



# Microbes and Infectious Diseases

Journal homepage: <https://mid.journals.ekb.eg/>

## Review article

# Evaluation of knowledge, attitude, and perception among healthcare workers towards monkeypox and its vaccines: A systematic review

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## ARTICLE INFO

### Article history:

Received 13 January 2025

Received in revised form 18 February 2025

Accepted 1 March 2025

### Keywords:

Attitudes  
Healthcare providers  
Human monkeypox  
Knowledge  
Perception

## ABSTRACT

**Background:** The Monkeypox (Mpox) outbreak in 2022, primarily spread through intimate contact with affected animals and contaminated objects, has raised concerns about its global health impact, especially in healthcare settings, due to potential human-to-human transmission. Healthcare Providers (HCPs) knowledge and attitudes about infectious diseases like Mpox can significantly impact their management and transmission risk reduction. However, gaps in awareness and varying attitudes may hinder vaccine uptake and safety concerns. This review aims to investigate the current knowledge, attitudes, and perceptions of Mpox among HCPs. **Methods:** This systematic review analyzed cross-sectional studies published between 2020 and 2024 using PubMed, Scopus, Web of Science, Cochrane Library, and Google Scholar. The quality of the studies was assessed using the Joanna Briggs Institute's quality checklist.

**Results:** This analysis comprised a total of 15 studies. The findings indicate that HCPs' awareness, attitudes, and knowledge of Mpox varied among the included research conducted in various locations and eras. Furthermore, HCPs' knowledge, attitudes, and awareness regarding Mpox are greatly influenced by specific demographic traits, such as occupation and educational attainment. Five research examined associated aspects of HCPs' awareness, attitudes, and knowledge regarding Mpox. Nine research were solely concerned with evaluating knowledge about Mpox. Furthermore, only one study assessed HCPs' knowledge of Mpox directly. **Conclusion:** This study of HCPs' knowledge, attitudes, and perceptions about monkeypox and vaccines reveals disparities in knowledge and the effectiveness of public health measures. Addressing these gaps requires education, training, and awareness initiatives.

## Introduction

The Monkeypox (Mpox) virus, which belongs to the Orthopoxvirus genus, is the source of the zoonotic illness known as monkeypox [1]. Similar to smallpox but often less severe, it was first

discovered in 1958 in research monkeys and then in people in the Democratic Republic of the Congo in 1970 [1]. The virus can cause fever, rash, and lymphadenopathy and is spread by close contact

with sick people, animals, or contaminated objects [2,3].

Nevertheless, the number of Mpox outbreaks as a human-to-human disease has increased significantly over the past few decades [4]. The Democratic Republic of Congo (DRC) registered the first documented case of Mpox in a 9-month-old infant in 1970, amidst intense surveillance for the eradication of the disease [5]. In July 2022, the World Health Organization (WHO) declared MPHV a public health issue following numerous outbreaks [6,7]. The majority of the diagnosed cases have been found in men who have intercourse with other men and travel [8].

The public health issue of Mpox was raised due to the close human-animal contact environments, particularly in West African territories [9]. Disease transmission can occur through direct contact between humans and infected animals' fluid, blood, or lesion debris [10]. Moreover, Pal *et al.* [11] have identified interpersonal contact as a mode of transmission. Droplets, contact with nasal secretions, and ingestion of flesh from livestock or wild animals are also modes of transmission between individuals. Besides, the placenta is not an exclusion for the virus to be transferred to the fetus [11,12].

The presentation of this distinctive disease is similar to that of smallpox; however, identifying Mpox from other infections, such as smallpox, remains a challenge [11]. Monkeypox is distinguished by the development of lymphadenopathy, as per Erez *et al.* [13]. However, the Smallpox vaccine is reputed to lessen the severity of the disease among infected individuals, with an efficacy of up to 85% [2,14].

Human monkeypox is associated with a diverse array of clinical manifestations, which range in severity from mild to severe [2]. A sequence of self-limiting symptoms commenced after 5 to 21 days, including fatigue, fever, shivers, and lymphadenopathy [15]. Monkeybox is characterized by rashes that progress through a series of stages, including pustules and papules, followed by the formation of vesicles and scabs [16]. For patients who are experiencing respiratory distress and dehydration, hospitalization is recommended [17].

Understanding the knowledge, attitude, and practices of HCPs regarding Mpox and its vaccines is essential for designing targeted interventions, training programs, and policy

frameworks [18]. The importance of timely detection, early management, and the implementation of control and preventive measures has been recently emphasized [19]. However, the lack of thorough knowledge of Mpox among healthcare providers (HCPs) is recognized as a barrier that may cause the disease to resurface and another pandemic like COVID-19 to break out [20]. Therefore, this systematic review aims to investigate HCPs' knowledge, attitude, and practice toward Mpox.

Along with obstacles to successful education and training initiatives, the analysis also looks at factors influencing HCPs' acceptance or reluctance to receive vaccines.

This review will answer the following research question: "What is the level of knowledge, attitudes, and awareness among healthcare providers regarding monkeypox and its vaccines, and how do these factors influence their preparedness and response to monkeypox outbreaks?"

## Methods

Healthcare providers' knowledge, attitudes, and perspectives of Mpox and its vaccines are assessed using a systematic review of the literature. It combines data from many geographic locations and healthcare environments to pinpoint important patterns, unmet needs, and difficulties impacting HCPs' readiness and reaction to Mpox epidemics. This systematic review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [21]. Observational cross-sectional studies were included in the current review with varying statistical analyses such as correlational, comparison, and description statically analysis tests.

## Searching strategy

The following databases were utilized, namely, Science Direct, Medline through (PubMed), ResearchGate, Scopus, EBSCO, ISI Web of Knowledge, ERIC (Education Resources Information Center), and the Cumulative Index to Nursing & Allied Health Literature (CINAHL) database for the years between January 2020 and September 2024. The keywords were used with the terms related to Monkeypox, healthcare workers, knowledge, Attitude, and Perception. The following descriptors were used in English in the six databases: Evaluation and Assessing AND "Monkeypox" "Perception" "Knowledge" "Attitude" "Health care workers" OR "Health care

providers". The articles are published in the English language with full text.

### Selection and Eligibility Criteria

Three independent authors were responsible for removing the duplicates, screening the title and abstract, and analyzing the full content of the studies following the inclusion criteria. To be included in the systematic review. The studies were included if they met the following criteria (a) published in the English language; (b) cross-sectional studies; (c) including health care workers; (d) articles related to the evaluation of knowledge, attitude, and perception among health care workers towards Monkeypox; (e) Full text; (f) published between 2020 and 2024. This review excluded protocols, posters, letters to editors, and editorials. Disagreements and clarifications were discussed between the reviewers.

### Data extraction and synthesis

Data from the included cross-sectional studies were extracted using the standardized data extraction form developed by Joanna Briggs Institute [22]. The data about: (1) First author; (2) Year of publication; (3) Country; (4) Aim of study; (5) Characteristics of the participants; (6) Education level (7) Specialty; (8) Study design; (9) Level of knowledge; (10) Level of attitude, (11) Level of perception; (12) Recommendation; and (13) Limitations (**Table 1**).

The researchers used the extracted data to determine the key components of the included interventions. A total of 193 papers were found, (n=70) papers were excluded after the removal of duplicate records, while only (n=15) records were included after excluding the illegible studies (**Figure 1**).

### Risk of Bias

The quality of the selected articles was assessed utilizing the Joanna Briggs Institute (JBI) critical appraisal checklists for cross-sectional studies (Munn, Moola, Lisy, Riitano, & Tufanaru, 2017). The checklists consist of nine items that examine the potential bias in cross-sectional studies. These items are categorized into three main groups: study design, sampling strategy, and measurement tools. The questions evaluate various aspects of the study, such as the sample's representativeness, appropriate measurement of variables of interest, and proper statistical analysis. The checklists consist of several items that can be answered with 'yes', 'no', or 'unclear'. The risk of bias of the study was

judged as follows: High risk if at least two domains were considered at high risk (no); Moderate risk if one domain was considered at high risk or if two or more domains were considered unclear; Low risk if no domains were considered at high risk (yes) (Munn et al., 2017). To ensure the reliability of the quality assessment process, two independent researchers (EHB-M and EQ) assessed the risk of bias in the included studies, and a third reviewer (BH) was consulted to resolve discrepancies.

### Risk of Bias Assessment

The findings of the risk of bias assessment (JBI) Critical Appraisal Checklist for analytical cross-sectional studies are presented in **Table 1**. Among the selected cross-sectional studies, three studies were deemed to be at high risk [23-25]. Three studies were deemed to be at low risk [18,26]. The risk of bias for each of the other studies was considered to be moderate.

### Results

#### Healthcare providers' knowledge about Monkeypox

The levels of knowledge among the healthcare workers were analyzed thematically, focusing on whether the participants demonstrated good, fair, or poor knowledge levels regarding monkeypox. The results show that there is no consistent level of knowledge among these healthcare workers across the studies in different regions and times. Whereas some studies showed that healthcare workers have good and fair knowledge, some of them reported poor levels, which paints a mosaic of overlapping and inconsistent knowledge levels. Nevertheless, the majority of the healthcare workers represented a higher number of studies and established adequate knowledge levels about monkeypox. For instance, a study performed by Alshahrani *et al.* [27] used a Pearson's Chi-square test to compare knowledge levels and explanatory variables. Out of 480, only 48% of the participants had high knowledge (mean score > 14). Participants' age, marital status, residential region, living in an urban area, education level, employment status, being a healthcare worker, income, and smoking status were significantly associated with the level of knowledge about monkeypox ( $p < 0.01$ ). Overall, social media (75.0%) was the most frequently reported source from where participants obtained monkeypox-related information, followed by TV and radio (45.6%), family or friends (15.6%), and healthcare providers (13.8%). Besides, a study performed by

Oche *et al.* [28] stated that every responder knew about Mpox, and over half (52.3%) of them cited the internet as their primary knowledge source. Only years of work experience was substantially correlated with illness knowledge, with the majority of doctors (72%) having a strong understanding. All of the respondents demonstrated good preventative habits, with the majority (73%) having suitable preventive practices.

A study performed by Amer *et al.* [24] stated that MPOX knowledge score's regression analysis, those who worked directly with patients and those who participated in training programs or courses scored 1.25 and 3.18 points higher, respectively. Besides, a study performed by Rony *et al.* [20] reported that the final analysis contained 1,047 datasets in total. Overall, 93.12% of respondents had a favorable attitude about the monkeypox disease, and 57.97% of participants showed strong knowledge. Compared to male nurses, female nurses demonstrated a more positive attitude (AOR 1.64; 95% CI 1.12–3.00) and greater knowledge (adjusted odds ratio (AOR) 1.36; 95% CI 0.88–1.98). Additionally, a positive attitude and good knowledge of monkeypox disease were shown to be strongly connected ( $r = 0.76$ ,  $p < 0.001$ ), whereas a negative attitude and inadequate knowledge were found to be somewhat correlated ( $r = 0.53$ ,  $p < 0.001$ ).

Furthermore, a study performed by Sobaikhi *et al.* [26] stated that the average age of the included participants was  $30.93 \pm 8.25$  years, and the majority were male, between the ages of 22 and 29, unmarried nurses employed in government hospitals with at least five years of experience. Age, marital status, work title, and medical practice were all substantially correlated with the participants' degree of knowledge, according to the chi-square and t-test results. The majority of participants had positive views and little understanding of how to prevent monkeypox. When all other significant bivariate connections between knowledge and demographics were controlled for, multivariate analysis revealed that younger age was related to better knowledge.

Also, a study was performed by Temsah *et al.* [25] to determine how healthcare workers (HCWs) view, worry about, and accept the monkeypox vaccination in the context of the COVID-19 pandemic's resolution. It was reported that 1,130 HCWs revealed that 41.6% have already

developed COVID-19, with 56.5% more concerned about COVID-19 than Monkeypox. The main cause of concern was the development of the post-COVID-19 pandemic, followed by the fear of contracting the infection. Most HCWs (60%) rated their self-awareness of Monkeypox as moderate to high. Predictors of vaccination advocacy included those who had previously developed COVID-19 and supported tighter infection control measures.

A recent study performed by Theban [29] reported that, in all, 195 nurses participated in the study. Of them, 56.4% were female, and nearly half (50.3%) were in the 35–44 age range. The majority of participating nurses (88.2%) acknowledged having heard about monkeypox in the past. Overall, it was found that 16.9% of the nurses knew a good deal about monkeypox, whereas 30.8% knew very little. Compared to their counterparts, nurses who were 45–54 years old, non-Saudi, and technicians/specialists knew more about monkeypox disease. Over half of the nurses (57.9%) had a favorable attitude toward monkeypox, especially the more seasoned nurses (>5 years) and those who knew a lot about the illness.

However, demographic variables such as age, sex, education level, professional role, workplace setting, and previous exposure to infectious diseases can influence knowledge, attitude, and awareness among healthcare workers. Older workers may have outdated training, while younger professionals may have more updated training but less experience. Professional roles, workplace settings, and prior experience can also influence knowledge levels.

Overall, these studies' findings indicate that healthcare professionals' degrees of awareness of monkeypox differ. Although some have a solid general comprehension, some significant gaps require focused treatments.

### **Healthcare providers' attitudes toward monkeypox**

Healthcare practitioners' opinions toward monkeypox vary; some have favorable attitudes, while others have negative and neutral attitudes, according to a thematic analysis of the findings from individual studies. However, it was seen that participants in the majority of the investigations had differing opinions about monkeypox, with many ideas surrounding it.

A positive attitude was expressed by a comparatively higher proportion of participants in

five studies included in this review [24,25,29]. Some studies reported specific aspects towards which the positive attitude about smallpox was exhibited, i.e., disease prevention and control practices, and the role of media in helping the management [28,30], while others only gave general attitude without specific circumstances [18,29]. This observation showed the divergent approaches and measures applied in the studies regarding healthcare workers' attitudes toward monkeypox.

Neutral and negative attitudes were also noted among some healthcare workers in some studies included in this review. Three studies had a relatively larger number of participants expressing negative attitudes toward various elements of monkeypox [25,27,28]. Some of the notable issues toward which the participants had negative attitudes included the significance and efficacy of the monkeypox vaccine and populations where transmission was possible [1,27]. At the same time, a neutral attitude was notable among healthcare workers in two research articles [25]. These outcomes, therefore, paint a picture of mixed reactions and feelings expressed by healthcare workers toward monkeypox.

However, it was also noted that healthcare workers' attitudes varied with some factors, including the profession and education level [18,27].

For instance, healthcare workers with postgraduate education expressed more confidence in monkeypox management than those with bachelor's degrees [31]. Similarly, physicians had considerably more positive attitudes towards monkeypox compared to other healthcare workers, like nurses.

#### **Healthcare providers' perception of monkeypox**

Five articles examined the perceptions of healthcare workers toward monkeypox, which showed significant variations in their views [1,20]. Again, this review noted that there is a mix of positive and negative perceptions held by healthcare workers towards the monkeypox disease.

The low and negative perceptions were expressed toward various elements of monkeypox, such as diagnosis and testing, disease management and burden, and vaccine efficacy [27]. Two research articles reported extremely low and negative perceptions of monkeypox disease among healthcare workers [25]. On the other hand, positive perceptions were expressed only in general without specific elements highlighted [24]. Again, this review also noted that healthcare workers with higher educational qualifications were more likely to express a more positive attitude toward monkeypox [27]. Overall, the results show that there are mixed reactions expressed by the healthcare workers toward monkeypox.

**Table 1.** The Joanna Briggs Institute (JBI) Critical Appraisal Checklist was used for the selected cross-sectional studies.

Publication	Criteria for Inclusion Defined	Detailed Description of Subjects and Setting	Measurement of Exposure Valid and Reliable	Measurement of Condition Done Using Objective and Standard Criteria	Confounding Factors Identified	Statement of Strategies to Deal with Confounding Factors	Measurement of Outcomes Valid and Reliable	Appropriate Statistical Analysis	Overall Risk of Bias
(Theban, 2024)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(AlBalas <i>et al.</i> , 2024)	YES	YES	YES	YES	YES	YES	YES	YES	LOW
(Amer <i>et al.</i> , 2024)	YES	YES	YES	YES	NO	NO	YES	YES	HIGH
(Aynalem <i>et al.</i> , 2024)	YES	YES	YES	YES	YES	YES	YES	YES	LOW
(Oche <i>et al.</i> , 2024)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Miraglia, 2023)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Ajayi, 2023)	YES	YES	YES	YES	NO	NO	YES	YES	HIGH
(Sobaikhi <i>et al.</i> , 2023)	YES	YES	YES	YES	YES	YES	YES	YES	LOW
(Thomas, 2023)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
Rony, Sharmi, Akter, Parvin, & Alamgir, 2023)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Alsanafi <i>et al.</i> , 2022)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Alshahrani <i>et al.</i> , 2022)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Anil <i>et al.</i> , 2024)	YES	YES	YES	YES	NO	NO	YES	YES	HIGH
(Sahin <i>et al.</i> , 2022)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
Sallam <i>et al.</i> , 2022)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE
(Harapan <i>et al.</i> , 2021)	YES	YES	YES	YES	NO	unclear	YES	YES	MODERATE

**Table 2.** Matrix of included study (n=15).

Author's name, year	Purpose	Type of the study	Statistical tests	Main finding	Conclusion
[29]	To assess the knowledge of and attitude toward monkeypox disease among nurses.	Cross-sectional study	Descriptive statistics such as percentages, frequencies, mean, and standard deviation were calculated, and analytical statistics using the Chi-square test were applied.	A lack of proper knowledge about the monkeypox disease is considered one of the barriers to controlling its re-emergence. The majority of nurses in the current study (88.2%) were aware of monkeypox disease.	The a need to organize educational programs for them about the disease, and this may assist the higher authorities in improving monkeypox prevention and control.
[35]	To assess the KAP (knowledge, attitude, and practices) among Jordanian clinicians	Cross-sectional study	Descriptive statistics such as frequencies and percentages, the independent sample t-test to compare two groups, one-way ANOVA to compare more than two groups, and multiple regression analysis using the Enter technique	Attitudes and practices towards MPX varied by age group and level of education, demonstrating how demographic factors impact these aspects of public health. Additionally, monkeypox attitudes were lower among women, those with a diploma degree, and those aged 31–40.	Being updated about new illnesses like MPX is crucial, as the COVID-19 pandemic demonstrated. To effectively tackle global health concerns, continuous learning, and up-to-date knowledge are essential.
[36]	To assess the knowledge, attitude, and perception of Egyptian HCWs and medical students towards human Mpox.	Cross-sectional study	Chi-square and binary logistic regression tests were used.	The study found that 55.3% of participants had adequate knowledge about Mpox, with 44.5% and 39.8% showing favorable attitudes and perceptions. Adequate knowledge was more prevalent in older individuals, married participants, and doctors, while positive attitudes were more prevalent among males, urban residents, and nurses.	Knowledge, attitude, and perception toward Mpox among Egyptian HCWs and medical students exhibit suboptimal levels.
[18]	To assess the knowledge, attitude, and factors associated with monkeypox infection among healthcare workers at Injibara General Hospital, Northwest Ethiopia.	Institution-based cross-sectional study	Multivariable logistic regression analysis to account for potential confounding variables.	It found that 38.5% of healthcare workers had good knowledge and positive attitudes about monkeypox, with factors such as having a master's degree, COVID-19 vaccination, and having access to information. A positive attitude was	Healthcare workers' knowledge and attitudes about monkeypox are low, influenced by factors like age, education, vaccination status, and access to information. To improve, hospitals should offer educational upgrades and comprehensive medical curricula.

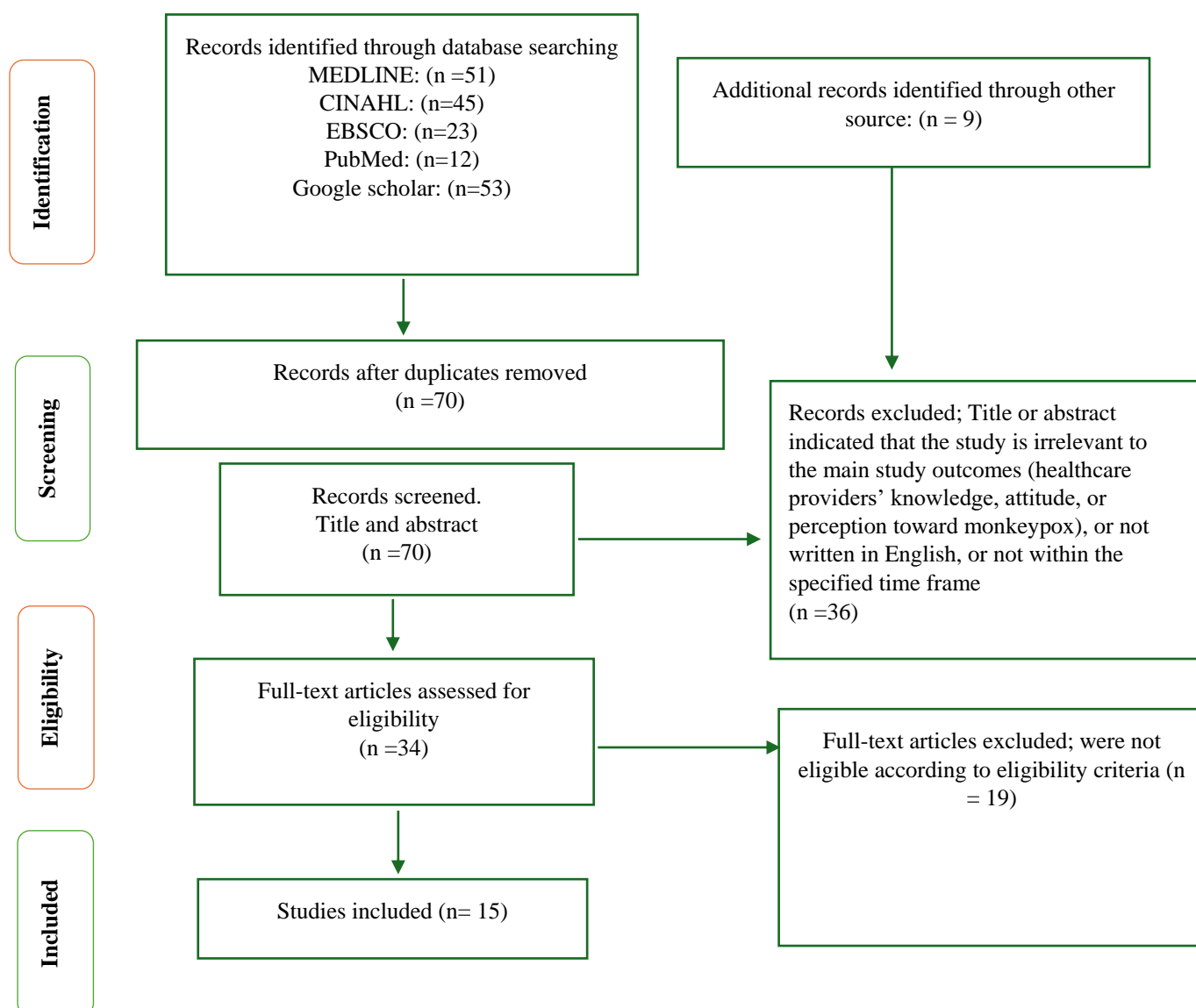
				significantly associated with being 30 years or older.	
[28]	To assess the knowledge and practices of medical doctors regarding Monkeypox.	A descriptive cross-sectional study	Descriptive statistics and univariate analysis were used.	Respondents were all aware of Mpox, with 52.3% using the internet for information. 72% had good knowledge, with 73% having appropriate preventive practices.	Maintaining a high suspicion index for Mpox outbreaks and potential epidemics requires sustained awareness and retraining of healthcare workers, as well as regular use of personal protective equipment.
[32]	To explore the knowledge and attitudes of Italian healthcare workers regarding monkeypox virus infection and the potential influence of various factors on its outcomes.	cross-sectional survey	A multivariate logistic regression model was used.	HCWs with a higher level of knowledge about mpox and those who needed additional information about mpox were more likely to have a higher level of perception of the severity of the disease.	The study indicates that healthcare workers (HCWs) have limited knowledge about mpox, with only half showing positive attitudes, suggesting the need for strategic health training programs.
[37]	To identify actionable strategies to mitigate the current Mpox outbreak by leveraging lessons from past health crises, particularly COVID-19, and to highlight future research priorities essential for global preparedness	Literature review	Relevant data were extracted systematically.	The resurgence of Mpox is driven by viral evolution, ecological changes, inadequate surveillance, inequitable healthcare access, and insufficient public health infrastructure, with existing vaccines and antiviral treatments lacking optimized care protocols.	Actionable recommendations include robust policies, sustainable funding, and global collaboration to strengthen pandemic preparedness and mitigate Mpox's impact.
[26]	To assess the factors associated with health workers' knowledge and attitudes toward monkeypox in southwestern Saudi Arabia	Online survey	Chi-square statistics, t-tests, and multivariate analysis were used.	The study found that participants' knowledge level was significantly influenced by age, marital status, job title, and medical practice, with low knowledge and good attitudes toward monkeypox prevention measures.	Saudi Arabia is prioritizing health workers' understanding of monkeypox epidemiology, prevention, and treatment to ensure readiness for future outbreaks.
[38]	To evaluate the potential of a simplified PCR test for the detection of mpox virus90 in saliva, aiming to enhance outbreak response and sustainable surveillance effort	Pilot investigation	The researchers assessed five PCR assays for detecting mpox DNA in saliva samples collected using Spectrum SDNA-1000 tubes. They also developed a simplified, extraction-free protocol to test raw	Detection in raw saliva remained relatively stable for 24-48 hours when stored at 4°C, room temperature (~19°C), and 30°C. Stability was also maintained under simulated shipping conditions.	The study suggests a flexible, saliva-based, extraction-free PCR test for diagnosing, responding to, and monitoring mpox outbreaks, potentially reducing costs and improving access in low-



			(unsupplemented) saliva samples.		and middle-income countries.
[20]	To investigate the knowledge and attitudes (KAs) of Bangladeshi nurses regarding the monkeypox infectious disease.	A cross-sectional study	Chi-square test, multivariable logistic regression, and Pearson correlation coefficient.	The study found that 57.97% of participants had good knowledge and 93.12% had a positive attitude towards monkeypox disease, with female nurses being more knowledgeable and having a more positive attitude, with a strong correlation between knowledge and attitude.	We suggest implementing additional training programs to improve nurses' abilities and motivation in managing monkeypox patients, as there is a need for further improvement in knowledge and attitude.
[31]	To evaluate human monkeypox knowledge and confidence in diagnosis and management among HCWs in Kuwait	Cross-sectional, web-based survey	Chi-squared ( $\chi^2$ ), Mann–Whitney U (M-W), and Kruskal–Wallis (K-W) tests. Logistic regression multivariate analyses were done.	The study reveals knowledge gaps among Kuwaiti healthcare workers (HCWs) regarding HMPX infection despite widespread media coverage and timely literature delivery.	Education and training should address knowledge and confidence differences in HMPX diagnosis and management and address the high prevalence of conspiratorial beliefs.
[39]	To summarize current knowledge on mpox, addressing critical knowledge gaps and guiding strategies for containing the outbreak and preventing future global emergence.	Narrative review	Not applicable	Mpox is a rare viral zoonotic disease endemic to Central and West Africa, caused by an orthopoxvirus similar to the variola virus (smallpox).	This comprehensive review serves as a valuable resource for healthcare professionals and public health authorities aiming to enhance their understanding and response to the mpox outbreak.
[40]	An Android-based mobile application uses deep learning to classify skin lesion images for monkeypox infection, aiding in quick diagnoses, medical consultations, and disease reduction.	Applied research study	Performance metrics such as accuracy, precision, sensitivity, F1 score, and Jaccard index to evaluate the model's effectiveness.	These results indicate a high level of accuracy in classifying images as either monkeypox-infected or non-infected.	The study showcases the use of a mobile application with a deep learning model for preliminary monkeypox diagnosis, demonstrating its potential for telemedicine and remote healthcare settings.
[41]	To assess the prevalence of conspiratorial attitudes toward EVIs and the measures implemented to control them among the general public in Jordan.	Cross-sectional study	Multivariate analysis	Over 50% of participants agreed, at least to some extent, with 9 out of 12 EVI conspiracy statements. Multivariate analysis revealed that being female and agreeing with or having no opinion on the role of	The study reveals a high prevalence of conspiracy beliefs about EVIs among the Jordanian public, with limited knowledge about MPX, recommending future research on their impact on health behaviors.

				MSM in MPX transmission was associated with a stronger endorsement of conspiracy beliefs.	
[42]	To offer a detailed and up-to-date synthesis of various aspects of monkeypox, including its epidemiology, etiology, pathogenesis, clinical features, diagnosis, management, preventive measures, vaccine developments, and areas for future research.	A narrative review article	Not applicable	Multi-country outbreak of monkeypox presents a significant public health challenge, exacerbated by the ongoing COVID-19 pandemic. They emphasize the necessity for healthcare workers and public health officials to be well-informed about monkeypox to implement effective mitigation strategies.	The importance of understanding the disease's transmission dynamics, clinical manifestations, and available preventive measures, including vaccination, to control its spread and impact.

**Figure 1.** PRISMA Flow diagram of study selection.



## Discussion

The recent outbreak of monkeypox has spread rapidly around the world, with a significant increase in confirmed and suspected cases. Thus, the World Health Organization (WHO) declared this outbreak a public health emergency. Therefore, this has highlighted the need for healthcare providers to understand the disease, its implications, and how to manage it. However, there is a concern that healthcare providers may not fully understand the implications of monkeypox, which could hinder their ability to provide effective care and control the spread of the disease.

The level of knowledge regarding monkeypox among healthcare providers varies significantly across different regions. To illustrate, in Southeast Asia, the findings of a cross-sectional online survey in Indonesia (Harapan et al., 2021) assessed the knowledge of monkeypox among 432 general practitioners (GPs). The findings revealed that only 36.5% of participants demonstrated a good level of knowledge about the disease. Factors such as graduating from universities outside Java, being older than 30 years, and working in private clinics were associated with lower knowledge levels. The study emphasized the need for systematic strategies to improve GPs' confidence and competence in managing potential monkeypox cases.

Also, a study was performed by Sahin *et al.* [30] among 283 physicians in Turkey to evaluate their knowledge, attitudes, concerns, and vaccine acceptance regarding monkeypox. The results showed that only 32.5% of physicians had a good level of knowledge about the disease, and 31.4% intended to receive the monkeypox vaccine. Factors positively associated with better knowledge included being female, older age ( $\geq 30$  years), specialization in internal medicine, prior education about monkeypox during medical training, and previous exposure to COVID-19. The study highlighted the need for targeted educational programs to enhance physicians' preparedness for emerging infectious diseases like monkeypox. It can be concluded that these studies underscore the importance of improving education and awareness about monkeypox among healthcare professionals to ensure effective diagnosis, management, and prevention of the disease.

In the Middle East, according to the results of recent cross-sectional studies, the situation seems to be more positive within the context of knowledge levels, for instance, Temsah *et al.* [25] reported that

48.7% of healthcare providers in Saudi Arabia were aware that monkeypox could have spread before skin lesions appeared. Thus, this indicates that they are more conscious of transmission mechanisms than the other healthcare providers in Southeast Asia. However, studies in Saudi Arabia and Kuwait showed that a significant proportion of healthcare professionals are unaware of essential aspects of monkeypox, including noncutaneous symptoms and mechanisms of transmission [27–31]. The findings from studies indicate a significant lack of awareness among healthcare professionals regarding essential aspects of monkeypox that could be explained by limited exposure to the virus of monkeypox, insufficient training and continuing education, and focus on other public health priorities such as diabetes and cardiovascular diseases. These disparities demonstrate the necessity of a proactive strategy to inform and equip medical professionals for newly developing infectious illnesses around the world.

In Africa, the knowledge of monkeypox among healthcare professionals varies significantly. To illustrate, a recent study conducted by Ajayi, *et al.* [23] revealed that 67% of healthcare workers in Nigeria had poor knowledge of the disease. It is important to note that this percentage represents the highest level of inadequate understanding among healthcare providers when compared to the other studies included in this review. Therefore, this result indicated that despite increasing global awareness, a significant proportion of healthcare professionals are inadequately prepared to handle potential outbreaks. Consequently, these research results emphasize the necessity of addressing healthcare providers' misunderstandings and knowledge gaps to promote appropriate monkeypox management and response. Overall, the variation in attitudes toward monkeypox among healthcare providers across geographical regions highlights the need for specific initiatives to improve their knowledge, attitudes, and practices in dealing with this public health issue.

The attitudes of healthcare providers toward monkeypox varied significantly among the included studies based on their geographical areas. To illustrate, in Bangladesh, 93.12% of healthcare providers showed a positive attitude toward monkeypox prevention [20]. Furthermore, in Ethiopia, 62% of healthcare providers have a positive attitude toward monkeypox [18]. Similarly, in Saudi Arabia, 57.9% of nurses reported a positive

attitude toward monkeypox [29], while another study in the same country found a positivity rate of approximately 66.4% among healthcare workers [26]. In contrast, healthcare providers in Egypt showed a lower positivity rate since only 44.5% of healthcare providers showed a positive attitude toward monkeypox [24], indicating a need for educational interventions in regions with less favorable attitudes. Moreover, in Southern Italy, only 10.5% of healthcare providers believed that monkeypox could be preventable [32].

Notably, healthcare professionals in Uttar Pradesh exhibited a neutral attitude, with 72.7% reporting neither positive nor negative feelings toward monkeypox preparedness [33]. Similarly, healthcare providers in Jordan demonstrated a more neutral perspective, with 71% acknowledging that vaccination is an effective measure for controlling the spread of monkeypox [18]. The neutral attitudes exhibited by healthcare professionals in regions such as Uttar Pradesh and Jordan toward monkeypox can be attributed to several interconnected factors such as the insufficient availability of comprehensive information regarding the disease, which may lead to uncertainty about its transmission, severity, and effective preventive measures (Thomas et al., 2023). Additionally, disparities in public health initiatives and the resources allocated for education and vaccination can further influence these neutral perspectives [27].

It is important to note that demographic factors such as age and education level could significantly influence the attitude of healthcare providers toward monkeypox. Specifically, in Jordan, a recent study conducted by Altindis *et al.* [1] found that the attitudes toward monkeypox were notably lower among women and those with a diploma education. Similarly, higher confidence in diagnosing monkeypox was observed among participants with postgraduate education in Kuwait [31]. Therefore, these results indicate that there is a necessity to provide educational courses, particularly for demographics exhibiting lower levels of confidence and knowledge. However, these findings are inconsistent with the result of a recent study conducted by Theban [29]. The researcher reported that demographic characteristics did not have a significant impact on knowledge or attitude.

In the context of the perception of healthcare providers towards monkeypox, few studies were found and included in this review that

measure the perception of healthcare providers towards monkeypox. The results of these studies highlight the complexities and variations in healthcare providers' perceptions of monkeypox. For instance, Amer *et al.* [24] found that only 39.8% of participants held a positive perception of monkeypox, with demographic factors such as age, urban residency, marital status, and professional background significantly correlating with positive perceptions. Meanwhile, Miraglia del Giudice *et al.* [32] reported that healthcare providers' perception of the severity of monkeypox was influenced by factors such as gender, knowledge level, and the need for additional information. Furthermore, Temsah *et al.* [34] highlighted the prevalence of misconceptions about vaccines, with a significant proportion of healthcare providers unsure about the efficacy of the chickenpox vaccine against monkeypox. These findings underscore the importance of targeted educational interventions, addressing misconceptions, and supporting vulnerable groups to enhance healthcare providers' understanding and response to monkeypox.

Finally, demographic factors could skew results in ways that obscure the true relationship between variables such as age, sex, and professional role. For example, older participants might have greater clinical experience, but outdated knowledge about monkeypox and its vaccines could distort the analysis of knowledge scores, as mentioned previously. Besides, differences in job responsibilities (e.g., direct patient care versus administrative duties) can influence exposure to relevant educational materials. So, demographic factors play a significant role in healthcare workers' knowledge, attitudes, and perceptions toward monkeypox and its vaccines. Emphasize that addressing these disparities through tailored educational programs and equitable access to resources can enhance preparedness for emerging infectious diseases.

### **limitations**

The majority of included studies in this systematic review are of high quality and with a moderate risk of bias, however, several limitations should be considered when interpreting the findings of this systematic review: Firstly, the variability in study designs and methodologies among the literature may present challenges in synthesizing results across different studies, this diversity could be related to differences in sampling methods, data

collection instruments, and analytical approaches. Secondly, temporal factors, such as the timing of data collection relative to the progression of the monkeypox pandemic, may impact the relevance and applicability of findings over time. Additionally, the majority of studies may have been conducted in specific geographic regions, potentially limiting the broader applicability of the review's conclusions to a more diverse global context. Lastly, while efforts were made to include studies in multiple languages, the review's language restrictions may have excluded pertinent literature published in languages other than English, potentially affecting the comprehensiveness of the review.

### **Implications and Recommendations in the Healthcare System**

This systematic review's findings have significant implications for public health preparedness, healthcare education, and policy-making, especially in the context of emerging infectious diseases like monkeypox. Healthcare workers' insufficient knowledge of monkeypox, particularly noncutaneous symptoms and transmission mechanisms, can delay diagnosis and hinder containment efforts, necessitating immediate detection and effective response to future outbreaks. Also, the review underscores the necessity of incorporating monkeypox-related education into healthcare curricula and professional development programs, enhancing understanding of symptoms, transmission, prevention, and vaccination importance. Important gaps in healthcare workers' awareness, attitudes, and understanding of monkeypox and its immunizations are brought to light by this systematic review. A concerted effort, including focused education, fair resource distribution, and strong policy backing, is needed to close these inequalities. Healthcare systems can improve their ability to respond to new infectious illnesses and protect public health and international security by equipping healthcare professionals with the skills and resources they need.

Through the integration of these ideas, this review seeks to educate healthcare organizations and policymakers on the strategic actions required to improve the competence and confidence of healthcare workers in handling cases of monkeypox and halting the spread of the illness.

### **Conclusion**

Healthcare providers have a crucial role in controlling and averting monkeypox outbreaks, according to the systematic review of HCPs' knowledge, attitudes, and perceptions regarding monkeypox and its vaccines. The results show several disparities in attitudes, perceptions, and knowledge regarding monkeypox and associated immunizations, which can affect how well public health measures work. Improving HCPs' readiness and self-assurance in handling monkeypox requires addressing these gaps through focused education, training, and awareness initiatives. This review highlights the need for ongoing research, policy development, and global collaboration to strengthen HCPs' role in combating monkeypox and similar threats.

**Disclosure of potential conflicts of interest:** Nothing to declare.

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