

ASSESSING THE USE OF BATS AS MATERIALS IN ZOOTHERAPEUTIC PRACTICES IN WESTERN UGANDA

By

Isma Kayiza

U20653001

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Department of Zoology and Entomology

Faculty of Natural and Agricultural Sciences

University of Pretoria

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Supervisor:

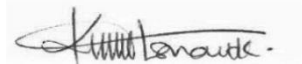
Dr Mark Keith

Co-supervisor:

Dr Celsus Sente

DECLARATION

I, Isma Kayiza, declare that the dissertation, which I hereby submit for the degree of Master of Science in Wildlife Management at the University of Pretoria, is my own work and has not previously been submitted by me or anyone else for a degree at this or any other tertiary institution.



Signature

18th December 2022

Date

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SUMMARY

Traditional healing is widely practiced among many indigenous tribes in Africa and worldwide. Over 85% of people in Sub-Saharan Africa consider traditional healing as an alternative form of treatment to the conventional western health care system. However, some tribes use animals associated with zoonoses, such as bats as materials in their zootherapeutic practices, yet much remains unknown. This study assessed the use of bats as materials in traditional zootherapeutic practices among the Bakiga and Banyankole tribes in Mitooma District, Western Uganda. The study provides information vital to the mitigation of zoonotic risks involved in using bats in zootherapeutic practices. The study involved a mixed research methodology comprising quantitative and qualitative data. Quantitative data were collected from 115 individuals using a systematic random sampling technique. One-on-one interviews were conducted using semi-structured questionnaires. Qualitative data were collected in audio format from 10 key informants using in-depth interviews. The most identified traditional use of bats (77.4%) in Mitooma District was the formulation of therapeutic concoctions used in female genital modification (FGM). A high percentage of respondents, 40/115 (38.8%), participated in FGM using concoctions extracted from bats. Sex was the primary determinant of people's participation in bat-related zootherapeutic practices. Age, academic qualification, and knowledge or awareness of potential zoonotic risks did not affect people's participation in bat-related FGM practices. The study determined that the method of capturing bats and preparing concoctions puts participants at great risk of being exposed to zoonotic pathogens associated with bats. Therefore, the government should conduct community sensitization programs through the ministry of health and the district health officers about the health risks associated with using wild animals in zootherapeutic practices.

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LIST OF ACRONYMS

DRC – Democratic Republic of Congo

EHF - Ebola Hemorrhagic Fever

FGM – Female Genital Modification

IACUC - Institutional Animal Care and Use Committee

LME - Labial Minora Elongation

MCFR - Maramagambo Central Forest Reserve

MHF - Marburg Hemorrhagic Fever

NPHC - National Population and Housing Census

PPE - Personal Protective Equipment

UBOS – Uganda Bureau of Statistics

WHO - World Health Organization

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CHAPTER ONE

GENERAL INTRODUCTION

Traditional healing is a significant ritual among indigenous communities worldwide (Gakuya et al., 2020; Marques et al., 2021; Mola et al., 2020). Traditional healing is defined as the incorporation of spiritual and natural remedies derived from plants, animals, and mineral resources to diagnose, prevent, and (or) treat physical or mental ailments based on unscientific indigenous knowledge normally obtained from the experience of the forebearers, and passed down from one generation to another verbally through socialization (Abbo, 2011; Antwi-Baffour et al., 2014; Marques et al., 2021; Nxumalo et al., 2011). Despite the increased access to western health care services, many indigenous communities worldwide still utilize traditional healing as an alternative means of treatment (Antwi-Baffour et al., 2014; Knoess & Wiesner, 2019). For example, 40% of health care in China is delivered through traditional healing (Nxumalo et al., 2011). According to the International Development Research Center (IDRC), traditional healing is used by over 85% of people as a treatment method in sub-Saharan Africa (Antwi-Baffour et al., 2014; Mola et al., 2020; Nxumalo et al., 2011).

Traditional healing in Uganda

Traditional healing has always played a vital role in the health sector of many countries in Sub-Saharan Africa (Antwi-Baffour et al., 2014), and Uganda isn't an exception (Abbo, 2011). Like in most developing countries, 80% of people in Uganda use traditional healing practices as their primary health service or as an alternative or additional treatment to western medical services (McCrary, 2014). Historically and culturally, traditional healing in Uganda is linked to witchcraft, superstitions, and evil spirits (living dead) (McCrary, 2014).

Some traditional healers, especially those that deal with spiritual healing, are perceived as dangerous and satanic, and some have been implicated in cases of child sacrifice (McCrary, 2014). As a result, traditional healing lost the trust and respect of western medical professionals and various religious groups and obtained a generally negative public perception (Tabuti, Dhillon, & Lye, 2003). For this reason, most traditional healers operate in a concealed and

inconspicuous manner, and most patients visit clandestinely (Abbo, 2011). Despite this, it is estimated that four out of five Ugandans in remote rural areas visit traditional healers (Abbo, 2011). There is at least one traditional healer in most villages in the rural parts of Uganda (Abbo, 2011). Traditional healing remains cheap, accessible, and familiar to most people in rural areas compared to western medicine (Abbo, 2011; Tabuti et al., 2003).

Types of traditional healing practices

Traditional healing practices are categorized into two types based on the materials used to prepare the healing portions or decoctions. The first type that involves using plant-based decoctions in treating various ailments is known as herbal medicine (Antwi-Baffour et al., 2014). Herbal medicines are widely accepted in many countries as an alternative treatment means (Knoess & Wiesner, 2019). More advanced research is being conducted on herbal medicine in countries like China, Nigeria, India, and the United States of America (Antwi-Baffour et al., 2014; Knoess & Wiesner, 2019). The second type that involves using decoctions extracted from animals, animal parts, or products of animal metabolism to prevent, diagnose, or treat various ailments among human subjects is known as zootherapy (Costa-Neto et al, 2005; Mahawar & Jaroli, 2006). Zootherapeutic practices are most observed in Asia (mainly in China and India) (Betlu & Lalduhawma, 2013; Mahawar & Jaroli, 2006), sub-Saharan Africa (mainly in Nigeria, Ghana, Sierra Leone and Cameroon) (Boakye et al., 2014; Mola et al., 2020) and South America (mainly in Brazil) (Alves & Rosa, 2006; Alves et al., 2016). Both domestic and wild animals can be used in zootherapeutic practices (Jugli, Chakravorty, & Meyer-Rochow, 2020).

Role of bats in traditional zootherapeutic practices

Bats play a significant role as materials used in traditional zootherapeutic practices among many indigenous communities worldwide (Ricucci, 2012). At least 167 species of bats worldwide are affected by bushmeat and as materials for zootherapeutic practices (Mildenstein, Tanshi, & Racey, 2016). The earliest human use of bats in zootherapeutic practices dates to 1500 BC in ancient Egyptian and Mesopotamian texts (Lev, 2006; Ricucci, 2012). To date, many cultures exploit bats or parts of bats as materials in zootherapeutic practices and other traditional rituals (Betlu & Lalduhawma, 2013). For instance, eating boiled meat of the cave nectar bat, *Eonycteris*

spelaea, is believed to heal enuresis among the Biata tribe in India (Betlu & Lalduhawma, 2013). The flying foxes (genus *Pteropus*) play essential roles as medicine and materials for manufacturing sacred items in the Melanesian culture in the south-west Pacific islands (Oedin et al., 2019; Wilson & Graham, 1992). The world's smallest bat species Kitti's hog-nosed bat (*Craseonycteris thonglongyai*), is killed, dried, and sold as souvenirs attached to spiritual cleansing among the people of Phu Kheio Sanctuary in Thailand (Mickleburgh, Waylen, & Racey, 2009). Some cultures in Uganda, Rwanda, and Mozambique use burnt bat wings to make decoctions for women's sexual enhancement practices (Larsen, 2010). Activities involving the exploitation of bats for their meat, body parts, or guano products, whether for commercial and (or) medicinal purposes, significantly increase contact between human beings, bats, and domestic animals (Hayman et al., 2013). The increased contact between bats, humans, and livestock increases the likelihood of spillover of bat-related zoonoses, putting public health and the conservation of bats at risk (Hayman et al., 2013).

Roles of bats in the ecosystem

Bats play a significant role in the generation and maintenance of ecosystem services. Bats are vital in forest regeneration, maintenance, and restoration due to their roles as pollinators and seed dispersers (Jones, Mickleburgh, Sechrest, & Walsh, 2009; Newman, 2011; Whittaker & Jones, 1994). Bats are more efficient than birds in dispersing seeds for many fruit and wood tree species (Kasso & Balakrishnan, 2013; Pennisi, Holland, & Stein, 2004). However, most bats' ecological and economic roles go unnoticed due to their nocturnal behaviours and negative public image (Kasso & Balakrishnan, 2013; Seltzer, Ndangalasi, & Cordeiro, 2013).

Bats as reservoirs for viral zoonoses

Numerous bat species have been implicated in cases of the emergence and re-emergence of various infectious diseases (Calisher, Childs, Field, Holmes, & Schountz, 2006; Guy, Ratcliffe, & Mideo, 2020; López-Baucells, Rocha, & Fernández-Llamazares, 2018). For example, the Egyptian fruit bats (*Rousettus aegyptiacus*) were linked to the emergence and re-emergence of Marburg Hemorrhagic Fever (MHF) in Kween and Ibanda districts in Uganda (Adjemian et al., 2011; Knust et al., 2015; Nyakarahuka et al., 2017). The flying foxes (*Pteropus ssp*) were linked

to the emergency of the Nipah virus in Malaysia (Epstein, Field, Luby, Pulliam, & Daszak, 2006; Sokolow et al., 2019). The vampire bats (*Demodus rotundus*) were linked to a rabies outbreak in Latin America (Sokolow et al., 2019). The horseshoe bats of the genus *Rhinolophus* are related to the emergence of Severe Acute Respiratory Syndrome Coronaviruses (SARS-Cov) in Guangxi province in China (Hayman et al., 2013; Wang & Eaton, 2007). Eight species of bats of the family Pteropodidae, including the African straw-coloured fruit bat (*Eidolon helvum*), Hammer-headed bat (*Hypsignathus monstrosus*), Franquet's epauletted fruit bat (*Epomops franqueti*), and Little collared fruit bats (*Myonycteris torquate*), are linked to the emergence and re-emergence of Ebola Hemorrhagic Fever (EHF) disease in various countries in Sub-Saharan Africa, including Democratic Republic of Congo (DRC), Sudan, Ivory Coast, Gabon, Republic of Congo and Uganda (Leroy et al., 2009; Olivero et al., 2020).

Factors that make bats suitable reservoirs of viral zoonoses

Unlike most animals used by humans in traditional zootherapeutic practices, bats are unique in several ways (Guy et al., 2020; Hayman et al., 2013). Bats have a longer life span relative to their body size compared to other mammals (Calisher et al., 2006). Most bat species have a highly gregarious social life (Akem & Pemunta, 2020); for example, the Mexican free-tailed bat (*Tadarida brasiliensis mexicana*) lives in colonies of up to one million bats per roosting site (Luis et al., 2013). Bats have a broad geographical range due to their ability to fly (Calisher et al., 2006; Guy et al., 2020; Kasso & Balakrishnan, 2013; Kityo & Kerbis, 1996). The large flying foxes of the *Pteropus vampyrus* species can travel 50 km to feed and return to their roosting site daily (Whittaker & Jones, 1994). Many species of bats adapt easily to peri-domestic habitats such as houses, farms, bridges, and other infrastructure in urban areas, making them more likely to live close to (or) within human communities, unlike most mammals (Bhartiy & Elangovan, 2020; Luis et al., 2013). A group of over 122,619 straw-coloured fruit bats of the *Eidolon helvum* species is known to accommodate various roosting sites within Kampala (the capital of Uganda) (Perpetra & Kityo, 2009). Bats' life characteristics, such as long lifespan, broader geographical range, and the formation of huge groups, make them more likely to host various disease pathogens (Guy et al., 2020; Luis et al., 2013), resulting in the highest number of disease

pathogens (most of which are zoonotic) per species than any other mammalian order (Calisher et al., 2006; Guy et al., 2020; Luis et al., 2013).

Study justification

Anthropogenic activities that expose humans to bats, bats' body fluids, and (or) bats' habitats increase the chances of transmission of bat-related zoonotic diseases to humans (Hayman et al., 2013; Leroy et al., 2009; Olivero et al., 2020). There is a need for scientific examination and understanding of all anthropogenic activities that bring about direct contact between humans and bats (Hayman et al., 2013). Research in this field is vital for preventing and effectively controlling future outbreaks of bat-related zoonoses by creating more understanding of human-bat interactions (Olivero et al., 2020). Hunting of bats for both meat and use in zootherapeutic practices are the most significant anthropogenic activities that put humans into direct contact with bats (Akem & Pemunta, 2020; Leroy et al., 2009). However, much of the research conducted in this field focuses on understanding the commercial exploitation of bats as bush meat (Jones et al., 2009; Kamins et al., 2011; Leroy et al., 2009; Mickleburgh et al., 2009; Mildenstein et al., 2016). Much remains unknown about the culturally motivated zootherapeutic practices that involve the use of bats despite being practised by many tribes worldwide (Alves & Alves, 2011; Betlu & Lalduhawma, 2013; Jaroli, Mahawar, & Vyas, 2010). This research assesses the use of bats as materials for traditional zootherapeutic practices in Western Uganda using Mitooma District as a case study. The study was conducted in Mitooma District firstly because it's home to the Bakiga and the Banyankole tribes who are known for their rich cultural practices including zootherapy (NPHC, 2014). Secondly, traditional cultural practices are more likely to be uninterrupted by urbanization and are well maintained, unlike in other districts occupied by the Banyankole and the Bakiga people that have been urbanized (James & Kabera, 1989). Thirdly, Mitooma District is in the western region of Uganda which not only have the highest population of bats (Kityo & Kerbis, 1996) but also the highest prevalence of bat related zoonoses (Aceng et al., 2020). This research will help us learn more about how people and bats interact in parts of the world that are thought to have a high risk of infectious disease outbreaks.

Research aim

To assess the use of bats as materials in traditional zootherapeutic practices in Western Uganda using Mitooma District as a case study.

Research objectives

- To profile the traditional zootherapeutic practices that involve the use of bats.
- To determine the health risks associated with bat-related zootherapeutic practices.
- To determine people's levels of involvement in bat-related zootherapeutic practices.
- To assess people's knowledge and awareness about the risks of bat-related zoonoses.
- To determine the factors influencing people's participation in bat-related zootherapeutic practices.

Research questions

- I. What zootherapeutic practices involve using bats as materials in Western Uganda?
- II. Are there any health risks associated with using bats in zootherapeutic practices?
- III. What is the people's involvement level in bat-related zootherapeutic practices in Western Uganda?
- IV. What is the level of knowledge and awareness of people in Mitooma District about potential risks involved in bat-related zootherapeutic practices?
- V. What factors influence people to participate in bat-related zootherapeutic practices in Mitooma District?

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CHAPTER TWO

METHODS AND MATERIALS

Study Area

Uganda

Uganda is a landlocked country located in the eastern part of Africa along the equator (Howard, 1991). South Sudan borders Uganda in the North, Kenya in the East, the Democratic Republic of Congo (DRC) in the West, Rwanda in the Southwest, and Lake Victoria and Tanzania in the South (Hamill et al., 2000; Howard, 1991). Western Uganda is a region that extends south from Lake Albert towards the DRC border and southwest towards the border of Rwanda. The vegetation of this region is comprised of savannah mosaic, tropical high rain forests, and alpine montane vegetation (Kityo & Kerbis, 1996). This region is dominated by the mountainous landscape and lakes formed as part of the Western Rift Valley (Howard, 1991). It has exceptional biodiversity due to its location in the East-Central African region, where two different ecological zones, namely the East African savanna and West African rainforests, overlap (Kityo & Kerbis, 1996). Western Uganda has tropical rain forests located in the distinct geographical zone along the eastern rim of Africa's great rift valley in the western part of the country (Kityo & Kerbis, 1996). This region receives large amounts of rainfall throughout the year (Kityo & Kerbis, 1996). According to the East African Meteorological Department, the climate of western Uganda is divided into four seasons (Monaghan et al., 2012). These seasons include a dry season from December to February, a long rainy season from March to May, a second dry season from June to August, and a shorter rainy season from September to November (Monaghan et al., 2012; Mubiru, Komutunga, Agona, Apok, & Ngara, 2012). Temperatures in Uganda are moderate throughout the year, with the mean average temperature of 28°C and the highest temperatures of 30°C received in the northern part of the country (Mubiru et al., 2012).

Mitooma District

The study was conducted in Mitooma district, located at 0.62°S, 30.02° E in the Southwest part of Uganda (NPHC, 2014) and about 25.80 km (16.03 miles) from the border of the DRC. It is a young district established in 2010 through the subdivision of the greater Bushenyi District (STAR-SW, 2010). The research was conducted in all the seven sub-counties that make up Mitooma District: Bitereko, Kabira, Kanyabwanga, Kashenshero, Kiyanga, Mitooma, and Mutara. Mitooma District is estimated to have about 194,300 people and settles on 544.0 square kilometres of land area at an average altitude of 1600 meters (5249ft) above sea level (NPHC, 2014).

Mitooma District is predominantly occupied by the Banyankole people, who belong to the Ankole tribe and a small population of the Bakiga tribe (Mutungi, 2018). The Banyankole and Bakiga people are known for their rich cultural heritage and practices, which they have expressed over centuries through dressing codes, folk songs, traditional dances, nuptial ceremonies, and traditional medicine (Bosco, Harriet, Caroline, Ronald, & Merciline, 2021; Mutungi, 2018). The Ankole tribe is divided into two social groups. The first group is the Bairu, who are predominant farmers (James & Kabera, 1989). The Bairu grow crops such as bananas, maize, millet, beans, sweet potatoes, and groundnuts for food and commercial purposes ((James & Kabera, 1989). The second group is the Bahima, who are predominantly cattle keepers known for rearing the Akole long-horned cattle for food and cash (James & Kabera, 1989). Mitooma District is bordered by Rukungiri District in the west, Ntungamo District in the south, Sheema District in the east, and Bushenyi District in the north and northeast (NPHC, 2014). The northern part of the district borders Maramagambo Central Forest Reserve (MCFR), a thick impenetrable rainforest that is a habitat for many wild animals, including migratory species of bats (Plumptre, Cox, & Mugume, 2003)

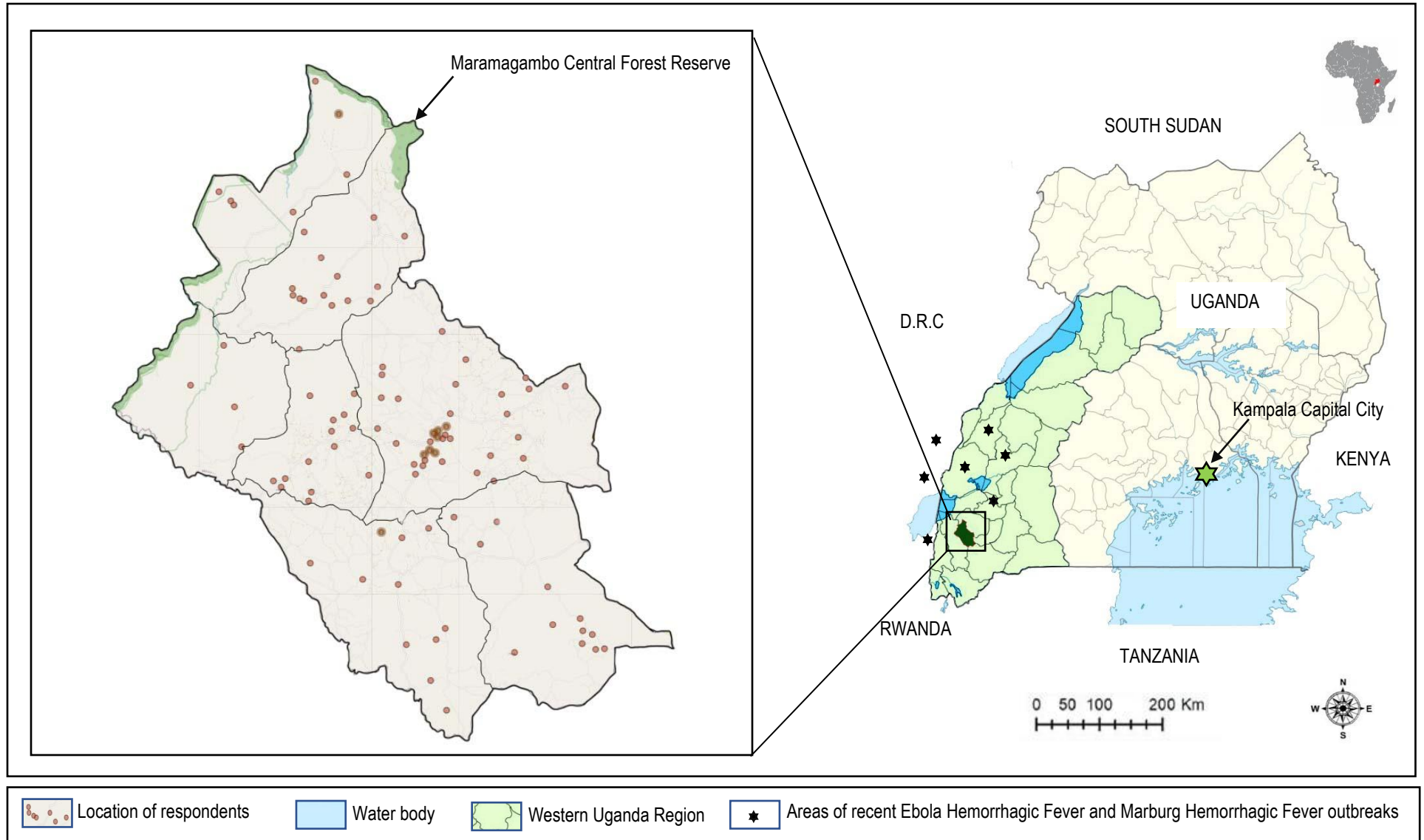


Figure 2.1. Study area, Mitooma District, Western Uganda

Justification of the study area.

The use of bats in traditional zootherapeutic practices occurs in many tribes and districts in Uganda's central and western regions (Larsen, 2010; Mickleburgh et al., 2009). For example, according to local anecdotal sources, bats are known to be used as materials in traditional healing practices among the Baganda people in several districts in central Uganda, such as Mityana, Mubenda, Masaka and Mpigi. According to the local news channel, some other tribes are also thought to use bats, such as the Lamogi people in Amuru District in the northwest, the Bamba and Bakonzo tribes in Bundibugyo District in the west and the Bagisu in Mbale District in Eastern Uganda. However, the limited resources and time did not enable us to investigate all the districts where zootherapeutic practices are carried out.

Mitooma District was selected out of the many possible study areas for the following reasons: Mitooma is located in the western region of Uganda, an area containing most of the country's biodiversity, including the largest populations of both Pteropodoidea and Vespertilioniformes species (Kityo & Kerbis, 1996). The hammer-headed fruit bat (*Hypsignathus monstrosus*), the singing fruit bat (*Epomops franqueti*), the little collared fruit bat (*Myonycteris torquata*), and the African straw-coloured fruit bat (*Eidolon helvum*) are some of the common species of bats identified in Western Uganda (Kityo & Kerbis, 1996). These bat species have been implicated as putative reservoir species of Ebola Hemorrhagic Fever (EHF) (Leroy, Gonzalez, & Pourrut, 2007). These bat species have a wide ecological range covering Northern Angola, Eastern Uganda, and the Democratic Republic of Congo, all the way to Gabon, Ghana, Ivory Coast, and Liberia in Western Africa (Kityo & Kerbis, 1996; Leroy et al., 2007). The high abundance and density of these bats in Western Uganda (Kityo & Kerbis, 1996) makes them more likely to be among the species of bats used by the Bakiga and Banyankole tribes in traditional zootherapeutic practices.

Mitooma District was among the 30 districts in Uganda designated as high-risk areas after the outbreaks of EHF in DRC on 1st August 2018 (Aceng et al., 2020; Riad, Sekamatte, Ocom, Makumbi, & Scoglio, 2019). The high-risk area comprised several districts with direct borders with North Kivu and Ituri provinces of DRC, districts with direct routes to DRC, and districts

that were more likely to receive a high influx of refugees due to the outbreak of EHF in DRC (Aceng et al., 2020; Riad et al., 2019). Some of these districts include, Isingiro, Rukungiri, Rubirizi, Kaseses, Kyegegwa, Bunyandabu, Kabarole, Kagadi, Hoima among others (Aceng et al., 2020). Mitooma District is most suitable for this study being a home to the Banyankole and Bakiga people, known for their rich cultural practices, including zootherapeutic practices involving bats (NPHC, 2014). Mitooma District is among the few remaining districts where the cultural values and traditions are still preserved (James & Kabera, 1989), making it an ideal district for an ethnozoological study.

Study Design

A mixed research methodology was used to achieve a more detailed investigation of the zootherapeutic uses of bats and a broader estimation of people's levels of involvement (Bernard, 2017; Saraswati, Sagun, & Ram, 2021; Schoonenboom & Johnson, 2017). The research was divided into two studies according to the nature of the data involved.

Quantitative study

Quantitative data were collected from 1st December 2021 to 31st January 2022 from respondents using a systematic random sampling technique (Bernard, 2017). The quantitative study was aimed at achieving the following objectives. First, to identify the various traditional zootherapeutic practices that involve the use of bats. Second, to determine people's levels of involvement in bat-related zootherapeutic practices. Third, to assess people's knowledge and awareness about the risks of bat-related zoonoses. Fourth, to determine the factors influencing people's involvement in bat-related zootherapeutic practices using key variables such as sex, age, levels of education and levels of awareness about bat related zoonoses. A respondent was defined as the primary decision-maker for a given household at the time of the interview.

Qualitative Study

Qualitative data were collected from 10 key informants using the purposive sampling technique (Marshall, 1996). This study was aimed at achieving the following objectives. First, to profile the traditional zootherapeutic practices that involve the use of bats. Second, to determine the health

risks associated with bat-related zootherapeutic practices. A key informant was defined as an individual with outstanding knowledge, skills, and experience in traditional zootherapeutic practices.

Justification of the study design.

A mixed research methodology was used to obtain detailed information to achieve our study objectives despite time and resource limitations. The systematic random sampling technique was used as an alternative to randomly select the households despite the lack of proper household identifier information, such as plot numbers in the study area, making it impossible to generate and use random numbers. Additionally, the purposive sampling technique enabled us to obtain sufficient data from individuals identified as experts/key informants without wasting resources.

Data collection

Sample size determination

The sample size (n) of respondents in the quantitative study was determined using Cochran's formula with an 8% margin of error (e) at a 95% Confidence interval (Bernard, 2017; Kotrlik & Higgins, 2001)

$$n = \frac{n_o}{(1 + n_o/N)} \quad \text{Where} \quad n_o = \frac{Z^2 PQ}{e^2}$$

The population of Mitooma District is estimated to be 194,300 people; thus, the study sample size was determined to be 150 individuals.

Additionally, ten key informants were selected to participate in the qualitative study based on their knowledge and expertise in zotherapy.

Quantitative Study

A systematic random sampling technique was employed to ensure that every household in Mitooma District had an equal chance of being interviewed (Bernard, 2017; Mostafa & Ahmad, 2018). The first sampled household was randomly selected, while the rest were selected using a

sample interval of 5 km. The first house observed after travelling 5 km on a navigable road from the previously sampled house was selected (Bernard, 2017; Mostafa & Ahmad, 2018). Google maps 9.172, and the Kobo toolbox applications were used to locate and navigate locations and mark already sampled areas in the district, respectively (Clifford, MacFadyen, & Macfarlane, 2013; Mohsin & Aldabbagh, 2014; Olajide, 2022). Quantitative data were collected by conducting one-on-one interviews using semi-structured questionnaires (Bernard, 2017), administered with the help of the Kobo toolbox data collection application installed on smartphones. The questionnaire consisted of 42 close-ended questions divided into four sections. The first section collected demographic data from the respondent. The second section assessed people's awareness of the conservation of bats. The third section assessed people's awareness of bat-related zoonoses, and the fourth section collected data on the extent to which people are involved in traditional zootherapeutic practices. A series of 18 strategically designed questions were used to assess people's levels of awareness about bat related zoonoses (see Appendix 3 and 4). The levels of awareness were determined using individual total scores converted into percentages. Only one individual between 18 and 100 years old was interviewed per household, preferably the primary decision-maker in the household. A primary decision maker was defined as an individual above 18 years and he/she is the oldest in the household at the time of the interview and was willing and capable of participating in our study. In case only minors or no one was found in the household, then the immediate neighbouring household was considered. The interview lasted between 20 and 30 minutes, depending on the respondent's ability to interpret the question and his/her response rate. The Kobo toolbox application captured all the data, including GPS location, and automatically uploaded it to the cloud-based online database. All interviews were recorded to ensure accurate translation from the local language (Runyankole) to English and allow future references to raw (original) data.

Qualitative study

Qualitative data were collected between November 2021 and January 2022 from 10 key informants using in-depth interviews administered with the help of an open-ended questionnaire (Bernard, 2017; Saraswati et al., 2021). Given the inconspicuous nature of traditional healing practitioners, key informants were identified using the purposive sampling technique with the

help of the local people (Nieman, Leslie, & Wilkinson, 2019). The key informants comprised village elders, senior women, herbalists, and traditional healers selected based on their knowledge, skills, and experience in traditional zootherapeutic practices. The interviews were administered in the local language (Runyankole) with the help of a female research assistant who is native to the study area and a student of public health management at African Renewal University. All the interview responses were audio-recorded and uploaded to an online database for analysis. Only key informants above 18 years of age willing to participate in the study were interviewed. The information collected included: how bats are being captured, how remedies are prepared, health conditions perceived to be treated, prescriptions for using the treatments, possible alternative medicine, and how the knowledge was obtained.

Data analysis

Quantitative Study

All quantitative data were collected using the Kobo toolbox, and downloaded as XLS and CSV files. Using Microsoft Excel 365, the downloaded data were cleaned, translated, coded, and studied utilizing fundamental descriptive analysis tools (Leedy, 2013). IBM SPSS version 28.0.1.1 and R version 4.1.3 software were used for statistical analyses (Bernard, 2017). Descriptive statistics were performed using IBM SPSS version 28.0.1.1, and data were summarized into formats that visualized the behaviour of the data. Inferential statistics were performed using R version 4.1.3 statistical software, and illative conclusions were made from the observations. Inferential statistical tests such as the Chi-Squared test, Spearman's rank correlation test and Wilcoxon signed-rank test were performed to determine the relationships between different variables.

Qualitative study

Qualitative data were collected from key informants as audio files were translated from Runyankole to English with the help of two assistants from Makerere University and then transcribed verbatim by the researcher using guidelines for handling qualitative data (Bernard,

2017). Using NVivo software version 12 (QSR International), the transcripts were coded and checked for credibility, transferability, dependability, and confirmability (White & Marsh, 2006). The coded data were then analysed in line with the research question, and the results were described and discussed accordingly (White & Marsh, 2006).

Ethical clearance

All participants were introduced to the aim of the study, and any questions or queries were addressed before the research was conducted. Participants were made aware of their right to decide to either voluntarily participate in the study or decline. For effective communication, all interviews were conducted in the local language of the informants. Only adult individuals between the ages of 18 and 100 years old were interviewed. All interviews were conducted anonymously, and all information was treated confidentially (Bernard, 2017). Verbal consent was obtained and recorded from each respondent before every interview. Ethical clearance was obtained from both the University of Pretoria (NAS246/2021) and the Uganda National Council for Science and Technology through Makerere University Institutional Animal Care and Use Committee (IACUC).

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CHAPTER THREE

AN ASSESSMENT OF TRADITIONAL ZOOTHERAPEUTIC PRACTICES THAT INVOLVE THE USE OF BATS AS MATERIALS AND THE FACTORS THAT INFLUENCE PEOPLE'S INVOLVEMENT, A CASE STUDY OF MITOOMA DISTRICT, WESTERN UGANDA.

Abstract

Bats are among the many animals used in zoonotic practices worldwide, even though they have been implicated in numerous cases of emergence and re-emergencies of various viral zoonoses. However, much remains unknown about the culturally motivated zoonotic practices that involve the use of bats. This research aimed to cover the knowledge gap on using bats as materials in traditional zoonotic practices in the Ankole tribe in Mitooma District in Western Uganda using a quantitative survey. The use of bats to make therapeutic concoctions used in female genital modification (FGM) was the major zoonotic use of bats reported by participants. An exceptionally large number of people use bats as concoctions in FGM in Mitooma District. Gender was the primary determinant of people's participation in bat-related zoonotic practices. Participants' age, academic qualification, and knowledge or awareness of potential zoonotic risks did not affect their levels of participation in bat-related zoonotic practices. The methods used in capturing and preparing extracts from bats are risky and likely to expose participants to the risks of spillover of bat-related zoonoses. Further research is needed to determine the species of bats used in bat-related zoonotic practices, their population, ecological range, and the likelihood of these bats being reservoirs for viral zoonoses endemic to Western Uganda.

Keywords: Bat-related zoonoses, Zoonotic practices, Labial elongation, Traditional healing practices.

Introduction

Traditional healing practices are prevalent among many indigenous tribes in Africa and worldwide (Antwi-Baffour et al., 2014). Over 85% of people in Sub-Saharan Africa consider traditional healing as an alternative form of treatment to the conventional western healthcare system (Mola et al., 2020). Four out of five people in Uganda, especially in remote areas, participate in traditional healing practices to meet some of their health needs (Abbo, 2011). Traditional healing is considered cheaper, more accessible, and familiar to most people in rural areas compared to conventional western medicine (Abbo, 2011; Tabuti et al., 2003). Traditional healing practices are categorized into two main groups: herbal medicine and zootherapeutic practices. Herbal medicine involves the use of plant parts or extractions to treat ailments. In contrast, zootherapeutic practices involve using decoctions or concoctions extracted from animals, animal parts, and (or) products of animal metabolism to prevent, diagnose and (or) treat ailments (Antwi-Baffour et al., 2014; Costa-Neto, 2005).

Bats are commonly used in zootherapeutic practices worldwide (Mickleburgh et al., 2009). Overall, at least 167 bats species worldwide are reported to be included as materials for zootherapeutic practices (Mildenstein et al., 2016). Unlike most animals used in zootherapeutic practices, bats have been implicated in numerous cases of emergence and re-emergencies of various viral zoonotic diseases (Calisher et al., 2006; Guy et al., 2020). Therefore, there is a need to investigate and understand the zootherapeutic practices that require humans to capture and use bats as materials (Hayman et al., 2013). Much remains unknown about the culturally motivated zootherapeutic practices that involve the use of bats despite these practices being commonly practised worldwide. (Alves & Alves, 2011; Betlu & Lalduhawma, 2013; Jaroli et al., 2010).

This research aimed to cover the knowledge gap on using bats as materials in zootherapeutic practices in the Ankole tribe in Mitooma District in Western Uganda. In this chapter, I aimed to estimate people's participation level in traditional zootherapeutic practices in the Mitooma district. I also determined the knowledge and awareness levels of people in Mitooma District about wildlife zoonoses and conservation. Finally, I determined the factors influencing people to participate in bat-related zootherapeutic practices.

Methods and Materials

Note: Information on the study area, study justification, and population sampling is described in chapter two.

Data Collection

Quantitative data were collected from 115 respondents using a systemic random sampling technique (Bernard, 2017). The first sampled household was randomly selected, while the rest were chosen using a sample interval of 5km. The first house observed after travelling 5km on a navigable road from the previously sampled house was selected (Bernard, 2017; Mostafa & Ahmad, 2018). Google maps and the Kobo toolbox applications were used to navigate and mark already sampled areas in the district, respectively (Clifford et al., 2013; Mohsin & Aldabbagh, 2014; Olajide, 2022). We conducted one-on-one interviews using semi-structured questionnaires (Bernard, 2017), administered with the help of the Kobo toolbox data collection application.

Data Analyses

All quantitative data collected using the Kobo toolbox was downloaded as XLS and CSV files. Then, using Microsoft Excel 365, the downloaded data were cleaned, translated, coded, and studied using fundamental descriptive analysis and pivot tables (P. D. Leedy & Ormrod, 2019). Inferential statistics were conducted using R version 4.2.1 and R-Studio Build 554. The Chi-Squared test of independence and the goodness of fit was conducted on categorical variables, for example, determining whether the observed differences in the level of participation in bat related FGM of people in different age groups and education status, was statistically significant. Since the data obtained were not normally distributed, the Wilcoxon signed-rank test was performed to determine whether the observed differences in the level of awareness about bat related zoonoses of people with different education status, was statistically significant. Additionally, the Spearman rank correlation test was used to determine whether one's age contributed to their awareness score about zoonoses.

Results

Demographic Information

A total of 115 respondents aged 18 years and above, comprising participants from all the seven sub-counties that make up Mitooma District, were interviewed. Many respondents, 53/115 (47.3%), were young adults aged between 25 to 44 years. The majority of the respondents, 100/115 (87.0%), were married. Overall, a large proportion of respondents, 48/115 (41.7%), had no formal education, and the majority, 78/115 (68.4%), relied on farming as an occupation. People in the Mitooma District are predominantly Christian, with most identifying as Protestants 57/115 (50.0%). Details are presented in Table 3.1.

Table 3.1. Demographic information of respondents in Mitooma District, Uganda .

Variable		N=115	Percentage (%)
Sex	Male	16	13.9
	Female	99	86.1
Age (years)	Youth (18-24)	16	14.3
	Young Adult (25-44)	53	47.3
	Adult (45-64)	32	28.6
	Old (65 and above)	11	9.8
Marital status	Single	13	11.3
	Married	100	87.0
	Divorced	2	1.7
Education Level	No formal education	48	41.7
	Primary	38	33.0
	Secondary	19	16.5
	Tertiary	10	8.7
Religion	Catholic	43	37.7
	Protestant	57	50.0
	Born Again	12	10.5
	Muslim	2	1.8

People's levels of involvement in traditional healing practices

All respondents (N=115) were familiar with and had previously used traditional healing practices to treat some ailments. However, the use of plants (herbal medicine) in the treatment of diseases was more popular than the use of animals (zootherapy). All respondents could prescribe therapy for at least one condition using herbal medicine compared to only 36/115 (31.3%) who could prescribe therapy for at least one condition using zootherapeutic practices. A total of 39 species of plants and 14 species of animals were named for the treatment of 20 and 16 different ailments, respectively (Details are presented in Appendixes 1 and 2).

Very few wild animals were reported to be seen in the Mitooma district. The commonest wildlife reported by the respondents are rodents, reported by 93/115 (80.87%) respondents, followed by bats 62/115 (53.91%), and birds 51/115 (44.35%). Other animals reported include monkeys (*Cercopithecidae*), banded mongoose (*Mungos mungo*), bush pigs (*Potamochoerus larvatus*), baboons (*Papio*) and snakes (*Serpentes*). All respondents reported having seen bats in their community. Most respondents, 51/115 (59.3%), reported seeing bats at least once a month, while 15/115 (17.4%) reported seeing bats daily.

People's levels of involvement in bat-related zootherapeutic practices

Roofs of people's houses were reported as the most common roosting site for bats 52/115 (45.2%), followed by banana plantations 51/115 (44.4%) and trees 45/115 (39.1%). Most people, 95/115 (83.3%), believed bats played essential roles in the environment, while 16/115 (14.0%) did not consider bats important to the environment. Most respondents, 82/115 (71.9%), reported an observed decline in the population of bats over the last ten years, and 73/115 (64.0%) believed that it is essential to conserve bats.

The most recognized importance of bats among the respondents was their use as materials in zootherapeutic practices conducted by females for FGM. Most respondents, 89/115 (77.4%), reported bats to be used in FGM, followed by the role of bats as natural predators for insect vectors 4/115 (3.5%). Other reported uses for bats include tourism (2.6%), witchcraft (2.6%), seed dispersal (0.9%), and research (0.9%).

When interviewed about the use of bats as materials in zootherapeutic practices, 40/115 (38.83%) of the respondents admitted having often used bats for FGM, 15/115 (14.6%) chose not to say, while 48/155 (46.6%) had never used concoctions extracted from bats before. Among the respondents who had never used bats before, 33/48 (76.7%) knew at least one person who had used bats for FGM. Most people 36/40 (90.0%) who used bats before in FGM ranked bats ten times more effective than the plant-based alternatives listed in Table 3.2. In addition, most people, 68/115 (78.2%), were likelier to encourage young girls to use bats in FGM.

Table 3.2. Plants used as alternative remedies to bats in female genital modification in Mitooma District in Uganda.

No	Local Name	Common Name	Scientific Name
1	Akabindirizi	Tobacco	<i>Nicotiana tabacum</i>
2	Akanyamafundo	Whitewort	<i>Leucas martini censis</i>
3	Akihabukuru	Perennial horse gram	<i>Macrotyloma axillare</i>
4	Ekyoganyanja	Sloanea tomentosa	<i>Sloanea tomentosa</i>
5	Enderema	Malabar spinach	<i>Basella elba</i>
6	Entarahindo	Guduchi	<i>Tinospora cordifolia</i>
7	Enyabalashama	Blackjack	<i>Bidens Pilosa</i>
8	Kutukumwe	Gotu kola	<i>Centella asiatica</i>

People's levels of knowledge about the risk of bat-related zoonoses

Respondents had moderate knowledge about the causes, signs/symptoms, transmissions, and prevention of zoonotic diseases frequently observed in the study area, which include rabies, Ebola Hemorrhagic Fever (EHF), Marburg Hemorrhagic Fever (MHF), and Brucellosis with a mean score of 56.9%. There was no statistical difference in the knowledge levels between respondents with formal education and those without formal education (W= 1322.5, p-value =

0.102). Additionally, the age of respondents did not contribute to people's levels of awareness and knowledge about zoonoses. There was no correlation between respondents' age and their knowledge and awareness about zoonoses ($S = 224431$, $p\text{-value} = 0.4829$, $\rho = 0.0667$). Only one person who happened to be a schoolteacher identified bats as potential reservoirs (vectors) for zoonoses. Bubonic plague was the most reported zoonotic disease in the community, followed by Ebola and Brucellosis (see details in Table 3.3).

Table 3.3. Most common zoonotic diseases reported in the Mitooma District, Western Uganda

No	Most common zoonoses in the community	Frequency of mention
1	Bubonic Plague	24
2	EHF	8
3	Brucellosis	7
4	Swine flue	6
5	Scabies	3
6	Swine fever	2
7	Rabies	1
8	Anthrax	1

Most respondents, 72/115 (62.6%), received information about the disease outbreak, prevention measures, transmission, signs and symptoms, and control measures of zoonotic diseases via the radio. Other respondents, 32/115 (27.8%), learned about certain zoonoses by seeing the symptoms and signs of the people who contracted the diseases. Other sources of information were through government sensitization programs 18/115 (15.7%), formal school education 11/115 (9.6%), Newspapers 1/115 (0.9%), the internet 2/155 (1.7%), and television 2/115 (1.7%).

Factors that determine people's involvement in bat-related zootherapeutic practices

My fifth objective was determining the factors influencing people's participation in bat-related zootherapeutic practices. This study investigated four variables, namely sex, level of education, age, and levels of awareness about zoonoses. FGM was the major traditional zootherapeutic practice that used bats, and women and (or) girls exclusively practised it. There was no significant difference between the level of participation of individuals without formal education and respondents with formal education ($\chi^2=1.24$, $df=1$, $p\text{-value}=0.266$). There was no significant difference in the level of participation of youth, young adults, adults and old people in bat related zootherapeutic practices ($\chi^2=4.13$, $df=3$, $p\text{-value}=0.248$). According to the Wilcoxon rank test, no significant difference was observed between the knowledge and awareness scores on bat-related zoonoses of people who participated in FGM and those who did not participate in FGM ($w=1625$, $p\text{-value}=0.46$.)

Discussion

People's levels of involvement in traditional healing practices.

This study found out that herbal medicine was more commonly used than zotherapy given that a large percentage of respondents 111/115 (99.1%) identified as users of herbal medicine compared to those who use zotherapy 36/115 (31.3%). A total of 39 species of plants were prescribed for the treatment of 20 different ailments in comparison to 14 species of animals (six domestic animals and eight wild animals) that were prescribed for treating 16 different ailments (details are provided in the Appendix 1 and 2). The low utilization of fauna in traditional zootherapeutic practices is more likely due to the decline in populations and diversity of wildlife in Mitooma District reported by respondents (Costa-Neto, 2005). Only two of the eight wildlife species (bats and rodents) reported to be used by respondents in zootherapeutic practices were classified as abundant in Mitooma District. The relatively high abundance of rodents and bats reported in Mitooma District is likely attributed to the ability of certain species within these two orders of mammals to quickly adapt and live in human-transformed environments (Luis et al.,

2013). In addition, people reported that bats mostly use the roofs of houses for roosting, which is evidence of bats-humans co-existence in Mitooma District.

People's levels of involvement in bat-related zoonotherapeutic practices

The observed high percentage of use of bats by women in FGM is more likely facilitated by the collective belief and perception that concoctions made from bats are far better than those made from herbs since 36/40 (90.0%) of bats users ranked better. However, the capturing of bats without specialized skills and (or) safety equipment carried out by respondents makes FGM extremely dangerous due to direct exposure to aerosols, blood, saliva, urine, and faecal matter, from bats (Hayman et al., 2013; Olivero et al., 2020). Exposure of people to bat body fluids creates a higher likelihood of spillover of bat-related viral zoonoses (Leroy et al., 2009; Olivero et al., 2020). Women and (or) young girls are more likely to be at risk of exposure to viral zoonoses since they exclusively participate in FGM. Many ethical concerns are raised about FGM especially given that girls are initiated at a non-consenting age as early as eleven years. Therefore, quick action is needed to mitigate the risks associated with FGM and protect women and girls from possible exposure to bat-related zoonoses. However, interventions that are more likely to succeed may need to acknowledge the cultural importance of FGM, given the strong devotion of the local people to FGM and its perceived roles (Friant et al., 2022). Integration of the local people in the process of mitigating zoonotic risks associated with FGM would be vital in achieving success.

People's levels of awareness about bat-related zoonoses.

People were asked basic questions about the causes, symptoms, transmission, and prevention of the most common and endemic zoonotic diseases in their area, including Ebola Hemorrhagic Fever (EHF), Marburg Hemorrhagic Fever (MHF), Rabies, and Brucellosis. A moderate score was observed among the respondents, with majority answering correctly 10 out of the 18 questions. People notably lacked knowledge and awareness about the signs and symptoms of zoonoses, their transmission from animal to human and potential wildlife reservoirs given the fact that majority of the people failed these questions. Asiimwe (2018) also observed the lack of basic knowledge and awareness of common zoonotic diseases among local medical practitioners

in Western Uganda. The limited or lack of access to vital infrastructure such as electricity, newspapers, and the internet in most parts of Western Uganda (UBOS, 2017) are more likely to be the limiting factor of access to information and, thus, the leading cause of the low, levels of awareness observed. There was no conclusive evidence that a formal education made one likely to be more knowledgeable or aware of common zoonotic diseases. This is because the difference in the scores of people with formal education and those without education was not statistically significant.

Most people, irrespective of their age, sex, or education level, reportedly acquired knowledge/information on zoonotic diseases from radios and through eyewitnesses or hearsay from victims and (or) families of the victims of zoonotic diseases. Very few individuals reported receiving information from other sources. The Uganda Bureau of Statistics similarly reported that 71.1% of the people in Mitooma District use radio as their main source of information, while only 4.8% obtain information from the internet through their phones. The two major sources of information to people in Mitooma District, namely radios and hearsay, potentially contribute to the observed low levels of knowledge and awareness about zoonotic diseases and can lead to distorted and (or) incomplete information (Smith, Menn, & McKyer, 2011).

Additionally, more reliable sources of information, such as the internet, schools, and government sensitization programs, are less accessible to the people of Mitooma District. This may explain why people with formal education similarly showed less awareness about zoonotic diseases. Therefore, there is a need to increase accessibility to more reliable information sources to the people of Mitooma District to increase people's knowledge and awareness about zoonotic diseases. Furthermore, raising awareness about zoonotic diseases will enable people to recognize and avoid behaviours with high risks of exposure to zoonotic diseases.

Factors that determine people's participation in bat-related zoonotherapeutic practices

Sex was the main determinant of people's participation in bat-related zoonotherapeutic practices. This is because the most significant use of bats in zoonotherapeutic practices was to make

concoctions exclusively used by girls and (or) women in Female Genital Modification (FGM). Education did not deter people from participating in FGM. People with formal education participated in FGM equally as did people with no formal education, in contrast to my expectation. Additionally, age did not affect people's participation in bat-related zoonotic practices. Respondents under different age categories, including youth, young adults, adults, and the old, participated in FGM equally. Furthermore, respondents who demonstrated moderate levels of knowledge and awareness about bat-related zoonotic diseases equally participated in bat-related zoonotic practices as those with very low levels of knowledge and awareness.

The observed unanimous participation of women and girls in bat-related zoonotic practices, irrespective of their age, education levels, and (or) knowledge of possible zoonotic risks involved is more likely due to people's strong devotion to their cultural beliefs and practices (Koster & Price, 2008; Pérez, Tomas Aznar, & Bagnol, 2014). FGM is among the traditional practices associated with cultural identity among the Banyankole People (Martínez-Pérez & Namulondo, 2010). Therefore, all Banyankole girls are expected to participate in FGM at menarche before they are initiated into womanhood (Martínez-Pérez & Namulondo, 2010). Sometimes those who do not participate in FGM are subjected to stigma and (or) rejection from family, friends, and (or) partners. Similar cultural practices were observed among other African tribes, such as Bahutu and Batutsi in Rwanda (Gallo, Villa, & Pagani, 2006; Koster & Price, 2008; Pérez et al., 2016; World Health, 2012). Such cultural behaviours are evidence of how firmly bat-related zoonotic practices are embedded in the cultural norms and values of the Ankole tribe. Therefore, there is a need for behavioural changes by establishing culturally acceptable zoonotic risk mitigation interventions that recognise the cultural importance of zoonotic practices rather than curtailing and (or) halting zoonotic practices themselves (Friant et al., 2022).

Study Limitation

We never acquired the required number of male individuals due to their reluctance to talk about bat-related zootherapeutic practices. This is because the most common use of bats was FGM which topic was avoided by men. Most women, too, were unwilling to talk about the use of bats in front of their husbands and preferred to be interviewed privately.

Conclusion

This research concluded that more women and girls in Mitooma District participate in bat-related zootherapeutic practices than expected. Participation in bat-related zootherapeutic practices is primarily motivated by people's devotion to their cultural values and norms, which translate into community expectations. Age, academic qualification, and knowledge or awareness of potential zoonotic risks don't deter people from participating in bat-related zootherapeutic practices. The methods used in harvesting and preparing extracts from bats remain highly dangerous and are likely to expose participants to the risks of bat-related zoonoses. Additionally, most people in Mitooma District lacked proper knowledge and awareness about wildlife zoonoses, signs and symptoms, causes of animal-to-human transmission, and identification of potential reservoirs of zoonoses. Given the high exposure of participants to bat body fluids during the capture and preparation of bat extracts into concoctions, there is a high likelihood of spill overs of viral zoonotic diseases from bats to humans. Further research is needed to determine the species of bats used in FGM, their population, ecological range, and the likelihood of these bats being reservoirs for viral zoonoses prevalent to Western Uganda. Acquiring more information on the bat species used by people in Mitooma District will allow us to quantify the zoonotic risks involved which is vital when sensitizing the community. There is also a need to change people's mindsets on using bats as materials in zootherapeutic practices and to create awareness about the potential risks of direct contact with bats.

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CHAPTER FOUR

AN ASSESSMENT OF THE USE OF BATS AS ZOOTHERAPEUTIC MATERIALS AND ITS IMPLICATIONS ON PUBLIC HEALTH; A CASE STUDY OF MITOOMA DISTRICT, WESTERN UGANDA.

Abstract

Traditional hunting of wildlife for food, cultural rituals, witchcraft, ornaments, trophies, and zootherapy is still common among many tribes, especially in Africa. Traditional zootherapy is one of the least investigated anthropogenic activities that involve direct contact with wild animals. This research investigates the use of bats as materials in female genital modification (FGM) in the Ankole tribe in Mitooma District in Western Uganda using in-depth interviews conducted with ten key informants. Bat extracts were the choice material for use in FGM among the Banyankole Women despite their awareness of several herbal alternatives. Bat extracts are perceived to cause no pain, no inflammation, or irritation and provide a faster stretching effect compared to herbal alternatives. The girls and (or) women are expected to capture the bats used in FGM by themselves. Bats' wings are then cut off, dried, crushed into powder, and used in FGM. Capturing and preparing bats by women and (or) girls without protective gear exposes them to bats metabolic fluids, such as saliva, faeces, sweat, and blood which creates risks of spillover of bat-related viral zoonoses. Further research is needed to determine the species of bats used in FGM, their population, ecological range, and the likelihood of these bats being reservoirs for viral zoonoses prevalent in Western Uganda. There is a need to create interventions that will work with the local people to establish ways of reducing the health risks associated with FGM without undermining the cultural importance of these practices to the communities involved.

Keywords: Zootherapeutic Practices, Female Genital Modification, Ankole Tribe, Sexual Enhancement Practices, Viral Zoonoses

Introduction

Wild fauna has played an essential role in the traditions of various cultures worldwide (R. R. N. Alves et al., 2016; Betlu & Lalduhawma, 2013; Costa-Neto, 2005; Quave & Pieroni, 2013). Traditional hunting of wildlife for food, cultural rituals, witchcraft, ornaments, trophies, and medicine is still common among many tribes, especially in Africa (Adeola, 1992; Baker et al., 2013; Maxwell K Boakye et al., 2014; Costa-Neto, 2005). Other activities that increase human-wildlife contact include tourism, mixed grazing, and wildlife habitat destruction through deforestation and encroachment (Maurice, Fuashi, Flaubert, Mbinde, & Mbah, 2017; Olivero et al., 2020). However, wildlife hunting is the most dangerous of all the above activities due to its direct impact on the wildlife population and direct exposure of people involved to body fluids from wild animals (Akem & Pemunta, 2020). For example, the outbreak of Ebola Hemorrhagic Fever in the Kansai province in DRC in 2007 was linked to an individual who purchased and ate bat meat from hunters (Leroy et al., 2009). Additionally, the illegal wildlife trade and trafficking are the number one causes of species decline, especially when it involves poaching endangered species (Maxwell Kwame Boakye, Pietersen, Kotzé, Dalton, & Jansen, 2015). In 2003, over 20,000 wild animals collected worldwide were confiscated from wildlife traders in Vietnam, most of which were destined for traditional zootherapeutic practices (Nguyen & Nguyen, 2008).

Despite increased access to formal education and the rapid urbanization of remote villages observed today, the poaching of wild animals has not declined (Betlu & Lalduhawma, 2013; Jugli et al., 2020). The high demand for bush meat, animal trophies, and animal parts for zotherapy are the drivers of the observed hunting and (or) poaching of wild animals today (Akem & Pemunta, 2020). Zotherapy is defined as the use of decoctions or concoctions extracted from animals, animal parts, and (or) products of animal metabolism to prevent, diagnose and (or) treat ailments (Costa-Neto, 2005; Mahawar & Jaroli, 2008). While research on the wildlife meat trade is substantial and still growing (Baker et al., 2013; Kamins et al., 2011), zotherapy remains one of the least investigated anthropogenic activities that facilitate human-wildlife contact (Friant et al., 2022). The available research on zotherapy mainly focuses on understanding its implications for the conservation of endangered wildlife species such as rhinos and pangolins (Maxwell Kwame Boakye et al., 2015; Maxwell K Boakye et al., 2014). Less is

known about the most traditional zootherapeutic practices and the potential health implication for the participants and the public (Friant et al., 2022).

Therefore, there is a need to increase scientific knowledge and understanding of traditional zootherapeutic practices and associated public health implications, especially when potential zoonotic disease reservoirs such as rodents and bats are involved (Friant et al., 2022). Increasing our knowledge of the traditional zootherapeutic practices will improve our understanding of the emergence and (or) re-emergence of viral zoonoses, such as the 2022 EHF outbreak in Mubende District in Uganda (Friant et al., 2022). Furthermore, being knowledgeable about traditional zootherapeutic practices is vital in preventing the outbreak of viral zoonoses in future (Wolfe, Daszak, Kilpatrick, & Burke, 2005). In this research, I investigated the use of bats as materials in traditional zootherapeutic practices among the women in the Ankole tribe in Mitooma District in Western Uganda. I described the procedures involved in using bats in zootherapeutic practices in Western Uganda using in-depth interviews conducted with ten key informants. In addition, through the in-depth interviews, my research investigates the process of capturing the bats, preparing bat extracts and administering the concoctions. I also assess the potential risks of spill overs involved in the handling of bats by the women when preparing concoctions from bat extracts.

Methods and Materials.

Note: Information on the study area and study design is described in chapter two.

Data Collection

This chapter describes the procedures involved in using bats as materials in the traditional zootherapeutic practices by the Ankole women in Mitooma District, Western Uganda and the potential health risks involved. Ten key informants were identified using purposive sampling techniques with the help of locals (Bernard, 2017) and were interviewed in-depth using open-ended questionnaires (Dawadi, Shrestha, & Giri, 2021; Ryan, Coughlan, & Cronin, 2009). The key informants were selected based on their knowledge and experience in using bats in

zootherapeutic practices and their willingness to participate in the study. The key informants had to be above 18 years of age to participate in the study. The survey script was designed to elicit information on how bats are captured, how concoctions are extracted from bats, how concoctions are administered, what are the alternative remedies, what motivates involvement in these practices and how knowledge about these practices is obtained. Given the sensitive nature of the study, only one on one interviews were conducted by a female research assistant to provide the privacy that enabled respondents to express themselves freely. The interviews were conducted in the local language (Runyankole) to allow the key informants to provide as many details as possible (Bernard, 2017; Ryan et al., 2009). All the interview responses were audio-recorded and uploaded to an online database for analysis. Research notes were taken to provide additional field information (Bernard, 2017).

Data Analysis

The audio recordings were transcribed verbatim into word transcripts using Microsoft Word (Version 2207) by personnel fluent in both Runyankole and English. The transcripts and audio recordings were re-examined by a third party to ensure that the interpretation was accurate. The word transcripts were imported into NVIVO Software version 12 by QSR International, where data were coded, categorized, and grouped into themes using the principles of grounded analysis (White & Marsh, 2006). Additional data from field notes, observations, records, and analysis memos were audited to ensure the validity of the data collected. Two themes emerged: "women genital enhancement practices " and "bat extracts".

Results

Role of bats in zootherapeutic practices

Respondents reported using bats by women and girls in Female Genital Modification (FGM) as the primary zootherapeutic practice that uses bats. The knowledge about FGM is kept exclusive to the females as it's considered sensitive and verboten to the males. The knowledge about FGM is passed down to girls before menarche, as early as eleven years, in preparation for their

initiation into women (adulthood). FGM is a societal obligation of every girl child in the Bahima clan (Ankole tribe), and a stigma is attached to girls and (or) women who never participated in these practices. The training is carried out by girls' grandmothers, aunties, elder sisters, and sometimes peers.

"I was told by my fellow adolescents when we were around 11 years old, we had a group going to fetch firewood, and we knew we had to go home after doing that thing. We first used other things, as I have shown you, but later, we got skills from parents who advised us how to do/behave, but they told us that the bat was the best. Its powder is so fast." (76-year female farmer from Mushunga Parish, Mitooma Sub-County, Ruhinda County, Mitooma District.)

Senior women/ teachers also provide FGM knowledge and other reproductive health, sex, and menstrual hygiene information during gender/ girl talks in some schools.

"My aunt told me when we would visit and fetch her water and firewood, she would tell us. I also learned it from school. Senior woman teacher would gather all the adolescent girls, and she would tell us." (25-year female farmer from Bukari Parish, Kashenshero Sub-County, Ruhinda County, Mitooma District.)

Why are bats used in FGM

Bats have played a role in female genital modification among the Bahima clan in the Ankole tribe for generations. According to a 76 years old, key informant from Mushunga parish, Mitooma sub-county, the Ankole name given to bats, i.e., "Orubaka"-singular, "Embaka"-plural means "something used to catch/ grasp properly". It was derived from the role bats play in enabling women to grasp and stretch the labia minora muscles of their genitals.

"It's faster than anything. They used to use other things, but later they realized it was very fast. You can even get it from its name, "orubaka", which means pull. Can't it pull it? And it is not

painful." (76-year female farmer from Mushunga Parish, Mitooma Sub-County, Ruhinda County, Mitooma District.)

At least eight species of plants were listed as possible alternatives to using bats in female genital modification (See Table 3.1).

Table 4.1 Plant species that can be used as alternatives to bats in FGM

No	Local name (Ankole Tribe)	Common name	Scientific name
1	Akabindirizi	Tobacco	<i>Nicotiana tabacum</i>
2	Akanyamafundo	Whitewort	<i>Leucas martini censis</i>
3	Akihabukuru	Perennial horse gram	<i>Macrotyloma axillare</i>
4	Ekyoganyanja	Sloanea tomentosa	<i>Sloanea tomentosa</i>
5	Enderema	Malabar spinach	<i>Basella elba</i>
6	Entarahindo	Guduchi	<i>Tinospora cordifolia</i>
7	Enyabalashama	Blackjack	<i>Bidens pilosa</i>
8	Kutukumwe	Gotu kola	<i>Centella asiatica</i>

However, powder extracts from bats were perceived as easier to use in FGM due to their lubrication properties. In addition, key informants commended it for being painless, causing no inflammation, and enabling a faster-stretching effect than herbal alternatives.

"I would recommend a bat. When you apply its powder on that part, it becomes so soft that when you pull, it's so elastic, making it grow very fast." (32-year female from Kyanzeire Parish, Kashenshero Sub-County, Ruhinda County, Mitooma District.)

Sources of bats used in traditional zootherapeutic practices

People physically capture the bats required to make concoctions/ extracts used in FGM. The high abundance of bats reported in the community (see Chapter 3), which often roost in people's houses, banana plantations, coffee plantations, and trees, especially during the migration season, makes them accessible and easy to capture by anyone, including young girls. Bats are captured using force, mostly by beating the bats to death with clothes, brooms, tree branches, sticks, and (or) throwing of stones.

"You can find it in banana plantations, and you beat it, or if it enters the house, you get like a broom and beat it." (25-year female from Bukari Parish, Kashenshero Sub-County, Ruhinda County, Mitooma District.)

Locals perceive bats as blind, which gives them the confidence to capture, especially when roosting during the daytime easily.

"If you want it, you get it during the day, it's always upside down, and it doesn't see during the day, so you can get a branched stick and beat it to death." (31-year female from Kirera Parish, Kashenshero Sub-County, Ruhinda County, Mitooma District.)

No commercial selling of bats or bats' extracts was reported or observed in the study area. Bats were said to be abundant, especially during the dry season, upon the arrival of more migratory species making bats more accessible.

Preparation of bat extracts or concoctions

Extracts from bats are obtained in many ways, all of which follow similar principles. First, bats are killed, and then their wings are cut off and dried in the sun or by exposing them to soot from kitchens. Some people prefer to dry the entire bat before cutting off the wings. Then, after drying, wings were pounded into powder, which was then used for FGM. Some people use the powder independently, while others mix it with petroleum jelly before its application.

"You target and kill it, and when you are lucky, and it dies, you remove its wings, expose them on the Sun for them to dry, and when they do, you smash them into powder. It's the that you use." (24-year female from Nyabubaare Parish, Kabira Sub-County, Ruhinda County, Mitooma District.)

The quickest way to prepare the extract involves cutting off the bat's wings and frying them in a pot until they are thoroughly dried. Then they pound them into powder, mix them with petroleum jelly and use it in FGM.

"When it's beaten, it falls down. You wet it and cut off its wings. You get it; put it on olugutsyo (part of a broken pot) and fly it. You make sure it's dry so that you smash it into powder. It's the powder that we use to pull. That's it." (30-year woman from Ijumo Parish, Mitooma Sub-County, Ruhinda County, Mitooma District.)

The powder extracted from the bats' wings is applied when stretching the labia minora tissue of the female genitalia until the desired length is obtained, measured using the longest figure (middle finger). Most girls conduct FGM in groups to help one another attain the recommended size of the labia minora.

"After killing it, you cut off its wings; after cutting them, it becomes powerless, and it dies because it's the ones it survives on. After cutting off those wings, you display them to dry. After they have dried, you smash them into powder. We use the powder to pull. You know, for us women, we have inside and outside parts, so you smear both ends as you pull, going down until the desired length. When pulling, we measure using the longest figure, and one must not exceed that." (62-year female from Kirembe Parish, Mitooma Sub-County, Ruhinda County, Mitooma District.)

The practice of FGM is part of the lifestyle of women and (or) girls in the Ankole tribe, and it's associated with a happy and stable marriage, high sexual pleasure, and ease of conceiving and

giving birth. FGM is started at a young age before a girl goes into menarche, and it continues throughout the lifetime of women, customarily carried out at intervals based on one's preference.

Discussion

Role of bats in zootherapeutic practices

The only zootherapeutic practice that required bats and (or) parts of bats reported by participants in the indepth interviews in this study was Female Genital Modification (FGM). The practice is popular among women and has been part of the Ankole tribe throughout history. FGM is a common practice, popular among various tribes in several African countries, including the Venda, and Shona in South Africa (Williams, 1969), the Makonde in Tanzania, the Bemba in Zambia, the Shona in Zimbabwe, the Alomwe, Achewa, and Sena and five other tribes in Malawi (Gallo, Moro, & Manganoni, 2009), the Hutu, Tutsi, and Twa in Rwanda (Koster & Price, 2008) and Nyungue tribes in Mozambique (Pérez et al., 2016). FGM is also practised in Benin, Burundi, Democratic Republic of Congo (DRC), Lesotho, Namibia, Sudan, and Uganda (Koster & Price, 2008; Martínez Pérez & Namulondo, 2011; Pérez et al., 2016). In Uganda, FGM has been reported among several tribes, including Baganda, Basoga, Bagishu, Banyankole, Banyoro, and Batoolo (Martínez Pérez & Namulondo, 2011), with herbs and vegetable oils reported to be the main material used (Koster & Price, 2008). Our research offers the first report on the use of bats in FGM among Banyankore women in Uganda. The use of bats for FGM was also reported in Rwanda and Mozambique by (Koster & Price, 2008; Pérez et al., 2014; WHO, 2012).

Reasons for the preference of bats (bats' extracts) in FGM

When asked why Banyankole women prefer to use bat extracts over herbal alternatives, the key informants reported bat extracts to be painless, cause no inflammation and (or) irritation, and are effective. However, more research is needed among other users of bats in FGM in Rwanda and Mozambique to confirm if the users are motivated by similar reasons (Pérez et al., 2014; WHO, 2012). Plants/ herbal extracts from plant species such as *Solanum incanum*, *Solanum*

aculeastrum Dunal, *Bidens pilosa*, and *Oxalis acetosella* are known to be used for FGM in most of the tribes in Africa (Pérez et al., 2016; Pérez et al., 2014).

The key informants from this study reported using plant/ herbal concoctions in FGM to be associated with pain, irritation, and sometimes inflammation. Similarly, (Koster & Price, 2008; Martínez Pérez & Namulondo, 2011) reported the same effects experienced by the Baganda (Uganda) and Hutu and Tutsi (Rwanda) women, respectively, who carry out FGM using plant extracts. Pérez (2014) reported the occurrence of ulcers, oedema, and laceration among herbal users, in addition to the effects reported by Ankole Women. In some cultures, aunts and grandmothers encourage young girls to continue with FGM despite the pain experienced, especially in the beginning (Martínez Pérez & Namulondo, 2011; Pérez et al., 2014). However, though bats may be perceived to have a lot of benefits, there are concerns about the possible implications on public health and also to an extent the conservation of bats.

Conducting FGM

Once dried, the bats' wings are pounded into powder/ flour, which is applied by women/ girls during FGM. Some people mix the powder obtained from bats with petroleum jelly, oil, and (or) ghee before using it. Although extracts from bats are unique to the Banyankole tribe, other tribes practising FGM in Uganda, such as the Baganda, Basoga, Bagisu, and Batoro, use herbal concoctions (Martínez Pérez & Namulondo, 2011). Irrespective of the extracts used (whether bats or plants), FGM procedures are the same across tribes and countries (WHO, 2012; Williams, 1969). The stretching is repeated consistently for a relatively long period until the desired length/ size is achieved (WHO, 2012). Girls may be required to pull for several months before the desired length is achieved, and some women may continue to practice FGM throughout their lifetime (Koster & Price, 2008). In Ankole, just like in Buganda, FGM is considered very sensitive and (or) detestable and carried out clandestinely to conceal it from men and (or) boys (Martínez Pérez & Namulondo, 2011).

Usually, Banyankole girls carry out these practices on their own, either alone or with their peers in the bushes as they collect firewood and (or) on their way to fetch water. On the contrary, the Baganda girls carry out FGM in designated places, usually in groups in the presence of their aunts, who act as instructors (Gallo et al., 2006; Martínez Pérez & Namulondo, 2011). Among

the Ankole, girls are recruited within FGM before menarche as early as eleven years. However, girls are recruited at an even younger age of nine among the Baganda tribe (Gallo et al., 2006; Koster & Price, 2008; Martínez Pérez & Namulondo, 2011). In almost all cultures, young girls are recruited into FGM at a non-consenting age which raises ethical questions given that their bodies are permanently modified (Gallo et al., 2006; Koster & Price, 2008). Additionally, the encouragement of under-aged girls to not only capture but also dissect bats among the Banyankole raises public health question which needs to be addressed.

Reasons for practising FGM

The use of bats in FGM is deeply embedded in the fabric of the Ankole culture. This explains why factors such as age, religious beliefs, and educational background had no significant effect on people's levels of participation in FGM in the quantitative research that was conducted concurrently. According to (Koster & Price, 2008; Pérez et al., 2014), FGM is carried out in rural and urban areas by people of all social statuses and academic qualifications. In addition, in some tribes, such as the Bahutu and Batutsi in Rwanda, FGM symbolizes cultural identity and belonging, which encourages the full participation of all women in that tribe (Gallo et al., 2006; Koster & Price, 2008; Pérez et al., 2016; WHO, 2012).

Among the Banyankole, the knowledge/ instructions about FGM are passed down over generations from the girl's aunt, grandmother, and (or) elder peers, which is the same observation among other tribes such as the Baganda and the Hutu and Tutsi in Rwanda (Gallo et al., 2006; Koster & Price, 2008; Martínez Pérez & Namulondo, 2011). FGM knowledge is packaged with additional traditional healing information and taught in informal sexual, menstrual hygiene, and marital girl child lessons, often by aunts, while initiating girls into womanhood or adulthood (Pérez et al., 2014; WHO, 2012).

According to the participants in this study, the Ankole society believed that women with long labia minora are more attractive, more capable of pleasing men sexually, and thus more likely to marry. Additionally, they think a man is less likely to cheat on someone who participated in FGM. Similar beliefs are observed in Mozambique among the Sena, Nyanja, and Nyungue people (WHO, 2012) and in Rwanda among the Hutu and Tutsi ((Koster & Price, 2008). Like with other tribes, girls in the Ankole tribe are persuaded by the expected rewards from FGM,

such as enhanced sexual pleasure for her and her husband, stabilized marriage, increased desire for her by her husband and ease of conception and child delivery (Gallo et al., 2006; Koster & Price, 2008; Martínez Pérez & Namulondo, 2011).

The fear of being stigmatized, ostracized, criticized, rejected, and mocked by society is used to lure girls into practising FGM in all tribes (Martínez Pérez & Namulondo, 2011). This is the same among communities that practice FGM in other countries, such as Rwanda, Malawi, Lesotho, Mozambique, and DRC (Koster & Price, 2008; WHO, 2012). However, there is no clear scientific evidence to confirm whether FGM enhances the sexual pleasure of women and (or) men or makes it easy for a woman to conceive and deliver babies.

Health risks associated with capturing bats and preparing extracts used in FGM

When asked how bats used in FGM are obtained, all respondents reported capturing the bats themselves. Many migratory bats roost in people's houses, banana plantations, and coffee plantations, especially during the dry season, which may explain why women and girls easily capture bats on their own. Women use physical force to capture bats by beating them to death using blooms, clothes, tree branches, sticks, and stones. Respondents reported sometimes experiencing bites and scratches while capturing the bats. In addition, women and girls reported using no personal protective equipment when capturing the bats, implying a higher exposure of the captors to metabolic fluids from bats, such as urine, saliva, faeces, and blood (Akem & Pemunta, 2020). Another incident of exposure to blood and other body fluids is during the preparation of bat extracts. Girls (women) cut off the bats' wings using a knife and dry them with sunlight, frying them in the pot or exposing them to kitchen soot. This processing exposes the user directly to the body fluids of bats, which is highly risky (Aceng et al., 2020; Akem & Pemunta, 2020). When asked about the risk of disease exposure, respondents inferred that their predecessors and elders have always used bats, but no disease exposure has ever been observed or reported. Using bats in traditional zootherapeutic practices such as FGM raises concerns about public health since bats are known reservoirs of numerous viral zoonoses (Breed, Field, Smith, Edmonston, & Meers, 2010). With the observed levels of exposure of girls and (or) women to body fluids from bats, there is a high likelihood of exposure to viral zoonoses associated with the species of bats captured.

Study Limitations

Most people were reluctant to talk about the use of bats in zootherapeutic practices and this affected number of respondents that were interviewed.

Conclusion

Considering the solid cultural motivations which drive women's participation in FGM, it is more likely that FGM will continue to occur among women in various tribes across Africa despite rapid urbanization and increased literacy levels. Additionally, given the perceived advantages of bats in FGM, Banyankole women are more likely to continue using them. Therefore, there is need to categorize and quantify the likelihood of zoonotic disease outbreaks in Mitooma District. This can be achieved through conducting additional investigations to identify the bats' species, sampling bats' specimen for viral zoonoses endemic to the region, and determine the bats' ecology (geographic range) in Western Uganda (Hayman et al., 2013). Furthermore, public health education about the prevention of infectious diseases and transmission of zoonotic diseases should include information on the health implications of using wildlife in traditional zootherapeutic practices (Akem & Pemunta, 2020; Friant et al., 2022). In addition, there is a need for interventions to stop people from using bats or bats' parts in FGM as a preventative measure for possible future spill overs of zoonoses. However, this will be more challenging, and several issues related to people's cultural values and the economy may need to be addressed (Friant et al., 2022). Therefore, recommended intervention should recognize the cultural importance of zotherapy and establish culturally acceptable risk mitigation ideas rather than curtailing and (or) halting zootherapeutic practices themselves (Friant et al., 2022).

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CHAPTER FIVE

GENERAL DISCUSSION

There are many health risks associated with FGM; however, the clandestine nature of FGM restricts the public and the scientific community from fully assessing these risks. Some challenges reported by people who use herbal concoctions for FGM include pain, inflammation, irritation, ulcers, oedema, and laceration (Martínez Pérez & Namulondo, 2011). The greater danger of FGM, however, is the high risk of spillover of zoonoses to the public, especially when common wildlife reservoirs of viral zoonoses, such as bats, are involved (Leroy et al., 2009). Respondents reported having direct contact with body fluids from bats without any protective gear, indicating high risks of zoonotic spillovers (Friant et al., 2022; Leroy et al., 2009; Moratelli & Calisher, 2015). In addition, most bats species common in Western Uganda, including the Egyptian fruit bats (*Rousettus aegyptiacus*), are identified as putative reservoirs of deadly viral zoonoses such as MHF, EHF and Rabies (Adjemian et al., 2011; Leroy et al., 2009). Therefore, there is a high threat to human health in Western Uganda, especially among the communities that use bats to make concoctions for FGM.

A high number of women, 40/115 (38.8%) in Mitooma District, identified as participants in FGM. This high level of participation represents higher risks of zoonotic disease spill overs. Additionally, the involvement of underaged girls in capturing bats and preparing them for FGM raises even more ethical questions. Girls and (or) women reportedly capture bats by physically beating them to death using objects such as brooms, clothes, and tree branches during the daytime when bats roost in houses and gardens. Respondents reported bat bites and scratches common during the bat-capturing process; thus, the girls and women involved become victims. Encouraging young girls to capture bats without personal protective equipment (PPE) is extremely dangerous and creates high risks of girls' exposure to viral pathogens. Therefore, there is a need for more research to categorise and quantify the risks involved in FGM and investigate the species of bats used and whether they are potential reservoirs of viral zoonoses endemic to Western Uganda.

The relatively low knowledge and awareness about wildlife zoonoses observed in Mitooma District raise more health concerns. People's lack of awareness about zoonoses is most likely attributed to the low literacy levels in the community and the lack of effective means of communication. Over 41.7% of the respondents had no formal education, 33.0% completed primary, 16.5% completed secondary, and only 8.7% completed tertiary education. Additionally, the lack of vital infrastructures such as electricity, the internet, and reliable road networks limits access to information in the community. Low literacy levels in the community limit people's ability to seek information through books, the internet, and newspapers. At the same time, the lack of infrastructure restricts government efforts to sensitize the community about health safety and risks associated with zootherapeutic practices.

The negligence of governments in sub-Saharan Africa to conduct disease bio surveillance on the traditional healing practices of various tribes in Africa contributes to the emergence and re-emergence of zoonoses (Aceng et al., 2020). For example, most EHF outbreaks in Uganda, including the August 2022 EHF outbreak, occur in districts with higher human-wildlife interactions motivated by traditional beliefs such as zotherapy and hunting. Understanding the health risks at various levels of human-wildlife interactions is vital in detecting and preventing future zoonotic disease re-emergence (Hayman et al., 2013). Therefore, more efforts are needed to understand the zootherapeutic practices of the different tribes, especially in regions endemic to deadly viral wildlife zoonoses.

Conclusion

Traditional healing practices continue to play an essential role in the cultures of many tribes in Africa today (Koster & Price, 2008). Some traditional healing practices, such as zotherapy, are more commonly practised today than expected. Tribes in Sub-Saharan Africa are more likely to continue practising FGM due to its role in cultural identity and its perceived benefits in marriage, conception, and child delivery. Therefore, the risks of spill over of viral zoonoses into communities that utilize bats in FGM will remain high. Additionally, many ethical issues surround using bats in FGM, such as the exposure of underaged girls to the body fluids of wild animals associated with viral zoonoses. Therefore, there is a need for government intervention to assess the health and conservation risks associated with zootherapeutic practices among different

tribes. The best interventions will be those that work with the people involved to create solutions that minimize risks involved in zootherapeutic practices without getting rid of the cultural norms and practices themselves.

Recommendations

More research is needed to ensure that zootherapeutic practices are conducted in ways that do not risk people's lives and (or) affect the conservation of wild animals (Hayman et al., 2013). There is a need for the government and the scientific body to conduct more investigations to understand and quantify the zoonotic risks and likelihood of zoonotic spill overs associated with the use of wildlife in traditional zootherapeutic practices in Uganda. Additionally, the government should conduct community sensitisation programs through the ministry of health and the district health officers about the health risks associated with using wild animals in zootherapeutic practices. Other necessary interventions may include promoting zoonotic risk-mitigating behaviours among FGM practitioners by promoting culturally acceptable, less risky practices. The best interventions involve integrating the local people in establishing ways to reduce the health risks associated with FGM without undermining the cultural importance of these practices to the local population.

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Appendix 1. Most common plants used in herbal medicine, their scientific names and the diseases perceived to be treated

No	Plant local name	Common name	Scientific name	Disease perceived to be treated
1	Akabindirizi	Tobacco	<i>Nicotiana tabacum</i>	Skin reaction Labial elongation.
2	Akanyamafundo	Whitewort	<i>Leucas martini censis</i>	Ulcers, Stomachache Labial elongation
3	Akihabukuru	Perennial horse gram	<i>Macrotyloma axillare</i>	Skin rashes Labial elongation
4	Amapera	Guava	<i>Pridium guajava</i>	Cough
5	Ebombo	Wild Cucumber	<i>Momordica foetida</i>	Bad body odour
6	Ekifa Bakazi	African tulip tree	<i>Spathodea campanulata</i>	Ulcers
7	Ekiferankuba	Sunflecks	<i>Guizotia scabra</i>	Influenza
8	Ekigologolo	Gale of wind	<i>Phyllanthus niruri</i>	Syphilis
9	Ekimarampaka	Nile tulip	<i>Markhamia lutea</i>	Headache
10	Ekitutu	Cape gooseberry	<i>Physalis peruviana</i>	Stomachache
11	Ekiyondo	Paddle plant	<i>Kalanchoe thyrsiflora</i>	Malaria
12	Ekizera	Silver spurflower	<i>Plectranthus argentatus</i>	Influenza Cough
13	Ekyoganyanja	Sloanea tomentosa	<i>Sloanea tomentosa</i>	Stomach ache Labial elongation Diarrhoea
14	Eleka	Common vervain	<i>Verbena officinalis</i>	Stomach worms
15	Emihanja	Ajuga	<i>Ajuga nipponensis</i>	Cough
16	Empunika	Gallant soldier	<i>Galinsoga parviflora</i>	Body wounds
17	Endasa	Life plant	<i>Bryophyllum pinnatum</i>	Stomach ache
18	Enderema	Malabar spinach	<i>Basella elba</i>	Labial elongation Rectal prolapse
19	Enjaga	Hemp	<i>Cannabis sativa</i>	Headache
20	Entarahindo	Guduchi	<i>Tinospora cord ifolia</i>	Stomach ulcers

				Labial elongation
21	Enyabalashama	Blackjack	<i>Bidens Pilosa</i>	Stomach ulcers
				Labial elongation
				Allergy
22	Eswinga	Black nightshade	<i>Solanum nigrum</i>	Stomach complications
23	Gahibale	Common self-heal	<i>Prunella Vulgaris</i>	Stomach-ache
24	Karitusi	Rose gum	<i>Eucalyptus grandis</i>	Cough
25	Kitinwa	Small flowered bugleweed	<i>Ajuga remota</i>	Allergy
26	Kutukumwe	Gotu kola	<i>Centella asiatica</i>	Labial elongation
27	Lukaka	Aloe	<i>Aleo vera</i>	Malaria
28	Mukazimurifa	Southern marigold	<i>Tagetes minuta</i>	Headache
29	Ngaro etano	Lippia	<i>Lippia gracilis</i>	Malaria
30	Omubirizi	Bitter leaf	<i>Vernonia amygdalina</i>	Malaria
				Constipation
31	Omuboro	African cherry orange	<i>Citropsis articulata</i>	Breast cancer
				Libido in men
32	Omuhiko	American pokeweed	<i>Phytolacca decandra</i>	Scabbies
33	Omuja	African basil	<i>Ocimum gratissimum</i>	Stomach ache
34	Omushoroza	Natal Indigo	<i>Indigofera arrecta</i>	Intestinal worms
35	Omwetango	Seaport goosefoot	<i>Chenopodium opulifolium</i>	Malaria
				Bad odour
36	Omwetenjoka	Wild sunflower	<i>Aspilia mossambicensis</i>	Worms
37	Omwiha	Ugandan greenheart	<i>Warburgia ugandensis</i>	Fever
38	Omwiwura	Snake food	<i>Momordica foetida</i>	Stroke
39	Rusharara	Common rue	<i>Ruta graveolens</i>	Stomach ache

Appendix 2. Most common animals used in zootherapeutic practices, their scientific names and the diseases perceived to be treated

No	Animal local name	Common name	Scientific name	Part used	Disease perceived to be treated
1	Ente	Cow	<i>Bos taurus</i>	Bone marrows Feet	Bone pain Nose bleeding
2	Embaka	Bat	<i>Chiroptera</i>	Whole	Labial elongation
3	Embuzi	Goat	<i>Capraegagrus hircus</i>	Fresh meat	Bleeding gums
4	Kappa	Domestic cat	<i>Felis catus</i>	Whole	Spiritual cleansing
5	Akame	Rabbit	<i>Oryctolagus cuniculus</i>	Far	Burns Hypertension
6	Akanyaankogote	Tortoise	<i>Testudinidae</i>	Shell	Rectal prolapse Hiccups
7	Enjoka	Python	<i>Pythonidae</i>	Back bone	Backache
8	Embwa	Dog	<i>Canis lupus familiaris</i>	Bones	Mental disorders
9	Ekichunchu	Lion	<i>Panthera leo</i>	Mane Intestine	Measles Stomach ache
10	Ensoba byuma	rat	<i>Rattus</i>	Whole	Kwashiako
11	Enyaruju	Chameleon	<i>Chamealeonidae</i>	Tail	Deafness
12	Kamuje	Squirrel	<i>Sciuridae</i>		Muscle pain
13	Esonzi	Mud fish	<i>Amia calva</i>	Whole	Kwashiorkor
14	Endiga	Sheep	<i>Ovis aries</i>	Tail	Stomachache

Appendix 3. Survey questionnaire for quantitative research.

Survey Questionnaire Mitooma District

SECTION ONE: Personal Demography.

In this section, you are kindly requested to provide personal demographic information. All information provided will be treated anonymously, and any identifying information will be treated with at most confidentiality.

1. CODE

2. GPS Location

latitude

longitude

altitude (m)

accuracy (m)

3. Sex

☐ Male

☐ Female

4. Age

5. Marital status

☐ Single

☐ Married

☐ Divorced

6. Education level

☐ No education

☐ Primary

☐ Secondary

☐ Tertiary

7. Occupation

8. Religious beliefs

☐ Catholic

☐ Protestant

☐ Born again

☐ Muslim

9. Home address

9.1. Parish

9.2. Sub county

9.3. County

9.4. District

SECTION TWO: Awareness about the conservation of bats.

This section will assess the respondent's level of awareness about the conservation of bats.

1. Some wild animals such as rats, monkeys, bats and birds live within our community. Please list any wild animal that you commonly see this area.

2. In which ways are wildlife in general important to our community?

3. Have you ever seen a bats?

☐ Yes

☐ No

4. How often do you see bats in this area?

☐ Every day

☐ Once a week

☐ Once a month

☐ Not at all

5. Where do you think bats live?

6.1 Do you think bats are important to people?

☐ Yes

☐ No

☐ Not sure

6.2. If yes, in which ways are bats important to people?

SECTION THREE: Awareness about wildlife and bat related zoonoses.

This session is aimed at assessing the levels of awareness of respondents about bat related zoonoses.

1.1. Do you know any wild animal (s) that live within this community?

☐ Yes

☐ No

1.2. If yes, name any wildlife that you know?

2.1. Some wild animals such as rats, bats, and cockroaches live in our houses, do you know of any danger(s) that can result from this?

☐ Yes

☐ No

☐ Not sure

2.2. If your answer was yes, what danger(s) can result from staying with wildlife?

3.1. Some animals can be found dead in our gardens, forests, houses and alongside the road, do you think there is any danger if someone touches or eats these dead animals?

☐ Yes

☐ No

☐ Not sure

3.2. If yes, what danger(s) can result from touching or eating animals found dead?

4.1. Do you know of any disease (s) that can be contracted from a wild animal (s)?

☐ Yes

☐ No

☐ Not sure

4.2. If yes, name any disease(s) that can be contracted from wild animals?

5.1 Do you know of any wild animal(s) known to be a carrier of a disease(s)?

- ☐ Yes
☐ No
☐ Not sure

5.2 If yes, name any animal(s) known to be a carrier of a disease(s)?

6.1. Do you know of any human activity or activities that could lead to the spreading of diseases from wild animals to people?

- ☐ Yes
☐ No
☐ Not sure

6.2. If yes, what are some of these activities?

7.1. Which of the following diseases do you know about?

- ☐ Marburg
☐ Ebola
☐ Rabies
☐ Brucellosis
☐ None of the above

7.2. How did you get to know about these diseases?

7.3. Tell us what you know about the selected disease or diseases?

8. Tick "yes" if you think the following activities increases the chances of contracting Ebola and "No" if you do not think so.

8.1 Attending funerals of Ebola victims

- ☐ Yes
☐ No

☐ Not sure

8.2 Touching blood of bats

☐ Yes

☐ No

☐ Not sure

8.3 Not eating a balanced diet

☐ Yes

☐ No

☐ Not sure

8.4 Nursing Ebola patients without protective gear

☐ Yes

☐ No

☐ Not sure

8.5 Not washing hands after visiting the toilet

☐ Yes

☐ No

☐ Not sure

8.6 Eating wildlife meat

☐ Yes

☐ No

☐ Not sure

8.7 Receiving Ebola vaccine

☐ Yes

☐ No

☐ Not sure

8.8 Eating unwashed fruits

☐ Yes

☐ No

☐ Not sure

8.9. Touching bodies of animals that are found dead

☐ Yes

☐ No

☐ Not sure

8.10. Not sleeping under a mosquito net

- ☐ Yes
☐ No
☐ Not sure

9. Which of the following statement is true about bats?

- ☐ The population of bats has decreased today compared to the past.
☐ There has been no significant change in the population of bats.
☐ The population of bats has increased today that it was in the past.
☐ Not sure.

10.1 Do you think it's necessary to conserve and protect bats and their habitats?

- ☐ Yes
☐ No
☐ Not sure

10.2. If yes, in which ways do you think you personally can contribute to the conservation of bats?

SECTION FOUR: Extent of use of bats in traditional medicine.

This session is aimed at determining the extent at which bats are used as materials in tradition healing practices.

1. Have you heard about the use of plants and animals in treatment of diseases and disorders in this community?

- ☐ Yes
☐ No

2.1 What are some of the plants you know to be used in treatment of certain diseases and disorders?

2.2 Which diseases are commonly treated with plants materials?

3.1. What are some of the animals that you know to be used in treatment of diseases and disorders?

3.2. Which diseases are commonly treated using animal materials?

4.1. Have you heard about the use of bats or part of bats for medicinal purposes?

- ☐ Yes
☐ No

4.2. If yes, which health conditions or disorders do you know to be treatable using bats as remedy or part of remedy?

5. How are bats used for medical purposes obtained?

6. How are bats prepared for use as remedies?

7.1. Have you ever used the bats as remedies for any health condition before?

- ☐ Yes
☐ No

7.2. If you have ever used bats as remedy, how often?

- ☐ Ounce
☐ Twice
☐ Very many times

8. Do you know some one who have ever used bats as medicine ?

- ☐ Yes
☐ No

9.1. Are there other know alternative remedies that can be used instead of bats?

- ☐ Yes
☐ No
☐ Not sure

9.2. If yes, list any alternative remedy that you know?

10.1. On a scale of 1 - 10 How effective would you considered bats remedies to be compared to other alternative remedies? (1 meaning not effective and 10 meaning extremely effective)

10.2. On a scale of 1 – 10, How likely are you to recommend some one to use bats as remedies? (1 meaning not likely and 10 meaning most likely)

Appendix 4. In-depth interview guidelines.

In-depth Interview Guide

Personal Demography.

In this section, you are kindly requested to provide personal demographic information. All information provided will be treated anonymously and any identifying information will be treated with at most confidentiality.

1. CODE

2. GPS Location

latitude

longitude

altitude (m)

accuracy (m)

3. Sex

☐

Male

☐

Female

4. Age

5. Marital status

☐

Single

☐

Married

☐

Divorced

6. Education level

☐

No education

☐

Primary

☐

Secondary

☐

Tertiary

7. Occupation

8. Religious beliefs

☐

Catholic

☐

Protestant

- ☐ Born again
- ☐ Muslim

9. Home address

- 9.5. Parish**
- 9.6. Sub county**
- 9.7. County**
- 9.8. District**

Use of bats in traditional medicine.

This session is aimed at determining the extent at which bats are used as materials in tradition healing practices.

1. Have you heard about the use of plants and animals in treatment of diseases and disorders in this community?

- ☐ Yes
- ☐ No

2.1. What are some of the plants you know to be used in treatment of certain diseases and disorders?

2.2. Which diseases are commonly treated with plants materials?

3.1. What are some of the animals that you know to be used in treatment of diseases and disorders?

3.2. Which diseases are commonly treated using animal materials?

4.1. Have you heard about the use of bats or part of bats for medicinal purposes?

- ☐ Yes
- ☐ No

4.2. If yes, which health conditions or disorders do you know to be treatable using bats as remedy or part of remedy?

5. How are bats used for medical purposes obtained?

6. How are bats prepared for use as remedies?

7.1. Have you ever used the bats as remedies for any health condition before?

- ☐ Yes
☐ No

7.2. If you have ever used bats as remedy, how often?

- ☐ Ounce
☐ Twice
☐ Very many times

8. Do you know some one who have ever used bats as medicine ?

- ☐ Yes
☐ No

9.1. Are there other know alternative remedies that can be used instead of bats?

- ☐ Yes
☐ No
☐ Not sure

9.2. If yes, list any alternative remedy that you know?

10.1. On a scale of 1 - 10 How effective would you considered bats remedies to be compared to other alternative remedies? (1 meaning not effective and 10 meaning extremely effective)

10.2. On a scale of 1 – 10, How likely are you to recommend some one to use bats as remedies? (1 meaning not likely and 10 meaning most likely)