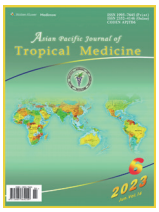

Original Article

Asian Pacific Journal of Tropical Medicine

apjtm.org

doi: 10.4103/1995-7645.378566

Impact Factor: 3.041

Knowledge and awareness of human mpox infection among healthcare workers: A cross-sectional study in southwestern Nigeria

Paul Oladapo Ajayi[1]✉, Deborah Tolulope Esan[2], Tope Michael Ipinnimo[3], Moronkeji Temitope Olanrewaju[4], Oluremi Olayinka Solomon[1], Olajumoke Oyewumi Atanda-Owoeye[5]

[1]*Department of Community Medicine, Faculty of Clinical Sciences, Ekiti State University, Ado-Ekiti, Ekiti State, Nigeria*

[2]*Department of Nursing Science, College of Health Sciences, BOWEN University, Iwo, Osun State, Nigeria*

[3]*Department of Community Medicine, Federal Teaching Hospital, Ido-Ekiti, Ekiti State, Nigeria*

[4]*Department of Family Medicine, Federal Teaching Hospital, Ido-Ekiti, Ekiti State, Nigeria*

[5]*Department of Community Medicine, Ekiti State University Teaching Hospital, Ado-Ekiti, Ekiti State, Nigeria*

ABSTRACT

Objective: To identify the knowledge and awareness level of human mpox viral infection among healthcare workers in southwestern Nigeria.

Methods: A cross-sectional study was conducted in Ekiti State, southwest Nigeria among 316 healthcare workers that were selected through a systematic random sampling. Data were collected with the aid of a semi-structured, self-administered questionnaire. The *Chi*-square test and binary logistic regression were used to find the association between the independent and dependent variables. The significance level was set at *P*-value <0.05.

Results: Two hundred and twenty-two (70.3%) of the respondents were aged ⩽40 years, mean age (36±9) years, 189 (59.8%) were female, 306 (96.8%) were Christians, and 203 (64.2%) were married. Three hundred and fourteen (99.4%) of the respondents were aware of mpox infection. Main sources of information about mpox were medical education (44.0%), radio/television (32.0%) and newspaper (21.0%). However, among those aware of the disease, 209 (67.0%) demonstrated poor knowledge levels. Longer than 5 years' experience of medical practice was the only significant predictor of higher knowledge level of the disease (*OR* 1.76, 95% *CI* 1.01-3.06; *P*=0.046).

Conclusions: Despite the high awareness level of mpox infection among healthcare workers, there still exists a huge knowledge gap. It is recommended that targeted intervention could be directed towards continuous medical education and simulation exercises on re-emerging infectious diseases like mpox to improve the knowledge of the healthcare workers.

KEYWORDS: Awareness; Knowledge; Human mpox viral infection; Healthcare workers; Nigeria

1. Introduction

Since the eradication of smallpox in 1980, human monkeypox (mpox) which used to be a rare disease has gradually become a public health threat with increasing incidence, spreading into new regions[1-4]. Human mpox is a re-emerging viral zoonotic disease that affects people in the tropical rainforest areas of west and

Significance

Human mpox is a re-emerging viral zoonotic disease, and a public health threat that affects people in the tropical rainforest areas of west and central Africa. It is occasionally exported to other regions of the world. Despite the high awareness level of Mpox infection among healthcare workers, there still exists a huge knowledge gap observed in its diagnosis, prevention, and treatment of mpox infection.

✉To whom correspondence may be addressed. E-mail: paulajayi123@gmail.com

How to cite this article: Ajayi PO, Esan DT, Ipinnimo TM, Olanrewaju MT, Solomon OO, Atanda-Owoeye OO. Knowledge and awareness of human mpox infection among healthcare workers: A cross-sectional study in southwestern Nigeria. Asian Pac J Trop Med 2023; 16(6): 245-252.

Article history: Received 16 December 2022 Revision 14 June 2023
Accepted 21 June 2023 Available online 26 June 2023

central Africa. It is occasionally exported to other regions of the world[2,5-8].

Mpox is caused by the mpox virus, a member of the *Orthopoxvirus* genus in the family Poxviridae; it is closely related to variola virus causing smallpox, vaccinia virus (proforma of smallpox vaccine), and cowpox virus[4,9,10]. Human mpox resembles smallpox disease, but it is milder in severity. It has two clades/strains: a milder West African strain and a more severe Central African strain[10,11]. The major clinical signs and symptoms include fever, intense headache, lymphadenopathy, back pain, myalgia, intense asthenia, maculo-papular rash, vesicles, pustules, and crusts[6,12]. There are 4 stages of the rashes: macular (a flat lesion), papula (an elevated lesion), vesicular (a fluid-filled lesion) and pustular (an inflamed, pus-filled lesion) and scab and flake appears afterwards[12]. It has an incubation period of 5-21 days, and it is largely a self-limiting disease with the symptoms lasting for 2 to 4 weeks[6,11]. However, severe cases can occur, leading to complications like pneumonitis, encephalitis, sight-threatening keratitis, and secondary bacterial infections[13], and its case fatality ratio is at 3%-6%[11]. Mpox is transmitted to human beings through direct close contact (human case or infested animal), or indirectly through material contaminated with the virus[6,11]. The disease spreads through direct close contact with infectious rash, scabs, body fluids, and respiratory secretions[12]. Vertical transmission of mpox from an infected pregnant mother to her unborn child can also occur[12]. The use of universal, contact and respiratory precaution has been the key practices in infection prevention control among healthcare workers (HCWs)[6,11].

Mpox virus was first isolated among research monkeys in Copenhagen, Demark in 1958. However, the first human case was reported in the Democratic Republic of Congo in 1970. Several other cases have been identified in Africa since then: Cote d'voire, Liberia, Sierra Leone, Gabon, Cameroon, Republic of Congo, Central African Republic and South Sudan[3,6,13-16]. Other regions of the world have equally witnessed a sudden rise in the number of cases of human mpox (USA, UK, Singapore, and Israel)[3,10]. Some of these cases had visited Nigeria in the recent past[3,11].

The first three cases of human mpox reported in Nigeria were in 1971 and 1978[6]. Two cases of mpox were recorded and reported in 1971, one of which occurred in an unvaccinated four-year-old child[6]. The next mpox case reported was about 40 years later, in September 2017 when Nigeria witnessed a re-emergence and outbreak of mpox with a surging number of cases[6]. Interestingly, the total number of confirmed cases in 2017, 2018, 2019, 2020, 2021 were 88, 49, 47, 8 and 34, respectively[6,17]. However, from January to May 29, 2022, there was a total number of 66 suspected cases and 21 confirmed cases, bringing a total number of confirmed cases between 2017 and May, 2022 to 247[15]. Furthermore, the total number of death was 9, with a case fatality rate of 3.6%[17]. Initially, the outbreak occurred majorly in the southern parts of the country but it is gradually moving to the northern states, and has affected 32 of the 36 states of Nigeria[17]. Ekiti state, however, has had two confirmed cases so far[17]. The different public health measures used include enhanced surveillance and health worker training, as well as case isolation, contact-tracing and quarantine of healthy exposed individuals[6]. Nonetheless, cases continue to occur in Nigeria on a sporadic basis, indicating that the disease may be endemic in the Ekiti state[9,18].

The awareness and knowledge level of human mpox among HCWs (which includes aetiology, symptomatology, transmission, treatment and prevention and control) are crucial if the disease is to be well-controlled[14]. Among the general population and medical students, studies from Saudi Arabia revealed 48% and 28% had high knowledge of mpox, respectively[19,20], however, only 55% of physician in Saudi Arabia had good knowledge of mpox[21]. In another study on awareness of mpox, Gallé *et al*. revealed low awareness level (26.7%) among Italian adults[22]. Similarly, only 27% of the HCWs in Italy were aware of mpox before May 2022; the knowledge level was unsatisfactory (52%) across all HCWs groups[23]. Furthermore, the World Health Organization revealed that one of the problems being faced in the prevention of the re-emergence of mpox, was the lack of knowledge about the virus, particularly among the HCWs[13]. The formerly rare disease may have become endemic within Nigeria[17], especially in the southern part where Ekiti state is located[6]. The rapidly increasing number of human mpox cases shows the importance of prevention, early detection, and quick public health response by the HCWs. Hence, this study investigated awareness and knowledge level of mpox viral infection among healthcare workers in Ekiti State, Southwest, Nigeria.

2. Subjects and methods

2.1. Study area and study participants

The cross-sectional study was conducted in Ekiti state, Southwest Nigeria, from 1st July 2022 to 30th September 2022. Ekiti state is one of the 36 states of Nigeria with the capital located at Ado-Ekiti. The study was conducted among doctors and nurses in the state, who are the key professionals who make diagnosis in the health facilities. The population of the doctors and nurses was 2 075 (650 doctors and 1 425 nurses) in the state.

Inclusion criteria: All doctors who registered with the Medical and Dental Council of Nigeria were considered eligible while all nurses who have registered with the Nursing and Midwifery Council of Nigeria were considered eligible. Exclusion criteria: All eligible on leave or who declined were excluded from the study.

2.2. Sample size determination

The minimum sample size used for this study was calculated using the Fischer's formula[24] for descriptive (proportions) studies for population <10 000.

$N=Z^2pq/d^2$ =304, z=standard normal derivate set at 1.96, d=degree of desired accuracy was 0.05; *P*=the proportion with a particular characteristic determined from a previous study[13] was 0.365. Adjusting for a non-response, assuming a non-response rate of 10%. Hence the study sample size was 338 participants.

2.3. Sampling technique

Systemic random sampling was used (Supplementary Figure 1). A list (sample frame) of registered doctors and nurses was collected from the Medical and Dental Council of Nigeria and Nursing and Midwifery Council of Nigeria.

With a sample size of 338, equal proportion of doctors and nurses were used, hence a sample of 169 doctors and nurses were selected by systematic random sampling. The sampling interval (k^{th}) was determined (for each group of HCWs) by dividing the total of number of healthcare workers by the desired sample size.

2.4. Study instruments

The study tool for quantitative data collection was adapted and pretested[13,19]. It was a 41-itemed, semi-structured, self-administered questionnaire. The reliability of the instrument (Cronbach alpha=0.72) was guaranteed by the pretesting of the questionnaires on 34 subjects that were not included in the study. Furthermore, appropriate corrections were made to the questionnaire after pre-testing, while face and content validity was done by epidemiology experts.

2.5. Data collection

Data were collected using the 41-itemed quantitative data tools. Four research assistants and two supervisors were recruited and trained for the purpose of data collection. Each selected HCW was visited at their workplace and questionnaire was filled after consent was given. Each filled questionnaire was checked daily for accuracy and completeness. Field supervision, daily briefing, and review of activities were carried out.

2.6. Study variables

The independent variables included socio-demographic (age, sex, religion, marital status, *etc*.) and socio-economic characteristics (level of education, occupation, and household income) and workplace factors while the dependent variables were awareness level and knowledge level of the respondents on monkeypox virus (MPXV) infection. The 2-itemed questions on the awareness level of respondents on MPXV infection were scored to determine if they were aware or unaware. Positive responses were scored 1 while negative responses were scored 0 (with a maximum score of 2 and minimum score of 0). Respondents were categorized as aware if they scored 2 points and unaware if the score was 1 point. The 25-itemed questions on the knowledge of respondents on MPXV infection were scored to determine if they had good or poor knowledge of MPXV infection. Positive responses were scored 1 while negative responses were scored 0 (with a maximum score of 25 and minimum score of 0 points). Respondents were categorized as had good knowledge if they scored 20 points and were considered to indicate poor knowledge if scores were <20 points[13,19].

2.7. Statistical analysis

Data were entered and analysed using Statistical Package for Social Sciences version 27. Univariate analysis was done using frequency distribution tables, charts and graphs. Bivariate (*Chi*-square) and binary logistic regression analysis was done to find association between the outcome variables and independent variables. The significance level was set at *P*-value 0.05.

2.8. Ethical considerations

Ethical clearance was obtained from the Ethics and Review Committee of the institution (EKSUTH/A67/2022/7/001). The study objectives and its protocol were thoroughly explained to the respondents. Confidentiality and autonomy were strictly maintained. Written informed consent was obtained from all participants.

3. Results

A total of 338 questionnaires were distributed, however, only 316 respondents completed the questionnaire, which gave a respondent rate of 93%.

Table 1 reveals the socio-demographic characteristics of the respondents: 70.3% of the respondents were aged ⩽40 years, with a mean age of (36±9) years. One hundred and eighty-nine (59.8%) of the respondents were female, 306 (96.8%) were Christians, and 203 (64.2%) were married. The socio-economic factors revealed that 169 (53.7%) of the respondents were nurses, and 281 (88.9%) had tertiary education.

Table 1. Socio-demographic characteristics of the respondents (*N*=316).

Variable	*n* (%)
Age, years	
≤40	222 (70.3)
>40	94 (29.7)
Sex	
Male	127 (40.2)
Female	189 (59.8)
Religion	
Christianity	306 (96.8)
Islam	9 (2.9)
African traditional	1 (0.3)
Ethnic group	
Yoruba	279 (88.3)
Igbo	27 (8.5)
Others	10 (3.2)
Marital status	
Single	110 (34.8)
Married	203 (64.2)
Separated/divorced	1 (0.3)
Widowed	2 (0.7)
Highest level of education attained/completed	
Secondary	1 (0.3)
Tertiary	281 (88.9)
Master/Ph.D	34 (10.8)
Occupation	
Doctors	147 (46.5)
Nurses	169 (53.5)
Average monthly earning (NGN)	
18 001-100 000	47 (14.9)
100 001-200 000	123 (38.9)
200 001-400 000	110 (34.8)
>400 000	36 (11.4)

Ph.D: Doctor of philosophy, SD: Standard deviation, NGN: Nigerian Naira.

Table 2. Workplace characteristics of the respondents (*N*=316).

Variable	*n* (%)
Doctor's grade (*n*=140)	
Consultant/CMO/MOH	20 (6.3)
Senior resident/PMO	30 (9.5)
Junior resident/SMO	56 (17.7)
Medical officer	23 (7.3)
House officer	18 (5.7)
Nurse's grade (*n*=176)	
Director nursing service/Deputy DNS	1 (0.3)
Assistant director of nursing service	7 (2.2)
Chief nursing officer	25 (7.9)
Assistant chief nursing officer	34 (10.8)
Senior nursing officer	30 (9.5)
Nursing officer 1	37 (11.7)
Nursing officer 2	35 (11.1)
Practice area	
Ado-Ekiti State Capital	246 (77.8)
Others Outside Capital	70 (22.2)
Workplace type	
Primary Health Centre	6 (1.9)
General hospital	15 (4.7)
Tertiary hospital	274 (86.7)
Private hospital	21 (6.7)
Medical experience (years of practice)	
≤5	133 (42.1)
>5	183 (57.9)

CMO: Chief medical officer, MOH: Medical officer of health, PMO: Principal medical officer, SMO: Senior medical officer, DDNS: Deputy director of nursing service.

Among the doctors, 56 (17.7%) were junior residents/senior medical officers while among the nurses, nursing officer 1 had the largest proportion (37, 11.7%). However, majority of the respondents practice in the tertiary facility 274 (86.7%), with a large proportion 183 (57.9%) having >5 years' experience, and 246 (77.8%) practice in Ado-Ekiti (Table 2).

Table 3 revealed that majority (314, 99.4%) of the respondents had heard about MPXV infection. Also, awareness level of mpox among the respondents was high (99.0% aware and 1.0% unaware). The three common sources of information about mpox were medical education (44.0%), radio/television (32.0%) and newspaper (21.0%).

Table 3. Awareness of healthcare workers to knowledge questions about mpox [*N*=316, *n* (%)].

	Awareness questions	Yes	No
Q1	Have you ever heard about human mpox before?	314 (99.4)	2 (0.6)
Q2	Have you ever received information about human mpox from medical education, seminars, colleagues, newpaper or radio/ television, *others?	314 (99.4)	2 (0.6)
Q3	Source of information (multiple response)		
	1. Medical education	138 (43.9)	
	2. Radio/television	100 (31.8)	
	3. Newspapers	65 (20.7)	
	4. Colleagues	53 (16.9)	
	5.Semiars/adult education	43 (13.7)	
	6.Others	19 (6.1)	

*Others=social media, friends and text messages.

Table 4 revealed the responses of the participants to the knowledge questions concerning mpox. Twenty (6.4%) respondents did not know the cause of mpox; 148 (47.1%) did not know if the diseases are endemic in Nigeria. Concerning the transmission of MPXV infection, 162 (51.6%) and 155 (49.4%) did not know whether the disease could be spread through close contact during sexual intercourse or vertically transmitted, respectively. Two hundred and thirty-two of the respondents (73.9%) did not know the symptoms of mpox. Also, only 164 (52.2%) of the respondents could correctly describe the rash. One hundred and ninty-five (62.1%) of the respondents could not correctly say if a vaccine was recommended. Furthermore, 198 (63.1%) of the respondents incorrectly answered there was an available recommended treatment for mpox. Knowledge of treatment with smallpox antiviral, though not recommended, may be used, this was supported by only 176 (56.1%) of the respondents. Also, 53 (16.9%) do not know that supportive treatment is crucial in the management of the mpox. Overall, (209, 67.0%) of the respondents demonstrated poor knowledge level concerning mpox.

Table 5 revealed the relationship between the factors (socio-demographic, socio-economic and workplace factors) and

Table 4. Knowledge of healthcare workers to knowledge questions about mpox (N=314, n (%)].

	Knowledge questions	Correct	Incorrect
Q1	Type of the etiology agent of mpox	297 (94.6)	17 (5.4)
Q2	Mpox is a rare disease	258 (82.2)	56 (17.8)
Q3	Mpox is endemic in Nigeria	166 (52.9)	148 (47.1)
Q4	Mpox is caused by the mpox virus	294 (93.6)	20 (6.4)
Q5	Mpox is common in the West & Central African countries	239 (76.1)	75 (23.9)
Q6	Human to human-transmission occurs through close contact	286 (91.1)	28 (8.9)
Q7	Transmission from animal to human	279 (88.9)	35 (11.1)
Q8	Transmission from contaminated materials to humans	250 (79.6)	64 (20.4)
Q9	Close contact during sexual transmission	152 (48.4)	162 (51.6)
Q10	Vertical transmission	159 (50.6)	155 (49.4)
Q11	Mpox is similar to smallpox	234 (74.5)	80 (25.5)
Q12	Symptom of mpox	82 (26.1)	232 (73.9)
Q13	Rash characteristics	164 (52.2)	150 (47.8)
Q14	Incubation period	281 (89.5)	33 (10.5)
Q15	Presence of Lymphadenopathy is a key distinguishing clinical sign	284 (90.4)	30 (9.6)
Q16	Universal precaution is important	302 (96.2)	12 (3.8)
Q17	Isolate the infected cases	297 (94.6)	17 (5.4)
Q18	Use of PPE is very important(including facemask and hand gloves)	298 (94.9)	16 (5.1)
Q19	Vaccination recommended	119 (37.9)	195 (62.1)
Q20	Avoid close contact with infected patients, animals and infested materials	303 (96.5)	11 (3.5)
Q21	PCR assay and virus isolation can be done to confirm organism	264 (84.1)	50 (15.9)
Q22	ELISA and antigen detection test can be done to detect antigen of MPXV infection	211 (67.2)	103 (32.8)
Q23	There is no approved treatment for mpox infection	116 (36.9)	198 (63.1)
Q24	Smallpox antiviral agent may be given but not recommended by WHO	176 (56.1)	138 (43.9)
Q25	Supporting treatment is crucial to alleviating patient suffering (*e.g.* use of paracetamol)	261 (83.1)	53 (16.9)

PPE: Personal protective equipment, PCR: Polymerase chain reaction, ELISA: enzyme-linked immunoassay, MPXV infection: Mpox viral infection, WHO: World Health Organization.

Table 5. The relationship between the factors and knowledge level of mpox infections.

Factors	Poor knowledge (n=209)	Good knowledge (n=105)	χ^2	df	P
Age group, years					
⩽40	147 (66.8)	73 (33.2)	0.02	1	0.882
>40	62 (66.0)	32 (34.0)			
Sex					
Male	89 (70.1)	38 (29.9)	1.19	1	0.330
Female	120 (64.2)	67 (35.8)			
Ethnic group					
Yoruba	181 (65.3)	96 (34.7)	2.83	2	0.243
Igbo	19 (70.4)	8 (29.6)			
Others	9 (90.0)	1 (10.0)			
Religion					
Christianity	201 (66.1)	103 (33.9)	1.04	2	0.595
Islam	7 (77.8)	2 (22.2)			
Traditional worshiper	1 (100.0)	0 (0.00)			
Marital status					
Single	77 (70.0)	33 (30.0)	1.65	3	0.647
Married	130 (64.7)	71 (35.3)			
Separated/divorced	1 (100.0)	0 (0.00)			
Widowed	1 (50.0)	1 (50.0)			
Highest level of education attained					
Secondary	0 (0.00)	1 (100.0)	2.78	2	0.249
Tertiary	184 (58.6)	95 (41.4)			
Masters/PHD	25 (73.5)	9 (26.5)			
Occupation					
Doctors	107 (72.8)	40 (27.2)	2.73	1	0.061
Nurses	102 (61.1)	65 (38.9)			
Average monthly earning (NGN)					
18 000-100 000	28 (59.6)	19 (40.4)	1.67	3	0.644
100 001-200 000	84 (69.4)	37 (30.6)			
200 001-400 000	72 (65.5)	38 (34.5)			
>400 000	25 (69.4)	11 (30.6)			
Workplace type					
Primary health centre	6 (100.0)	0 (0.00)	3.82	3	0.282
General hospital	11 (73.3)	4 (26.7)			
Tertiary hospital	177 (65.1)	95 (34.9)			
Private hospital	15 (71.4)	6 (28.6)			
Practice area					
Ado-Ekiti	171 (69.5)	75 (30.5)	4.45	1	0.026*
Others	38 (55.9)	30 (44.1)			
Medical experience (practice years)					
⩽5	96 (72.2)	37 (27.8)	3.27	1	0.045*
>5	113 (62.4)	68 (37.6)			

NGN: Nigerian Naira. *Statistically significant.

knowledge level of the HCWs about mpox. Practice area (P=0.026) and higher years of medical experience (P=0.045) were the two factors significantly related to knowledge level of the respondents about mpox. Healthcare workers who had >5 years' medical experience had better knowledge level of mpox than those with 5 years medical experience. Also, HCWs practicing outside Ado-Ekiti (the state capital) had better knowledge. All other factors (age, sex, ethnicity, religion, marital status, educational level attained, occupation, income and workplace type) were not statistically significant.

After binary logistic regression analysis, the only significant predictor associated with knowledge level of mpox included >5 years' medical experience (*OR* 1.76, 95% *CI* 1.01-3.06; P=0.046) which was statistically significant (Table 6).

Table 6. Binary logistic regression analysis of the predictors associated with knowledge level of mpox infection among healthcare workers.

Factors	Adjusted odds ratio (95% confidence interval)	*P*
Medical experience (practice years)		
≤5	1	
>5	1.76 (1.01-3.06)	0.046*
Practice area		
Ado-Ekiti	1	
Others	1.53 (0.94-2.48)	0.090

*Statistically significant.

4. Discussion

The outbreak of MPXV infection (which is common in west and central Africa) is spreading to almost all parts of the world, raising a lot of concerns especially because of the rapid spread and high mortality[14,25,26]. The responsibilities on the already overburdened frontline HCWs are (coming from COVID-19 pandemic) increasing. However, the HCWs are responsible for case detection, case reporting, notification and clinical case management of all MPXV infection in their health facilities. In order to achieve this, the HCWs must be knowledgeable about the disease, hence the study assessed the awareness and knowledge level of the HCWs on mpox. Majority of the respondents were middle-aged and were professionals having at least tertiary medical education.

This study showed that almost all the participants were aware of mpox. This is similar to a study by Lin *et al*[27] among clinical students in Malaysia University (94.4%) and in another study by Jairoun *et al*[28] among University students in United Arab Emirate (68.6%). The high level of awareness may have resulted from the sensitization created in a COVID-19 pandemic era and social media information overload. In addition, the HCWs who may have been trained in the diagnosis and management of the MPXV infection in the past, and recently during the regular annual surveillance training of HCWs. However, in contrast to this study, awareness level was low in several other studies among Italian adults and Italian HCWs[22,23]. MPXV infection in Nigeria has recorded repeated outbreaks over the last six years, bringing a huge health burden; the awareness about MPXV has increased in Nigeria when compared with the developed countries.

The key source(s) of information in this study include medical education, radio/television, and newspaper. In contrast, the sources of information identified among the university students[28] revealed that social media (64.5%), television (27.4%), awareness campaigns (3.4%) and family/friends (4.8%) were major sources of information, also in several studies amongst general population, HCWs and medical students in Saudi Arabia[19,20,25], it revealed that social media was the most common source of information. This differences in the sources of information may have resulted from the continuous medical education which was the main mode of medical information among the medics, which is usually compulsory and part of their trainings (it is compulsory for their yearly renewal of practicing license). However, in this part of the world, social media is universality used.

This study also revealed that about two-third of respondents had poor knowledge level of mpox, which highlights the huge knowledge gap among the HCWs. This is similar to a study by Harapan *et al*[15] in Indonesia among general practioners using 80% cut-off (>90% of their respondents had knowledge gap among general practioners). In addition, Alshahrani *et al*[21] also revealed that 45% of physicians had poor knowledge of MPXV infection. Also, Sallam *et al.* and Alshahrani *et al*[20,29] revealed poor knowledge level among university students and medical students in Jordan and Saudi Arabia, respectively. The study by Harapan *et al*[15] used similar cut-off of 80% for the knowledge score, and both used a cross-sectional study design. However, the present study used a self-administer questionnaire mode of data collection compared to an online survey conducted by Harapen *et al.*, which is subject to high non-response bias[15]. However, moderate level of knowledge was reported among HCWs in Saudi Arabia[25]. Unlike developed countries like Saudi Arabia where health training and access to internet and social media might be easier, the present study was done in a developing country, hence improving their knowledge level is critical. In this study, the HCWs showed poor knowledge in identifying the symptoms and prevention of mpox, investigation and treatment of MPXV infection. This is similar to a study by Temsah *et al*[25] in Saudi Arabia where HCWs had massive gaps in their knowledge related to clinical presentation identification and vaccination against MPXV infection.

This study revealed that having above 5 years' medical experience was the only significant predictor of a higher knowledge level

of mpox. Nigeria has witnessed a significant outbreak of mpox between 2017 and 2022[30,31]. Hence, HCWs working over the last 6 years will likely be more informed about mpox than new HCWs who have worked less than 5 years. Similarly, a study in Saudi Arabia revealed that senior medical students show higher knowledge level compared to junior medical students[20]. In contrast, a study by Alshahrani *et al*[21] revealed that female physicians, working in the private sector, and having information on human mpox during medical school or residency training were associated with a good level of knowledge about human mpox. Jairoun *et al*[27] revealed a higher knowledge level among older age group. Similar to this study, there was a higher knowledge level among older age but not statistically significant. In contrast to our study, another study[25] recorded a higher level of qualification, high disease awareness, and high worry of contracting the disease, all associated with higher knowledge scores for MPXV infection. Furthermore, in another study by Harapan *et al*[14], different factors were observed to affect knowledge level which included cut-off of knowledge score and younger health workers in Indonesia.

In conclusion, despite the high awareness level of MPXV infection among HCWs, there still exists a huge knowledge gap observed especially in identifying the symptoms and prevention of mpox, and investigation and treatment of MPXV infection. The common sources of information were medical education, radio/television and newspaper. Medical experience above 5 years was identified as a predictor of higher knowledge level of MPXV infection among the respondents. It is recommended that targeted intervention could be directed towards continuous medical education and simulation exercises on re-emerging infectious diseases like Mpox and the use of mass media (radio/television) by public health experts could help to improve the knowledge of the HCWs.

Conflict of interest statement

The authors declare that they have no conflict of interest.

Funding

The authors received no extramural funding for the study.

Authors' contributions

APO, EDT, ITM, OMT, SOO, AOO participated in the development of the concept, design, definition of intellectual content, literature search, data acquisition, data and statistical analysis, manuscript preparation, manuscript editing and manuscript review. APO is the guarantor.

References

[1] World Health Organization. *Informal consultation on monkeypox 2017*. [Online]. Available from: https://apps.who.int/iris/bitstream/handle/10665/272620/WHO-WHE-IHM-2018.3-eng.pdf. [Accessed on 7 July 2022].

[2] Costello V, Sowash M, Gaur A, Cardis M, Pasieka H, Wortmann G, et al. Imported monkeypox from international traveler, Maryland, USA, 2021. *Emerg Infect Dis* 2022; **28**(5): 1002-1005.

[3] Bass J, Tack DM, McCollum AM, Kabamba J, Pakuta E, Malekani J, et al. Enhancing health care worker ability to detect and care for patients with monkeypox in the Democratic Republic of the Congo. *Int Health* 2013; **5**(4): 237-243.

[4] Sofyantoro F, Kusuma HI, Vento S, Vento S, Rademaker M, Frediansyah A. Global research profile on monkeypox-related literature (1962-2022): A bibliometric analysis. *Narra J* 2022; **2**(3): e96. http://doi.org/10.52225/narra.v2i3.96.

[5] Vaughan A, Aarons E, Astbury J, Brooks T, Chand M, Flegg P, et al. Human-to-human transmission of monkeypox virus, United Kingdom, October 2018. *Emerg Infect Dis* 2020; **26**(4): 782-785.

[6] Federal Ministry of Health-Nigeria Centre for Disease Control. *National monkeypox public health response guidelines 2019*. [Online]. Available from: https://ncdc.gov.ng/themes/common/docs/protocols/96_1577798337.pdf. [Accessed on 7 July 2022].

[7] McCollum AM, Damon IK. Human monkeypox. *Clin Infect Dis* 2014; **58**(2): 260-267.

[8] World Health Organization. *Multi–country monkeypox outbreak in non–endemic countries*. [Online]. Available from: https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON385. [Accessed on 30 May 2022].

[9] Roess AA, Monroe BP, Kinzoni EA, Gallagher S, Ibata SR, Badinga N, et al. Assessing the effectiveness of a community intervention for monkeypox prevention in the Congo Basin. *PLoS Negl Trop Dis* 2011; **5**(10): e1356. doi: 10.1371/journal.pntd.0001356.

[10] Brown K, Leggat PA. Human monkeypox: Current state of knowledge and implications for the future. *Trop Med Infect Dis* 2016; **1**(1): 8. doi: 10.3390/tropicalmed1010008.

[11] World Health Organization. *Fact sheet, monkeypox*. [Online]. Available from: https://www.who.int/news-room/fact-sheets/detail/monkeypox. [Accessed on 30 May 2022].

[12] Tusabe F, Tahir IM, Akpa CI, Mtaki V, Baryamujura J, Kamau B, et al. Lessons learned from the Ebola virus disease and COVID-19 preparedness to respond to the human monkeypox virus outbreak in

low- and middle-income countries. *Infect Drug Resist* 2022; **15**: 6279-6286.

[13]Adler H, Gould S, Hine P, Snell LB, Wong W, Houlihan CF, et al. NHS England high consequence infectious diseases (airborne) network. Clinical features and management of human monkeypox: A retrospective observational study in the UK. *Lancet Infect Dis* 2022; doi: 10.1016/S1473-3099(22)00228-6.

[14]Harapan H, Setiawan AM, Yufika A, Anwar S, Wahyuni S, Asrizal FW, 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.

[15]Harapan H, Abdul MS, Amanda Y, Samsul A, Sri W, Febrivan WA, et al. Confidence in managing human monkeypox cases in Asia: A cross-sectional survey among general practitioners in Indonesia. *Acta Trop* 2020; doi: https://doi.org/10.1016/j.actatropica.2020.105450.

[16]Ophinni Y, Frediansyah A, Sirinam S, Megawati D, Stoian AM, Enitan SS, et al. Monkeypox: Immune response, vaccination and preventive efforts. *Narra J* 2022; doi: http://doi.org/10.52225/narra.v2i3.90.

[17]Nigeria Centre for Disease Control. *An update of monkeypox outbreak in Nigeria for week 21, May 29, 2022.* [Online]. Available from: https://ncdc.gov.ng/themes/common/files/sitreps /fe6bfb6b22289ff41303bcee6a93eefc.pdf. [Accessed on 20 December 2022].

[18]Kara ND, Andrea MM, Yoshinori N, Brett WP, Mary GR, Sylvie B, et al. Emergence of monkeypox-west and central Africa, 1970-2017. *MMWR* 2018; **67**(10): 306-310.

[19]Alshahrani NZ, Alzahrani F, Alarifi AM, Algethami MR, Alhumam MN, Ayied HAM, et al. Assessment of knowledge of monkeypox viral infection among the general population in Saudi Arabia. *Pathogens* 2022; **11**(8): 904.

[20]Alshahrani NZ, Mitra S, Alkuwaiti AA, Alhumam MN, Altmimi SMB, Alamri MHM, et al. Medical students' perception regarding the re-emerging monkeypox virus: An institution-based cross-sectional study from Saudi Arabia. *Cureus* 2022; **14**(8): e28060. doi: 10.7759/cureus.28060.

[21]Alshahrani NZ, Algethami MR, Alarifi AM, Alzahrani F, Alshehri EA, Alshehri AM, et al. Knowledge and attitude regarding monkeypox virus among physicians in Saudi Arabia: A cross-sectional study. *Vaccines* 2022; **10**(12): 2099. doi: https://doi.org/10.3390/vaccines10122099.

[22]Riccò M, Ferraro P, Camisa V, Satta E, Zaniboni A, Ranzieri S, et al. When a neglected tropical disease goes global: Knowledge, attitudes and practices of italian physicians towards monkeypox, preliminary results. *Trop Med Infect Dis* 2022; **7**(7): 135.

[23]Gallè F, Bianco L, Da Molin G, Mancini R, Sciacchitano S, Ferracuti S, et al. "Monkeypox: What do you know about that?" Italian adults' awareness of a new epidemic. *Pathogens* 2022; **11**(11): 1285. doi: https://doi.org/10.3390/pathogens11111285.

[24]Jekel JF, Katz DL, Elmore JG. Sample size, randomization, and probability theory. In, Maddox S, Schmitt W, editors. *Epidemiology, biostatistics and preventive medicine.* 2nd edition. Philadelphia: Saunders Elsevier; 2001. p, 194-199.

[25]Temsah MH, Aljamaan F, Alenezi S, Abouammoh N, Alhasan K, Dasuqi SA, et al. Monkeypox disease (MPOX) perceptions among healthcare workers versus general population during the first month of the WHO alert: Cross-sectional survey in Saudi Arabia. *Vaccines* 2022; **10**(12): 2071. doi: https://doi.org/10.3390/vaccines10122071.

[26]Shafaati M, Zandi M. Monkeypox virus neurological manifestations in comparison to other orthopoxviruses. *Travel Med Infect Dis* 2022; **49**: 102414. doi: 10.1016/j.tmaid.2022.102414.

[27]Lin GSS, Tan WW, Chan DZK, Ooi KS, Hashim H. Monkeypox awareness, knowledge, and attitude among undergraduate preclinical and clinical students at a Malaysian dental school: An emerging outbreak during the COVID-19 era. *Asian Pac J Trop Med* 2022; **15**(10): 461-467.

[28]Jairoun AA, Al-Hemyari SS, Abdulla NM, El-Dahiyat F, Shahwan M, Hassan N, et al. Awareness and preparedness of human monkeypox outbreak among university student: Time to worry or one to ignore? *J Infect Public Health* 2022; **15**(10): 1065-1071.

[29]Sallam M, Al-Mahzoum K, Dardas LA, Al-Tammemi AB, Al-Majali L, Al-Naimat H, et al. Knowledge of human monkeypox and its relation to conspiracy beliefs among students in Jordanian health schools: Filling the knowledge gap on emerging zoonotic viruses. *Medicina* 2022; **58**: 924.

[30]Tusabe F, Tahir IM, Akpa CI, Mtaki V, Baryamujura J, Kamau B, et al. Lessons learned from the ebola virus disease and COVID-19 preparedness to respond to the human monkeypox virus outbreak in low- and middle-income countries. *Infect Drug Resist* 2022; **15**: 6279-6286.

[31]World Health Organization. *Rally to defeat mpox in Nigeria.* [Online]. Available from: https://www.afro.who.int/photo-story/rallying-defeat-mpox-nigeria. [Assessed on 12 January 2023].

Publisher's note