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Skills and knowledge of clinical veterinarians regarding monkeypox in the Democratic Republic of the Congo

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Abstract

Introduction: Monkeypox, an Orthopoxvirus zoonosis, is caused by a virus belonging to the Orthopoxvirus genus. This emerging zoonotic disease represents a growing threat to public health in the Democratic Republic of the Congo (DRC) and other regions. Given the zoonotic nature of this disease, veterinarians play a crucial role in its detection, management, prevention, and surveillance. Assessing the skills and knowledge of these professionals is therefore essential to identify gaps and strengthen the response to zoonotic diseases.

Objective: The aim of this study was to assess the knowledge and skills of clinical veterinarians in the DRC regarding specific zoonotic diseases such as monkeypox.

Methods: A cross-sectional online survey was conducted to evaluate the knowledge and skills of clinical veterinarians in the DRC concerning Mpox. Semi-structured questionnaires were distributed via Google Forms. Data were collected from 79 clinical veterinarians registered with the Veterinary Medical Association of Congo, across 14 provinces of the DRC. The study was conducted between September and October 2024.

Results: The majority of respondents were male (85%) and aged between 30 and 50 years. Most of the surveyed veterinarians had at least five years of professional experience. Regarding the knowledge of transmission routes, 93.7% of participants were aware of them, and 93.3% were familiar with the symptoms of the disease. The most frequently cited diagnostic methods included molecular analyses and clinical signs evaluation.

Conclusion: Although the overall level of knowledge about monkeypox among clinical veterinarians is high, most of them have never received specific training on the management of this disease. Clinical symptoms, transmission routes, and the most affected species are generally well known. However, very few veterinarians participate in epidemiological surveillance programs for monkeypox in the DRC. Classical preventive measures such as hygiene and disinfection, isolation of suspected cases, and the use of personal protective equipment (PPE) remain effective in combating the spread of Mpox.

Keywords: Knowledge; Skills; Practice; Veterinarian; Monkeypox; DR Congo

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1. Introduction

Monkeypox is a zoonotic disease caused by a virus belonging to the Orthopoxvirus genus [1]. It is considered an emerging disease in Central and West Africa. Transmission occurs primarily through direct contact with the bodily fluids or skin lesions of infected animals, as well as via respiratory droplets between humans [2]. These characteristics make monkeypox a potential threat in both public health and veterinary contexts.

In the Democratic Republic of the Congo (DRC), monkeypox is endemic, with human cases regularly reported [3]. However, the disease has been drawing increased international attention since cases were reported in several countries outside of Africa, raising concerns about the surveillance and management of this zoonosis. Clinical veterinarians play a key role in the early detection, surveillance, and prevention of zoonotic diseases such as monkeypox, particularly due to their direct interaction with both domestic and wild animals [4].

Veterinarians' ability to identify, treat, and prevent zoonotic diseases largely depends on their knowledge and skills in specific areas [5].

The level of knowledge among veterinarians regarding monkeypox in the DRC is presumed to be variable. Several studies on zoonoses have shown that veterinarians in sub-Saharan Africa are often well-informed about certain endemic diseases such as rabies, brucellosis, and bovine tuberculosis [6]; [7]; [8]; [9]), but much less so about emerging diseases like monkeypox. Veterinarians working in close contact with wildlife particularly in rural areas near tropical forests may have a better understanding of this disease due to their frequent exposure to potential reservoir species [10].

The study by Nka [11] revealed very limited knowledge of the monkeypox virus among healthcare workers, regardless of their sociodemographic or professional characteristics. Consequently, to ensure optimal preparedness and timely responses to Mpox and other similar emerging pathogens, capacity-building programs should be implemented for health professionals. In the DRC, training for veterinarians on the management of suspected monkeypox cases remains limited. There are no formal programs or regular workshops specifically dedicated to the management of this disease in most veterinary schools or professional associations. Furthermore, clinical guidelines for recognizing and managing monkeypox are still largely based on human health protocols, making them difficult to apply in the veterinary field [12].

Clinical veterinarians generally perceive their role in the surveillance and prevention of zoonotic diseases as crucial [13]. However, several obstacles limit their ability to fully carry out this mission. In the DRC, limited resources, the lack of specific guidelines, and the absence of institutional collaboration between animal and human health services often hinder their active participation in zoonosis prevention, including monkeypox [14].

Since its identification in the DRC, monkeypox has represented a growing public health risk, especially considering the key role veterinarians play in zoonotic disease surveillance. Most research on disease surveillance, however, has focused primarily on human health professionals. The overall objective of this study is to assess the knowledge and skills of clinical veterinarians in the DRC regarding specific zoonotic diseases such as monkeypox.

2. Materials and methods

2.1. Study Area

Our research was conducted in the Democratic Republic of the Congo (DRC), a country located in the heart of Africa, covering an area of 2,345,410 km^2, situated at approximately 4°00′00.00″ South latitude and 21°00′00.00″ East longitude. The country is currently divided into 26 provinces and is geographically structured into three main zones:

- The **central basin**, with the lowest elevation, covers about one-third of the national territory. It is characterized by alternating equatorial forests and swampy lands, watered year-round by the Congo River and its tributaries.
- The **plateaus** surrounding the basin, mainly covered by savannas.
- The **eastern mountain ranges**, located in the provinces of North Kivu and South Kivu.

The DRC is bordered to the south by Zambia and Angola; to the east by Zambia, Tanzania, Rwanda, Burundi, and Uganda; to the north by the Central African Republic and South Sudan; and to the west by the Republic of the Congo, the Angolan province of Cabinda, and the Atlantic Ocean.

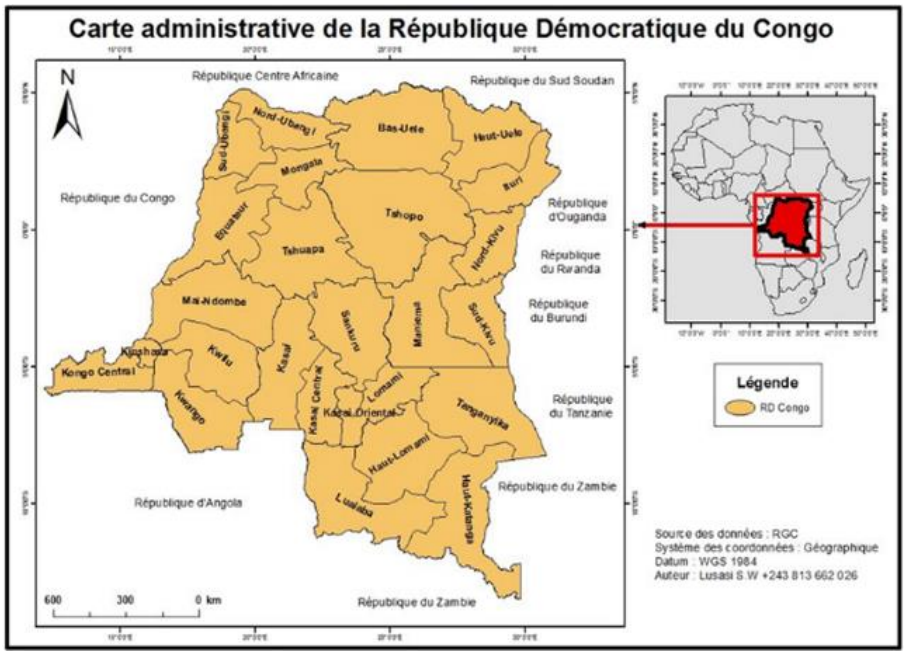

Figure 1 Map of the Democratic Republic of the Congo [15].

3. Methods

We conducted a cross-sectional and prospective study with descriptive objective, based on the use of questionnaires, interviews, and analysis of data collected directly in the field. This study was carried out in the DRC between September and October 2024 and focused on the knowledge and skills of clinical veterinarians regarding Mpox.

The study population consisted entirely of clinical veterinarians affiliated with the Veterinary Medical Association of Congo. A random sampling method was used, and 79 clinical veterinarians from 14 different provinces of the DRC responded to the survey [16].

3.1. Study Variables

3.1.1. Independent variables

We assessed four main groups of independent variables that could influence knowledge and skills: sociodemographic status (Age, Sex, Province), characteristics of the work area (urban, rural, peri-urban), medical professional development characteristics, professional experience (in years) [16, 17]

3.1.2. Dependent Variables

In this study, the dependent variables were the knowledge and skills of clinical veterinarians in the DRC regarding Mpox. Questions were asked to assess their knowledge and competencies, focusing on: the zoonotic nature of Mpox, its modes of transmission, clinical symptoms, available diagnostic methods, risk of transmission, the most affected animal species, treatment of confirmed cases, specific training received, applicable preventive measures, use of personal protective equipment (PPE) and accessibility of vaccines for animals [16, 17]

3.1.3. Survey and Data Collection

A link to the survey questionnaire was shared on WhatsApp platforms used by veterinary doctors. Responses were collected anonymously, and to ensure data confidentiality, access to participants' responses was managed solely by the principal investigator. The survey questions focused on sociodemographic information, and the knowledge and skills of clinical veterinarians regarding monkeypox.

Respondents provided free and informed consent on the first page of the questionnaire.

- The questionnaire was designed to assess veterinarians' knowledge of monkeypox, including questions on symptoms, modes of transmission, preventive measures, and the management of suspected cases.
- Semi-structured interviews were also conducted to explore veterinarians' perceptions of zoonotic risks and to identify gaps in training.
- Field observations were carried out through visits to veterinary clinics and offices, where we observed biosafety practices and the availability of diagnostic tools.

3.2. Data Analysis

The data collected were analyzed using an Excel spreadsheet (EpiCollect5), frequencies were calculated. Key themes, opinions, and experiences recorded in the dataset were explored using basic statistical calculations to determine the proportions reflecting veterinarians' knowledge and skills regarding monkeypox in the DRC.

3.3. Ethical Considerations and Data Confidentiality

Respondents were interviewed based on informed consent and their voluntary decision to answer the survey questions. Data confidentiality for each participant was strictly maintained throughout the data collection and analysis phases.

4. Results

We present the results obtained from our investigation.

4.1. Sociodemographic Characteristics of Respondents

The sociodemographic characteristics of the surveyed veterinarians are presented in Table 1 below:

Table 1 Sociodemographic Characteristics of Surveyed Veterinarians

Variables	Number (n=79)	Frequencies (%)
Gender		
Male	67	85
Female	12	15
Age group (year)		
Under 30	18	23
] 30 - 40]	30	38
] 40 - 50]	20	25
Over 50	10	14
Province of residence		
Haut-Katanga	37	48
Haut-Uélé	1	1
Ituri	2	2.5
Kasaï-Oriental	1	1
Kinshasa	19	25
Kongo-Central	4	5
Kwango	1	1
Kwilu	1	1
Lualaba	1	1
Nord-Kivu	4	5
Sud-Kivu	4	5
Sankuru	1	1
Tanganyika	1	1
Tshopo	2	2.5

Years of experience as a clinical veterinarian		
Less than 5 year	18	23
] 5 – 10 ans]	26	33
] 10 – 15 ans]	16	20
More than 15 year	19	24
Work area		
Urban	51	64.5
Rural	11	14
Urban-rural (peri-urban)	17	21.5

From this table, it appears that the majority of the clinical veterinarians interviewed were male. Most were over 30 years old. They came from 14 different provinces of the Democratic Republic of the Congo, with a predominance of clinical veterinarians from Haut-Katanga Province (48%). The majority had at least 5 years of professional experience and worked either in urban areas (64.5%), rural areas (14%), or peri-urban zones (21.5%).

4.2. Knowledge About Monkeypox

Table 2a Proportion of Respondents Who Reported Knowledge of Monkeypox Symptoms and Modes of Transmission

Variables	**Number (n=79)**	**Frequencies %**
Knowledge of monkeypox symptoms		
Yes	74	93.7
No	5	6.3
Symptoms listed	Number of times mentioned	%
Fever	74	93.6
Skin lesions	73	92.4
Fatigue	38	48.1
Loss of appetite	37	58.2
others	7	8.8
No reponse	5	6.3
Knowledge of monkeypox transmission modes	Number (n=79)	%
Yes	77	97.5
No	2	2.5
Modes of transmission listed	Number of times mentioned	%
Direct contact with infected secretions	77	97.5
Bites/scratches	30	50.6
Consumption of infected meat	53	68.8
Contact with contaminated surfaces	55	71.4
Aerosol transmission	19	24.6
Others	4	5.2
No reponse	2	2.6

It appears from Table 2a that 93.7% of respondents reported being aware of the symptoms of monkeypox. The most frequently listed symptoms were fever, skin lesions, fatigue, and loss of appetite. Among those respondents, 97.5% indicated that they were aware of the modes of transmission of the disease.

Table 2b Disease Definition, Affected Animal Species, and Diagnostic Procedures

Monkeypox known as a zoonotic disease	**Number (n=79)**	**%**
Yes	78	98.7
No	1	1.3
Animal species affected by monkeypox	Number of times mentioned	%
Primates	77	97.4
Rodents	52	65.8
Domestics animals	15	18.9
Others (prairie dog)	3	3.8
Aware of monkeypox diagnostic methods	Number (n=79)	%
Yes	59	75
No	19	24
No response	1	1
Known diagnostic methods	Number of times mentioned	%
Clinical signs evaluation	28	47.4
Paraclinical analyses	19	32.2
Serology (ELISA)	9	6.7
Molecular analysis (PCR)	32	54.2
GeneXpert	1	1.6
Monkeypox Antigen test cassette	1	1.6
Ont déjà traité les cas de variole du singe	Number (n=79)	%
Yes	7	9
No	72	91
Have already treated monkeypox cases	Number (n=79)	%
Yes	29	36,7
No	50	63,3

Table 2b reveals that 98.7% of respondents identified monkeypox as a zoonotic disease, with the most frequently cited animal sources being monkeys, rodents, and domestic animals. Among these respondents, 75% reported knowing diagnostic methods for the disease, with molecular analyses and clinical signs evaluation being the most commonly mentioned techniques. A minority (36.7%) indicated having received specific training on monkeypox, and 9% reported having provided therapeutic care for monkeypox cases.

4.3. Practices of Respondents Regarding Monkeypox

Table 3 presents the practices of clinical veterinarians concerning animals carrying monkeypox.

Table 3 Practices of Clinical Veterinarians Regarding Animals Infected with Monkeypox

Practices toward sick animals	**Number of times mentioned**	**Frequencies %**
Isolation	74	93.7
Sampling	49	62
Symptomatic treatment	42	53
Notification to health authories	65	82
Others	2	2.5

No reponse	1	1
Use of diagnostic tools in clinics/offices	Number (n=79)	%
Yes No No reponse	3 74 2	3.8 93.7 2.5
Knowledge of preventive measures against monkeypox	Number (n=79)	%
Yes No	59 20	74.7 25.3
Preventive measures mentioned	number of mentions	%
Isolation of sick animals Wearing personal protective equipment (PPE) Maintaining hygiene and disinfection Respecting barrier measures Following biosecurity and biosafety measures Avoiding direct contact Vaccination Training of healthcare staff Informing authorities	24 26 30 6 6 18 8 1 1	40.6 44 50.8 10 10 30.5 13.5 1.6 1.6
Frequency of PPE use when handling a suspected monkeypox case	Number (n=79)	%
Always Sometimes Never No reponse	34 18 17 10	43 22.8 21.5 12.7
Accessibility of vaccines against Mpox in animals	Number (n=79)	%
Yes No	2 77	2.5 97.4

From Table 3, we note that isolation of animals suspected of having monkeypox and notification of sick animal cases to authorities are the most frequently reported practices among respondents. A small percentage (3.8%) of respondents declared having the necessary equipment to manage monkeypox cases in their workplaces. The majority of respondents reported knowing preventive measures against the disease. Among these preventive measures, hygiene and surface disinfection, use of personal protective equipment (PPE), isolation of sick animals, and avoidance of contact with infected animals were the most commonly cited.

4.4. Perceptions of Respondents on the Epidemiological Risk of Monkeypox and Challenges Encountered

Table 4 Perception of the Epidemiological Risk of Monkeypox

Epidemiological risk of Mpox for animals is:	**Number of times mentioned**	**Frequencies %**
Low Moderate High Very high No reponse	31 16 28 3 1	39.2 20.3 35.4 3.8 1
Risk of zoonotic transmission of Mpox	Number (n=79)	%

Low	10	12.6
Moderate	37	46.8
High	24	30.4
Very high	6	7.6
No reponse	2	2.5
Challenges encountered in managing monkeypox cases	Number of times mentioned	%
Lack of reliable information	54	68.3
Lack of diagnostic tools	61	77.2
Lack of medicines	40	50.6
Cost of care	29	36.7
Lack of collaboration with health authorities	54	68.3
Others	1	1

From Table 4, it appears that opinions among surveyed veterinarians are divided regarding the epidemiological and zoonotic risk of monkeypox. This risk is perceived as low by some, moderate by others, and high or very high by others still. The major challenges identified in managing monkeypox include, in order, the lack of diagnostic tools, absence of reliable information and collaboration with health authorities, shortage of medicines, and the cost of care.

4.5. Epidemiological Surveillance of Monkeypox

Table 5 Practices Regarding Epidemiological Surveillance of Monkeypox

Is there an epidemiological surveillance program for monkeypox?	**Number (n=79)**	**Frequencies %**
Yes	26	33
No	53	67
Have participated in monkeypox epidemiological surveillance programs?		
Yes	18	23
No	61	77
Tasks assumed by participants in surveillance programs	Number (n=18)	%
Case reporting	15	83
Collection of epidemiological data	18	100
Monitoring of infected animals	11	13.2
Others	1	5.5
Attendance at workshops or seminars on zoonoses management, including monkeypox	Number (n=78)	%
Yes	42	53.8
No	36	46.2

Table 5 shows that 33% of respondents reported the existence of an epidemiological surveillance program for monkeypox, and 23% of them have already participated in this program. The tasks they undertake during surveillance include case reporting, collection of epidemiological data, and monitoring of infected animals. More than half, 53.8%, participate in workshops addressing zoonoses management, including monkeypox.

Table 6 Suggestions and Recommendations for the Management of Monkeypox Useful tools to improve veterinarians' knowledge and practices on MPOX, what is needed to better fight monkeypox in veterinary practice:

Useful tools to improve veterinarians' knowledge and practices on MPOX		
Tools	Number of times mentioned	%
Additional training	74	93.6
Access to diagnostic kits	64	81
Access to personal protective equipment (PPE)	56	70.8
Technical assistance from veterinary authorities	56	70.8
Others	2	2.5
What is needed to better fight monkeypox in veterinary practice:		
Effective communication among clinical veterinarians	4	5
Monitoring wildlife movements	2	2.5
Multidisciplinary approach in case management	3	3.8
Vaccination	5	6.3
Funding	2	2.5
Training	21	26.5
Develop a clear protocol for MPOX management	1	1
Equip veterinarians with diagnostic tools	8	10.1
Implementation of surveillance programs	3	3.8
Personal protective equipment (PPE)	2	2.5
Experimental research	1	1
Awareness raising and popularization	8	10.1
Monitoring hunters, combating poaching	3	3.8
Promotion of wildlife conservation	1	1
Good hygiene practices	6	7.5
Collaboration between human health and veterinary authorities	5	6.3

Table 6 shows that respondents emphasize the need for training sessions on monkeypox management to better fight the disease. Several other suggestions were made, ranging from improved communication to enhanced collaboration between human health and veterinary authorities.

5. Discussion

The Democratic Republic of Congo (DRC) has experienced sporadic cases of monkeypox, and with the resurgence of zoonoses, it was imperative for this study to assess the preparedness and capacity of veterinarians to respond to this disease. This topic allows for an exploration of the impact of veterinary knowledge on epidemiological surveillance and case management, which is vital for public health. The interconnection between human and animal health, highlighted by the "One Health" concept, underscores the importance of an integrated approach to zoonosis control. By assessing veterinarians' knowledge, this research will facilitate collaboration between veterinarians and human health professionals, thereby promoting a holistic approach to managing monkeypox-related risks.

After the first case of monkeypox was documented in Saudi Arabia, a cross-sectional study assessing the knowledge and attitudes of medical students regarding monkeypox was conducted in a medical school in the country in 2022. Subsequently, two other studies [18]; [19]) carried out in Syria and Jordan revealed a low level of Mpox knowledge among healthcare workers in Jordan, which was associated with lower confidence in case management and diagnosis among physicians and nurses [20]). However, no studies on this topic have been reported in the DRC regarding clinical veterinarians, who play an essential role in zoonosis management. Given this research gap, our study aimed to evaluate the knowledge and skills of clinical veterinarians regarding monkeypox in the DRC.

Our study involved 79 clinical veterinarians who were surveyed with a questionnaire. At the end of the study, we observed that clinical veterinarians in the DRC have extensive knowledge about monkeypox: 93.5% of respondents reported knowing the symptoms of monkeypox; 75% reported knowing diagnostic methods, which include molecular analyses and evaluation of clinical signs.

Many hypotheses suggest that the virus is transmitted from animals to humans, but human-to-human transmission is also possible. It can spread through contact, aerosols, bites from infected animals, or scratches [21]; [22]; [23]). According to a study conducted in Saudi Arabia on knowledge and attitudes towards Mpox, only 36.5% reported knowing the modes of transmission, which is significantly lower than our results showing that 97.5% of interviewed veterinarians knew the modes of transmission.

Studies by Lönnbro [24] and McNair [25] showed that students were confident in their ability to combat the Mpox outbreak using available prevention and control measures. Our results indicate a certain level of confidence among clinical veterinarians in their ability to fight Mpox, which aligns with the study by Harapan [17], who conducted a cross-sectional survey among primary care physicians to assess their confidence level in managing monkeypox virus and found comparable results. In our study, clinical veterinarians also stated that hygiene and surface disinfection, use of personal protective equipment (PPE), isolation of sick animals, and avoiding direct contact with animals are effective preventive measures.

A 2013 survey on strengthening the capacity of health workers to detect and treat suspected smallpox cases in the DRC demonstrated that the lack of diagnostic kits, lack of PPE, insufficient training of health personnel, and poor collaboration between health zones were limiting factors for the involvement of these agents in disease control and monitoring [13]. In our study, the major challenges reported in managing monkeypox were the lack of diagnostic tools, lack of reliable information and collaboration with health authorities, shortage of medication, and the cost of care.

Some studies [26]; [27]; [28]) have suggested that veterinarians, when properly trained and appropriately involved, can play a key role in early detection and prevention of zoonotic disease outbreaks. However, for this to be possible, coordination between veterinary authorities and public health services must be strengthened [29]. This observation was also made by clinical veterinarians in the DRC, who noted the need to increase resources allocated for continuous training and active surveillance of zoonotic diseases.

The current state of knowledge and skills of clinical veterinarians in the DRC regarding monkeypox still appears limited, although their role is potentially crucial in managing this zoonosis. There is an urgent need to strengthen their training and improve access to up-to-date information. Furthermore, it is imperative to enhance collaboration between veterinary institutions and public health authorities to ensure a coordinated and effective response to future monkeypox outbreaks and other similar zoonoses, as suggested by the study of Ollierou [30].

6. Conclusion

Our study focused on the knowledge and skills of clinical veterinarians regarding monkeypox (Mpox) in the Democratic Republic of Congo. The overall objective was to contribute to improving the gaps in veterinarians' knowledge and skills about monkeypox in the DRC, while strengthening the country's capacity to respond to emerging zoonoses.

To achieve this objective, we conducted a cross-sectional and prospective study based on semi-structured individual interviews using a survey questionnaire, semi-directive interviews, and field observations with participants who voluntarily agreed to take part in our study.

Based on the analysis of data collected from 79 clinical veterinarians across 14 different provinces of the DRC, we can say that they generally have good knowledge about monkeypox. A very small number of them have already received specific training on the management of this zoonosis. Their skills in managing cases are limited by the lack of availability of diagnostic tools, lack of reliable information and training, and limited participation in Mpox surveillance programs.

The majority of clinical veterinarians (97.5%) are aware of the transmission routes of monkeypox. Transmission through direct contact with fluids from infected animals and via contaminated surfaces are the main modes of transmission known to clinicians. However, they perceive the level of zoonotic transmission risk as moderate (46.8%). More than half of our target population (75%) know the diagnostic methods for monkeypox, mainly based on laboratory examinations using PCR analysis. Clinical veterinarians believe that classic preventive measures can help limit the spread of this zoonosis between animal species, including humans. Thirty-three percent of veterinarians participate in

epidemiological surveillance programs. Clinical veterinarians in the DRC perceive their role in the surveillance and prevention of monkeypox as limited due to the lack of clear guidelines and collaboration with public health authorities.

Training sessions on monkeypox management would be necessary to enable them to better combat the disease. Several other suggestions, ranging from improved communication to enhanced collaboration between human health and veterinary authorities, were also formulated.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

Author Contribution Statement

- **Tshikung Kambol Mosses Didier**: Conceptualization, Methodology, Resources, Writing – review and editing, Project administration, Funding acquisition.
- **Ndongo Katengo Erudit**: Methodology, Investigation, Writing – original draft, Project administration, Software, Analysis.
- **Kalamba Kamba Betty**: Investigation, Literature review, Writing – review and editing.
- **Kanyimbu Mbal Marco**: Investigation, Writing – review and editing.
- **Tshasuma Alain**: Validation, Data curation, Software, Analysis.
- **Kayiba Shekinah**: Data collection, Data curation, Writing – original draft.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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