on the experience of facing real cases rather than information from online sources [25]. Saudi Arabia is shown to have the highest level of knowledge (26.81%), followed by Qatar (22.34%); None of the participants from Morocco knew about mpox. This is in contrast to the findings of a study from Arab countries, which assessed the COVID-19 pandemic and reported a high level of knowledge related to risk assessment and the route of infection of Coronavirus with sufficient knowledge about proper management [22]. Another study was done to estimate the level of knowledge about Coronavirus among medical students in the United Arab Emirates; it has shown that high knowledge level, positive attitudes, and practice toward COVID-19 pandemic [23] when compared to very low knowledge levels regarding mpox in the United Arab Emirates (16%) in our study. Although Saudi Arabia shows the highest level of knowledge regarding mpox compared to other countries, its level of knowledge is still low compared to the same country's knowledge about COVID-19 among the general population (2020) [24].

Table 2
Information sources on virus information based on good knowledge (using a cut-off of 70%) score (n = 5874).

Sources of information received on virus	n (%)	Good knowledge, n (%)
Social media	5280 (89.9)	505 (9.56)
TV	2218 (37.8)	279 (12.58)
Medical seminars	782 (13.3)	181 (23.15)
Friends	3116 (53.0)	358 (11.49)
Health sector workers	2010 (34.2)	309 (15.37)
Internet	4858 (82.7)	480 (9.88)

The first case of human mpox was reported in Singapore in May 2019. After that, all healthcare systems in Asia started strengthening their surveillance systems to face the mpox disease. Because every nation is now connected using international air travel, an infection might spread quickly from one country to another [26–28]. Human-to-human transmission of the mpox virus occurs, as reported by different studies [29–35]. Given the potential for the virus to spread, medical education on the infection will become more crucial and pertinent for efforts at prevention and control. It may be necessary to develop strategies to improve healthcare professionals' knowledge and degree of clinical skill in handling mpox.

5. Limitations

Despite its accessibility and value, a cross-sectional study methodology cannot now prove causal association between the potential determinants and mpox knowledge. Additionally, the generalizability of this study was enhanced by including participants from Arab countries and achieving a response rate of 99%, which is higher than the standard response rate for surveys conducted for organizational research. So far, our findings could be generalized on the medical students and doctors at the level of Arabic countries. We made an effort to eliminate bias in the data-collecting procedure, random replies, and multiple-auto responses by including questions about the names of universities for medical students and hospitals for physicians. Additionally, there was an investigator from each included country to validate the accuracy of the inserted information and to ensure that the participants were from the medical field by closely monitoring the excel sheet drive and the timing of the responses inserted, and we permitted all participants to take the online survey just once. One important limitation of our study is that the nationality sub-groups were unbalanced, potentially resulting in an inaccurate representation of knowledge status in countries with a low number of participants. Finally, it is imperative to state that the findings of our study cannot be applied to those who are older or do not have access to the internet since these groups will all be left out of our research. Several measures were taken to improve the study's dependability despite these restrictions. Use of validated instrument ensured

that relevant confounders are considered in the final model, and choose a sample from various research sites, for example, to improve the internal validity of study findings. Calculations of the a priori sample size are also done to ensure the research results are effective.

6. Conclusions

According to our findings, medical students and clinical doctors in the Middle East have poor levels of awareness of mpox. Although the Arabic area didn't face any outbreak by mpox recent past, there is a serious concern in the wake of a global pandemic, we may have a pandemic without being aware of its features following COVID-19 due to medical students', GPs', residents, and specialists limited knowledge of the mpox virus. It is essential to address this knowledge gap by adopting strategies such as continuous medical education (CMEs) on mpox among the Arab health care personal. Raising awareness and educating individuals about risk factors and ways to minimize exposure to the virus is the primary mpox preventative strategy. Clinicians must be aware of the warning signs and understand how to manage suspected cases. Performing more lectures and compulsory refresher courses for healthcare providers and medical students regarding the monkeypox virus is important to remain up-to-date with the latest updates in epidemic diseases and establish a foundational understanding of how to effectively manage such cases, which may potentially contribute to reducing its consequences.

Ethics approval and consent to participate

The IRB was received from the Ethical Society for Scientific Research in Syria (IRB = 784–21). In addition, ethical approval was obtained from all Arabic nations contributing to the study.

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Availability of data and materials

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Transparency declaration

The lead author (Dr. Sarya Swed) affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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Declaration of competing interest

None for all other authors.

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List of the abbreviations

MPXV	monkeypox virus
WHO	World Health Organization
GPs	general practitioners
CDC	Centers for Disease Control and Prevention
DRC	Democratic Republic of the Congo
NCDC	Nigeria Center for Disease Control
SORMAS	Surveillance, Outbreak Response Management, and Analysis System
PCR	polymerase chain reaction
HCWs	healthcare workers

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nmni.2023.101146.

References

[1] Moore M, Zahra F. Monkeypox. In: edn StatPearls, editor. Treasure Island (FL). StatPearls Publishing. Copyright © 2022, StatPearls Publishing LLC.; 2022.
[2] Kabuga AI, El Zowalaty ME. A review of the monkeypox virus and a recent outbreak of skin rash disease in Nigeria. J Med Virol 2019;91(4):533–40.
[3] CDC. About monkeypox. https://wwwcdcgov/poxvirus/monkeypox/abouthtml.
[4] McCollum AM, Damon IK. Human monkeypox. Clin Infect Dis : an official publication of the Infectious Diseases Society of America 2014;58(2):260–7.
[5] Cho CT, Wenner HA. Monkeypox virus. Bacteriol Rev 1973;37(1):1–18.
[6] Petersen E, Kantele A, Koopmans M, Asogun D, Yinka-Ogunleye A, Ihekweazu C, Zumla A. Human monkeypox: epidemiologic and clinical characteristics, diagnosis, and prevention. Infect Dis Clin 2019;33(4):1027–43.
[7] Di Giulio DB, Eckburg PB. Human monkeypox: an emerging zoonosis. Lancet Infect Dis 2004;4(1):15–25.
[8] Jezek Z, Szczeniowski M, Paluku KM, Mutombo M. Human monkeypox: clinical features of 282 patients. J Infect Dis 1987;156(2):293–8.
[9] Alakunle E, Moens U, Nchinda G, Okeke MI. Monkeypox virus in Nigeria: infection biology, epidemiology, and evolution. Viruses 2020;12(11).
[10] Silenou BC, Tom-Aba D, Adeoye O, Arinze CC, Oyiri F, Suleman AK, Yinka-Ogunleye A, Dörrbecker J, Ihekweazu C, Krause G. Use of surveillance outbreak response management and analysis system for human monkeypox outbreak, Nigeria, 2017-2019. Emerg Infect Dis 2020;26(2):345–9.
[11] Bass J, Tack DM, McCollum AM, Kabamba J, Pakuta E, Malekani J, Nguete B, Monroe BP, Doty JB, Karhemere S, et al. Enhancing health care worker ability to detect and care for patients with monkeypox in the Democratic Republic of the Congo. International health 2013;5(4):237–43.
[12] WHO. Multi-country monkeypox outbreak: situation update. https://wwwwhoint/emergencies/disease-outbreak-news/item/2022-DON390.
[13] Harapan Harapan, et al. Knowledge of human monkeypox viral infection among general practitioners: a cross-sectional study in Indonesia. Pathog Glob Health 2020;114(2):68–75. https://doi.org/10.1080/20477724.2020.1743037.
[14] Riccò Matteo, et al. When a neglected tropical disease goes global: knowledge, attitudes and practices of Italian physicians towards monkeypox, preliminary results. Tropical medicine and infectious disease July 14 2022;7(7 135). https://doi.org/10.3390/tropicalmed7070135.
[15] Harapan H, Setiawan AM, Yufika A, Anwar S, Wahyuni S, Asrizal FW, Sufri MR, Putra RP, Wijayanti NP, Salwiyadi S, et al. Knowledge of human monkeypox viral infection among general practitioners: a cross-sectional study in Indonesia. Pathog Glob Health 2020;114(2):68–75.
[16] Agha R, Abdall-Razak A, Crossley E, Dowlut N, Iosifidis C, Mathew G, for the STROCSS Group. The STROCSS 2019 guideline: strengthening the reporting of Cohort studies in surgery. Int J Surg 2019;72:156–65.
[17] Yardley S, Teunissen PW, Dornan T. Experiential learning: AMEE guide No. 63. Med Teach 2012;34(2):e102–15.
[18] Harapan H, Setiawan AM, Yufika A, Anwar S, Wahyuni S, Asrizal FW, Sufri MR, Putra RP, Wijayanti NP, Salwiyadi S, Maulana R, Khusna A, Nusrina I, Shidiq M, Fitriani D, Muharrir M, Husna CA, Yusri F, Maulana R, Andalas M, Mudatsir M. Knowledge of human monkeypox viral infection among general practitioners: a cross-sectional study in Indonesia. Pathog Glob Health 2020;114(2):68–75. https://doi.org/10.1080/20477724.2020.1743037.
[19] Harapan H, Setiawan AM, Yufika A, Anwar S, Wahyuni S, Asrizal FW, Mudatsir M. Confidence in managing human monkeypox cases in Asia: a cross-sectional survey among general practitioners in Indonesia. Acta Trop 2020;206:105450.
[20] Abou-Abbas L, Nasser Z, Fares Y, Chahrour M, El Haidari R, Atoui R. Knowledge and practice of physicians during COVID-19 pandemic: a cross-sectional study in Lebanon. BMC Publ Health 2020;20(1):1–9.
[21] Asaad A, El-Sokkary R, Alzamanan M, El-Shafei M. Knowledge and attitudes towards Middle East respiratory sydrome-coronavirus (MERS-CoV) among health care workers in south-western Saudi Arabia. East Mediterr Health J 2020:435–42.
[22] Zaki MK, Sobh ZK. Knowledge, attitude, and practice of forensic practitioners during COVID-19 pandemic in Arab countries. Leg Med 2021;52:101903.
[23] Baniyas N, Sheek-Hussein M, Al Kaabi N, Al Shamsi M, Al Neyadi M, Al Khoori R, Abu-Zidan FM. COVID-19 knowledge, attitudes, and practices of United Arab Emirates medical and health sciences students: a cross sectional study. PLoS One 2021;16(5):e0246226.
[24] Almofada SK, Alherbisch RJ, Almuhraj NA, Almeshary BN, Alrabiah B, Al Saffan A, Baseer MA. Knowledge, attitudes, and practices toward COVID-19 in a Saudi Arabian population: a cross-sectional study. Cureus 2020;12(6).
[25] Hisham R, Ng C, Liew S, et al. Why is there variation in the practice of evidence-based medicine in primary care? A qualitative study. BMJ Open 2016;6(3):e010565.
[26] Brown K, Lenggat PA. Human monkeypox: current state of knowledge and implications for the future. Trav Med Infect Dis 2016;1:8.
[27] Reynolds MG, Carroll DS, Karem KL. Factors affecting the likelihood of monkeypox's emergence and spread in the post-smallpox era. Curr Opin Virol 2012;2(3):335–43.
[28] Jezek Z, Grab B, Dixon H. Stochastic model for interhuman spread of monkeypox. Am J Epidemiol 1987;126(6):1082–92.
[29] Learned LA, Reynolds MG, Wassa DW, et al. Extended interhuman transmission of monkeypox in a hospital community in the Republic of the Congo, 2003. Am J Trop Med Hyg 2005;73(2):428–34.
[30] Nolen LD, Osadebe L, Katomba J, et al. Extended human-to-human transmission during a monkeypox outbreak in the Democratic Republic of the Congo. Emerg Infect Dis 2016;22(6):1014–21.
[31] Farahat RA, Sah R, El-Sakka AA, Benmelouka AY, Kundu M, Labieb F, et al. Human monkeypox disease (MPX). Inf Med 2022 Sep 1;30(3):372–91.
[32] Beer EM, Rao VB. A systematic review of the epidemiology of human monkeypox outbreaks and implications for outbreak strategy. PLoS Neglected Trop Dis 2019;13(10):e0007791.
[33] Yinka-Ogunleye A, Aruna O, Dalhat M, et al. Outbreak of human monkeypox in Nigeria in 2017–18: a clinical and epidemiological report. Lancet Infect Dis 2019;19(8):872–9.
[34] Vaughan A, Aarons E, Astbury J, et al. Human-to-human transmission of monkeypox virus, United Kingdom, October 2018. Emerg Infect Dis 2020;26(4). https://doi.org/10.3201/eid2604.
[35] Sah R, Abdelaal A, Reda A, Katamesh BE, Manirambona E, Abdelmonem H, et al. Monkeypox and its possible sexual transmission: where are we now with its evidence? Pathogens 2022 Aug 17;11(8):924.