



A COMMUNITY HOUSEHOLD SURVEY AND QUALITATIVE INQUIRY OF DISEASE SPILLOVER AT BAT-HUMAN INTERFACE IN BUNDIBUGYO DISTRICT, UGANDA.

A report from STOP Spillover

March 1st – 14th, 2023



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Abbreviations

- CAPI.....Computer Assisted Personnel Interview
- FGDs.....Focus Group Discussion
- LC1.....Local council one
- STOPs.....Strategies to Prevent Spillover
- USAID.....United States Agency for International Development
- VHT.....Village Health Team

STRATEGIES TO PREVENT SPILLOVER (STOP SPILLOVER)

Strategies to Prevent (STOP) Spillover, a USAID-funded project led by Tufts University, is a global consortium of experts in human, animal, and environmental health who will take the next step in understanding and addressing the risks posed by known zoonotic viruses that have the potential to spill over and cause pandemic crises.

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SECTION ONE: INTRODUCTION

1.1 Background

Uganda has documented outbreaks from several bat borne pathogens, including six Ebola outbreaks in the districts of Mubende (2022), Gulu (2000), Bundibugyo (2007), Luwero (2011 and 2012), and Kibaale (2012), and Luwero (2012) (Aceng, 2023; Okware, 2022). Marburg viral haemorrhagic fever outbreaks have also occurred in Uganda, in the districts of Ibanda, in 2007, Kabale, in 2012, and Kween, in 2017.

The viral reservoir for Ebola Virus Disease (EVD), however, has not been definitively determined. Nyakarahuka et al., (2020) stated that the recent Marburg outbreak in Kween district was traced to rock salt mining in a bat cave, and the Egyptian fruit bat *Rousettus aegyptiacus* has been identified as the reservoir of Marburg virus. Therefore, to help avoid zoonotic spillover through bat-human contact, the STOP Spillover project was launched in Uganda in 2020 with the aim of preventing the spillover of zoonotic diseases from animals to humans.

In September 2021, a national workshop was held where stakeholders identified the bat-human interface as a high-risk interface for the project and focused on potential risk reduction interventions. The district of Bundibugyo was selected as the target area due to the presence of various modes of human-bat interaction, including hunting, cave tourism, and agricultural fields, as well as a history of an Ebola outbreak in 2007.

To inform the identification of potential interventions to reduce the risk of zoonotic disease spillover at the bat human interface, community surveys and focus group discussions (FGDs) were conducted in March 2023 in the three sub-counties of Bundibugyo, namely, Harugale, Ntandi, and Burondo. The research aimed to explore the behavioral, socio-cultural, gender-specific, and economic risk factors associated with bat-human interaction in the study areas.

This report reports provides preliminary results arising from data collected during this field research and presents highlights of the key findings related to community knowledge, perceptions, and interactions with bats and potentially risky practices. We originally intended to survey 900 households, 24 FGDs and 24 KII. But we were able to do 313 house surveys, all the 24 planned FGDs, but did not do any KIIs. This therefore limits the conclusions from this study.

1.2 Objective

The aim of this activity was to conduct a household survey in at least 300 households and conduct at least 24 FGDs, in order to gain a deeper understanding of the socio-cultural, economic, and behavioral and gender-based risk factors in the community that can potentially lead to zoonotic disease spillover.

1.3 Outputs

During the field data collection activities, 24 focus group discussions were conducted, with eight focus group discussions held in each of the three sub-counties . Community survey data were collected from 313 households in the three sub-counties: Burondo (n=104), Harugale (n=100) and Ntandi county town council (n=109).

The focus group discussions were conducted with community members who engage in activities that involve bat-animal interaction, such as hunting, cave tourism, and agriculture. The focus group discussions were conducted separately for men and women to ensure that gender-specific issues are adequately explored.

To capture sufficient knowledge through “*citizen science*”, *the discussions were conducted in the local languages to ensure that all participants were able to fully participate and share their experiences and knowledge.* In Harugale, we interacted mainly with the household heads, while in Burondo and Ntandi, more interviews were attended to by their spouses. Interestingly, we also noticed that there were more nonfamily members (distant relatives) living in the same households in Burondo.

SECTION TWO: METHODS

2.1 Study area

The study was conducted in three sub-counties of Bundibugyo - Harugale, Ntandi, and Burondo - from March 1 to 14, 2023. Bundibugyo district is located in western Uganda along the Rwenzori Mountain ranges is bordered by the Democratic Republic of the Congo to the east, Ntoroko District to the north, Kasese to the south, and Kabarole to the east. It has a total area of 241,551 square kilometers, of which the land area covers 200,523 square kilometers. Bundibugyo had a projected population of 263,800 in 2020 (https://www.citypopulation.de/en/uganda/western/admin/003__bundibugyo/) based on the Uganda Population and Housing Census of 2014. The study sub counties Burondo had an estimated population 6,400, Harugali had an estimated population of 14,800 and Ntandi town council had an estimated population of 9,300.

A sketch map of Bundibugyo district showing study area

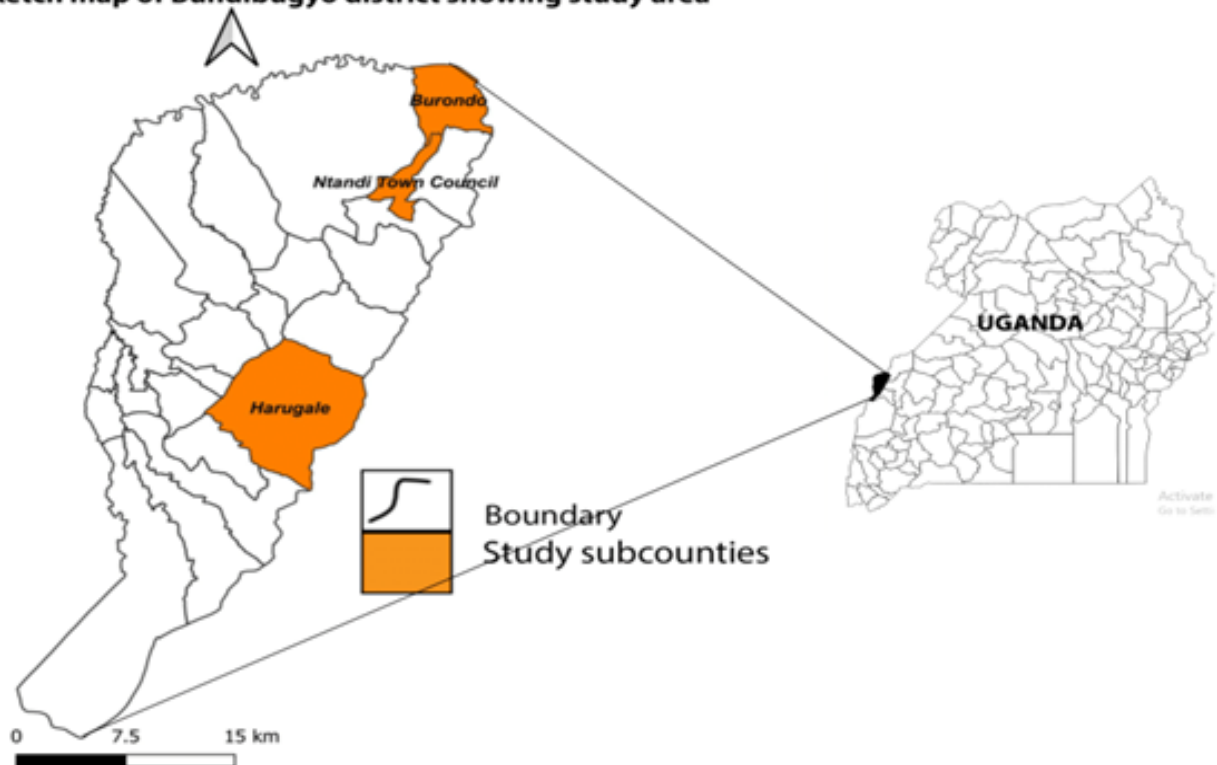


Figure 1. Map of Bundibugyo showing study areas

2.2 Study Population

To achieve greater insight, the study used a mixed methods research design. This included both qualitative and quantitative approaches to gathering data across the target population. A total of 24 Focus group discussions (FGDs), with eight per sub county, were conducted alongside the 313 household survey interviews.

2.2 Sampling plan

Based on the design of the survey tools, a sampling strategy was developed for the field survey. The strategy involved a consultative process with partners outside Uganda, the district team, and the Makerere University team to identify the target population and determine the appropriate sample size.

Two teams were constituted for the field survey: one team for quantitative interviews and the other for qualitative interviews. The sampling strategy for the quantitative team involved selecting a representative sample of the target population using a probability sampling technique, such as random sampling or stratified sampling.

The qualitative team used purposive sampling to select participants who were representative of the target population and could provide valuable insights into the research questions. The team included both local teams on the ground and those from Makerere University.

2.3 Data collection

2.3.1 Composition and training of field staff.

The two teams, consisting of quantitative and qualitative interviewers, received two days of training in Bundibugyo, including a pretest of the survey tools. Three sub-counties were selected for the study, and parishes and villages were randomly chosen with the guidance of community leaders. A transect walk was used, and enumerators were instructed to skip three households before interviewing the next household. Consent was obtained from household heads or members 18 years of age or older.

The teams used CAPI data collection tools, and uploaded data every evening with quality checks and briefings. The second team of quantitative analysts was divided into two and moved to different locations for interviews. The community was mobilized to attend FGDs, and participants included women, men, youth, and mixed groups to encourage participation.

2.3.2 Focus Group Discussions:

Twenty four Focus group discussions were conducted to gather information on the different risk factors associated with human-bat interactions. The discussions were divided into groups of men and women to ensure that all gender-sensitive issues were captured.

The discussions were facilitated by trained moderators who used open-ended questions to encourage participants to share their experiences and perceptions on human-bat interactions. During the discussions, different participatory epidemiology tools (PE) tools were used to understand certain phenomenon associated with bat- human interactions.



Figure 2. A Focused group discussion being conducted with women in Harugale subcounty

2.3.2.1.1 Matrix Scoring:

Matrix scoring was used to identify and prioritize the various risk factors associated with human-bat interactions. This tool involved the creation of a matrix with different factors such as hunting, cave tourism, and agricultural fields on one axis and the level of risk on the other axis. Participants were asked to score each factor based on its level of risk. The scores were then used to prioritize the factors for further investigation.

2.3.2.1.2 Dividing Piles:

Proportional piling dividing piles was used to explore the perception of the community members on the prevalence of bats in the community and the influencing factors. This tool involved asking participants to divide a pile of beans or stones into different categories based on the factors that influence the seasonal variation in bat populations. The categories included: habitat destruction, hunting, and weather patterns. The number of beans or stones in each category was then used to determine the level of influence of each factor.

2.3.2.1.3 Seasonal Calendars:

Seasonal calendars were used to show the seasonal variation in bat populations and the factors that influence it. The calendars were created using information gathered from the community members about the different seasons and the activities that occur during those seasons. The calendars were used to identify the peak season for bat populations and the factors that contribute to it.

2.4 Data management and Analysis

Before analysis, qualitative data collected during the survey was uploaded to the survey system every evening and checked for completeness and accuracy. The data was then downloaded and checked again for completeness and consistency. Any errors or missing values were identified and corrected. Summary statistics were then run on the cleaned data.

Qualitative data was managed using NVivo software, which is a powerful tool for managing and analyzing qualitative data. The software allows for the organization and analysis of textual, audio, and visual data, as well as the identification of themes and patterns in the data. The qualitative team transcribed the data every evening and made callbacks for more information where necessary. Recorders, phones, and photos were also taken with the consent of the participants.

After the data was transcribed, it was imported into NVivo software for analysis. The data was organized into themes and categories, and coding was used to identify patterns and relationships in the data. The software also allowed for the visualization of the data through diagrams and charts, which made it easier to interpret and present the findings.

The quantitative data was uploaded to the survey excel system every evening, and a quality check was done to ensure the completeness and accuracy of the data. After the fieldwork, the data was downloaded and checked again for completeness and consistency. Excel software was used to manage the data. Any errors or missing values were identified and corrected before running summary statistics.

SECTION THREE: RESULTS

3.1 Key Findings

3.1.1 Summary of Focus Group Discussions (FGDs)

FGDs were conducted in three different study areas, namely Burondo, Harugale, and Ntandi. In total, 24 FGDs were conducted across the three areas, with eight FGDs conducted in each area. The FGDs were conducted with a total of 240 participants, comprising 120 males and 120 females.

The FGDs were categorized based on the composition of the participants. Out of the 24 FGDs, six FGDs were conducted exclusively with male participants, six FGDs were conducted exclusively with female participants, and 12 FGDs were mixed gender. The number of FGDs conducted in each category was evenly distributed across the three study areas.

Table 1: Summary of FGDs conducted.

	STUDY AREA			TOTAL
	<i>Burondo</i>	<i>Harugale</i>	<i>Ntandi</i>	
<i>Total FGDs</i>	8	8	8	24
<i>Total FGDs for males</i>	2	2	2	6
<i>Total FGDs for females</i>	2	2	2	6
<i>Total FGDs mixed</i>	4	4	4	12
<i>Total males</i>	40	40	40	120
<i>Total females</i>	40	40	40	120

3.1.2 Demographic characteristics of respondents

Table 2. Social demography of the respondents

<i>Do you own any of the following assets in this household?</i>	<i>Radio</i>	<i>227 (73%)</i>
	<i>Mobile phone</i>	<i>250 (80%)</i>
	<i>Smartphone</i>	<i>47 (15%)</i>
	<i>Television</i>	<i>45 (14%)</i>
	<i>Bicycle</i>	<i>36 (12%)</i>
	<i>Motorcycle</i>	<i>21 (6.7%)</i>
	<i>Car</i>	<i>3 (1.0%)</i>
<i>Does your household grow any of the following crops on the farm</i>	<i>Cocoa</i>	<i>281 (90%)</i>
	<i>Banana</i>	<i>278 (89%)</i>
	<i>Maize</i>	<i>122 (39%)</i>
	<i>Beans</i>	<i>182 (58%)</i>
	<i>Millet</i>	<i>2 (0.6%)</i>
	<i>Gnuts</i>	<i>61 (19%)</i>
	<i>Cassava</i>	<i>264 (84%)</i>
	<i>Potatoes</i>	<i>78 (25%)</i>
	<i>Rice</i>	<i>4 (1.3%)</i>
	<i>Vanilla</i>	<i>137 (44%)</i>
	<i>Coffee</i>	<i>133 (42%)</i>
<i>What is the main source of income of your household?</i>	<i>Business</i>	<i>24 (7.7%)</i>
	<i>Charcoal burning</i>	<i>3 (1.0%)</i>
	<i>Fishing</i>	<i>1 (0.3%)</i>
	<i>Others (specify)</i>	<i>7 (2.2%)</i>
	<i>Salaried job</i>	<i>11 (3.5%)</i>
	<i>Sale of agricultural produce</i>	<i>267 (85%)</i>

The main source of income for most of the households was agriculture. This involved sale of harvested agriculture produce, although trading also contributed to the people's income.

3.1.3 Knowledge About Bats

Overall, a significant proportion of the participants, roughly one-third, (107/313) never heard about the dangers of bats to humans. The communities get information about bats from different sources but mainly from radio (Fig.2). Other common sources of information are from health workers including village health team members. However a significant population of not heard of any information about bats except for the common myths and perceptions within the different communities.

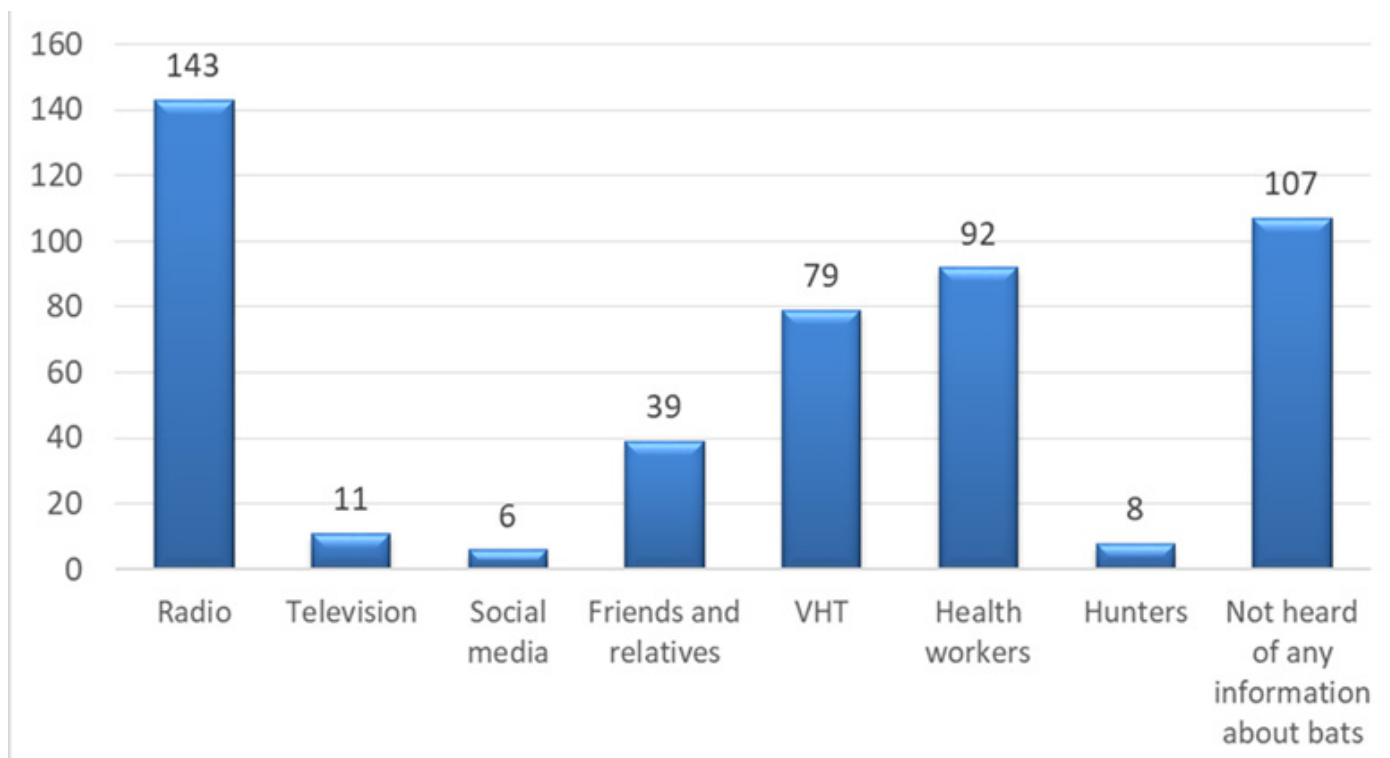


Figure 3. Communities source of knowledge and information about bats

3.1.3.1 Duration of stay with bats in community.

It was reported across all the three sub-counties that bats had been present in the communities since time immemorial. The duration was equal to the number of years they had stayed in that community.

“As for me I think all of us seated here were born when all these bats were already there. So, we found them here and our grandfathers found them here also” (FGD 01 – Ntandi).

“We have been in this area and have seen them since birth. We have grown up seeing them” (FGD 05 – Burondo)

“Since I was born, of which I am 20 years now, I have been seeing bats and my fellow colleagues here can agree with me” (FGD 07) – Harugale).

3.1.3.2 Bat species/types

In all of the FGDs, the communities generally described broadly two types of bats. These included big bats that are brown in color (locally known as emelema) and the small one that is black in color (locally known as kakolokombe / kelibo).

“We have Kakolokombe which is small and black in Lukonjo (also known as Kelibo in Lubwisi). Small one’s feed on mosquitoes and the other types are naturally brown and some are medium in size”. (FGD 05 – Ntandi)

“We only see two types of bats. Emelema and Obukorokombe. Emelemma are big and brown while Obukorokombe are small and black”. (FGD 01 – Harugale)

“We normally have two types of bats here; that’s the big bats which we called “emerema” and the small bats which is called “akakorokombe”.’ (FGD 04 – Burondo)



Figure 4. A focused group discussion conducted in Ntandi showing participants doing proportional piling

3.1.3.3 Bat Habitats

The habitats for bats in the communities mentioned included banana plantations, mango trees, caves/stones/culverts, cocoa plantations, houses, church ceilings, and school ceilings.

“Bats hide ceilings in houses for houses where they are ceilings. This is common in churches, hospitals, and schools”

(FGD 06 – Harugale)

“Here in our community bats are most common on mango trees especially when they are ripe” (FGD 08 – Burontdo)

“Bats are found in caves and also in bridges and culverts. When there is sunshine, they live under banana leaves and cocoa plantations” (FGD 01 – Ntandi)

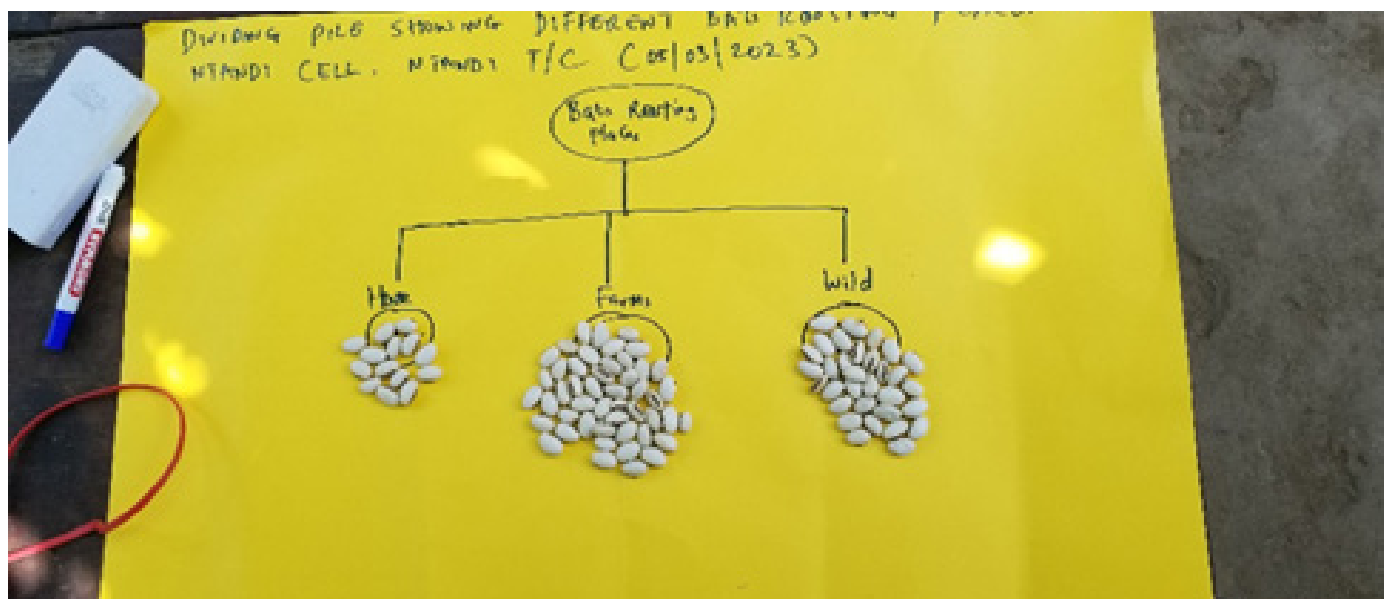


Figure 5. A dividing pile showing the different bats roosting places during an FGD in Ntandi

3.1.3.4 Factors that attract bats to the communities.

The community members mentioned various factors that they believe attract bats to the places where they live. In the houses, the factors included comfort, feeding on mosquitoes and cockroaches, and darkness in the ceilings.

“They stay in houses because they like eating mosquitoes and Cockroaches” (FGD 06 – Ntandi)

“They come to look for shelter in houses where they are comfortable” (FGD 03 – Harugale).

“Bats like to leave near people that’s why they come in our houses” (FGD 04 – Burondo).

In trees and plantations, bats feed on the fruits and bananas and therefore stay there in search for food. The trees and plantations most preferred by bats include mangoes, guava, bananas, and cocoa.

The other reasons for staying in

trees and plantations included coldness and quietness in the leaves of these trees and plantations.

“Bats go to farms to look for fruits to feed on like mangoes, guavas, pawpaw. Others just look for cool places to sleep during day” (FGD 08 – Ntandi).

“They come to gardens to feed on ready mangoes and palm fruits which they prefer so much” (FGD 02 – Harugale).

In the caves and stones, bats are attracted by the coldness, darkness, and freedom from disturbances by people and other animals. Other similar places mentioned included culverts.

“The reason they stay in stone caves first of all they are always dark, so during the day these bats don’t want to move” (FGD 02 – Burondo)..

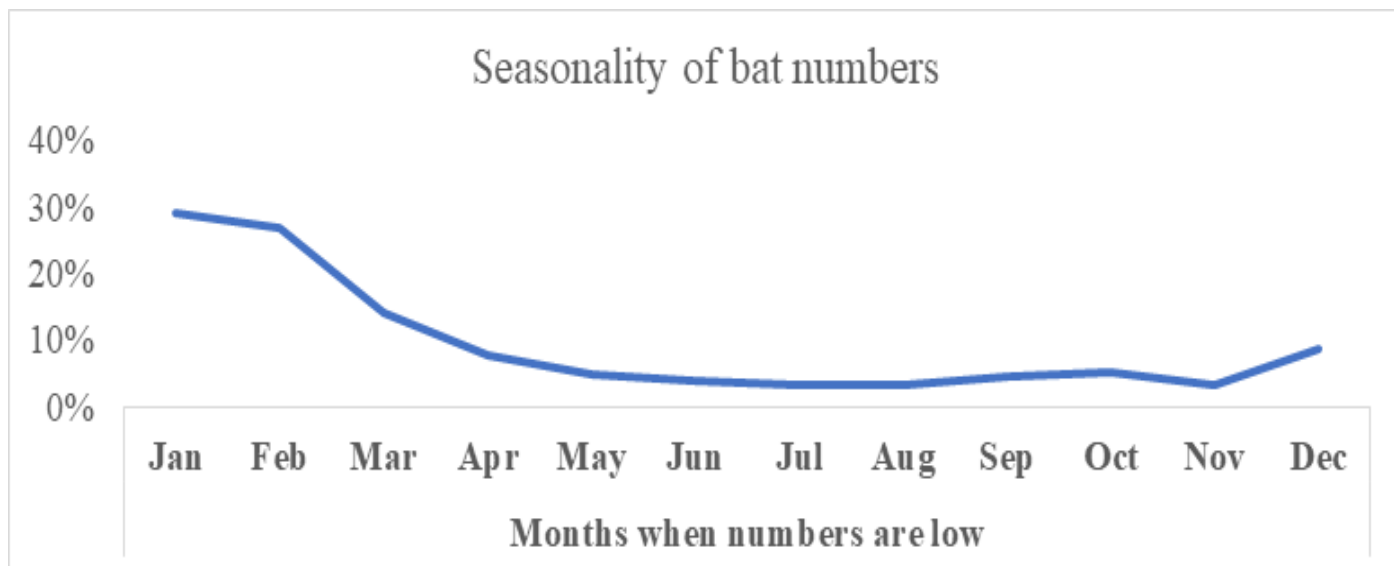
“Bats are also found in Caves in dark places because they fear light, so they go and hide inside those caves” (FGD 07 – Harugale).

“Bats hide where there is darkness, that’s why they like to hide in caves where it is dark and cool for them” (FGD 08 – Harugale).



Figure 6. FGD participants use proportional piling in Burondocounty

Seasonality and bat populations



Most of the respondents revealed that the bat numbers are lowest in January compared to other months. The numbers reduce from November through February according to the participants.

Most of the respondents revealed that the bat numbers are the highest in October compared to other months. It can be concluded from the graph below that the bat numbers increase July through October, the reduce till January when they start to rise.

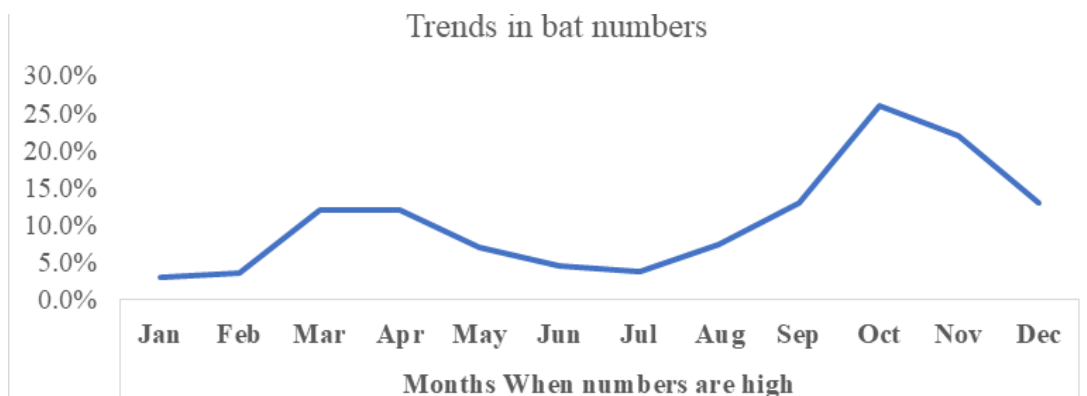


Figure 7. Trends in data numbers

As presented in figure above, bats were reported to be more present in the community in the months of October, November and December.

3.1.4 Community Perception of Bats

3.1.4.1 Events signified by bats.

i. Cannibalism: The presence of bats in someone’s home was associated with cannibalism. The respondents explained that cannibals use bats to fly from one place to another to feed on flesh

“Presence of bats on trees would signal the owner is a cannibal and uses bats as means of transport” (FGD 04 – Burondo)..

ii. Witchcraft: Bats were also associated with witchcraft and bad omens because the community member believed that witchdoctors send them to pluck people’s hair and nails to be used for witchcraft activities;

“Culturally when you see bat around flying, it plucks off hair it means the witchdoctor has sent it” (FGD 06 – Ntandi).

“House bats or small bats coming into your house means a bad omen and signifies that a witch has come into your

house. Religiously, it is believed that a bat can pick your hair or clothes to take to the witch” (FGD 06 – Ntandi).

iii. Harvesting season: Presence of bats is also associated with harvesting season especially for fruits such as mangoes and guavas. This is because bats feed on them when they are ripe;

“When you see many bats, you know the season for mangoes have come” (FGD 01 – Ntandi).

“We they invade gardens in large numbers, they communicate that fruits are ready and it is time for harvesting. Reduced numbers of bats signals, scarcity of foods and famine” (FGD 07 – Harugale).

“High population of bats in gardens symbolizes that fruits are ready as bats come to eat them” (FGD 03 – Burondo).

iv. Wet season: Presence of many bats in the community also is signified the beginning of rainy season.

“I think high bats population symbolizes wet season since bats prefer cool places” (FGD 08 – Burondo).

“When there are too many bats in the community it also signifies change of season, because normally in wet season there are

abundance of fruits, so they come to feed on them” (FGD 02 – Ntandi).

“High populations of bats communicate that its almost rainy season” (FGD 05 – Harugale).

v. Danger around: Presence of bats signified that a disaster such as fire has befallen them and alerts the neighbors to be keen to avoid loss of property;

“Bats signify bush burning alert for the neighbors to be kin so the fire doesn’t destroy their properties in the process” (FGD 06 – Ntandi).

They also signify the presence of a dangerous predator such as a snake which feed on them or intruders in the

3.2.2 Interaction with Bats

a) Community activities

The common activities that bring community members in contact directly or indirectly with bats included hunting, pruning, cultivation, harvesting, fetching water, collecting firewood, building and construction, grazing, and daily household chores.

“I always interact with them during my daily activities in the house when cooking or doing other work. Sometimes at night during sleep” (FGD 06 – Harugale).

“Some ladies and children interact with bats when they have gone to fetch water from wells and streams” (FGD 07 – Ntandi).

“I always get in contact with these bats during pruning cocoa trees in the garden” (FGD 04 – Burondo).

“Women are allowed to access the park to collect firewood thus come across

homes and houses.

“We also use the bat as a warning sign of danger when they leave houses. This can tell us whether something has entered inside like a snake” (FGD 03 – Ntandi).

“For us here when we hear bats fly at night in large numbers it shows the presence of enemies or intruders on your compound” (FGD 04 – Harugale).

vi. Grasshoppers season: Bats feed on grasshoppers and therefore their presence in large numbers, especially in December signifies that the grasshopper’s season is close or has started; Even when the season for grasshoppers is approaching especially in November and December bats are seen in large numbers” (FGD 02 – Burondo).

bats flying over them on their heads, catch in their excreta” (FGD 02 – Ntandi).

“Young children play with bats and are also involved in hunting” (FGD 01 – Harugale).

b) Sharing of water sources

Community members also shared water sources with bats since most of them fetched water from open sources in the communities. They also said that bats contaminate the water sources by urinating and defecating in them. Bats also contaminate the containers they use to fetch water.

“Our water sources are open in the community and these bats have access to them. When the bats are thirsty, they go to drink water from where we fetch from” (FGD 08 – Ntandi).

“I have also found bat guano in the jerry can where I collect and store water” (FGD 06 – Burondo).

“I have also found bat guano in food in my house and water storage bucket” (FGD 04 – Harugale).

3.1.4.2 Perceived benefits of bats

Whereas the majority seem to demonize association with bats, nevertheless they also perceive some benefits and advantages of bats in the communities. Almost a half (143/313) reported that bats have some advantages. The benefits reported were many, including: eating of mosquitoes, provision of food, use as medicine for anemia or lack of blood, facilitate seed dispersal, used as love attraction among women, their guano can be used for fertilizer, source of income, source of medicine for measles and research.,

i. Source of food:

In some communities especially in Ntandi and Burondo, bats were used as a source of food. The big bats (locally known as emelema) were the common ones eaten in the community;

“Bats are also used as a source of meat when people eat them. For people who do not have money to buy meat from the market, they resort to bats meat as an alternative” (FGD 06 – Ntandi).

“Big bats are used as food, sweet like chicken” (FGD 01 – Burondo).

ii. Seed dispersal: Bats act as agents of seed dispersal by carrying fruits from one place to another;

“They bring seeds that I dint have like guavas in my garden which later grow. In otherwise they are used for seed dispersal” (FGD 04 – Burondo).

“These bats carry fruits from one place to another hence aiding in seed dispersal since it takes a seed from other places to other places” (FGD 06 – Harugale).

“Bats transport fruit seeds from one village to another, we see new fruits abruptly growing in our compounds and gardens” (FGD 08 – Ntandi).

iii. Manure: The guano and fecal contents from bats were used as a source of manure which improves soil fertility.

“The droppings from bats are used in gardens as manure to improve soil fertility” (FGD 07 – Burondo).

“Manure with the vomits and guano, especially in the gardens with the trees where they roost” (FGD 08 – Harugale)

iv. Tourism: Bats also attract tourists to the areas where they roost, bringing revenue to the country.

“Tourists come also come to see these bats especially the ones in caves” (FGD 05 – Burondo).

“They also attract tourists to come ie the whites have been seen coming to see bats” (FGD 03 – Burondo).

v. Cultural mandates: Some parts of the bat were attached to some culture events in some communities; *“The heart of a big bat is used by women for cultural mandates of pulling” (FGD 04 – Ntandi).*

vi. Feeding on dangerous insects: Bats feed on insects such as mosquitoes and cockroaches which would otherwise cause diseases or destroy property in the house respectively;

“They feed on mosquitoes in the houses which reduces on the risk of getting malaria” (FGD 07 – Harugale)

Table 3: The Medicinal use of bats

Condition	Mode of preparation
Anaemia	a) The bats are captured, killed and the blood collected and given to the sick child to drink. Then it is further cooked, and the meat also given to the child.
Love potion	They kill the bat, burn it and crush it into ash/powder and put in husband's food or tea
Stomach complications	For kids who have stomach complications they burn the mouth and the wings of the bat and smear on the stomach of the child with that problem
Delivery complications	Bats are tied around the wastes of pregnant women to help them during delivery. It's believed that it provides ease of delivery
Manpower	Bats are captured, killed, roasted, and dried, crushed it into ash, then using a razorblade, cut at the back of their husband's back and they start to dig very well.
Boosting brain and immunity	When it eats on the fruit, then you give it to a child to eat it, you cut part of the fruit that is not eaten by the bat, it brings knowledge to the child and does not normally get sick all the time.
Wounds	They also cure wounds when they are burnt into ashes and the ash is smeared on the wound
Boosting walking in children	Bat legs are tied on the legs of children to enhance and speed up walking.

3.1.4.3 Dangers of bats

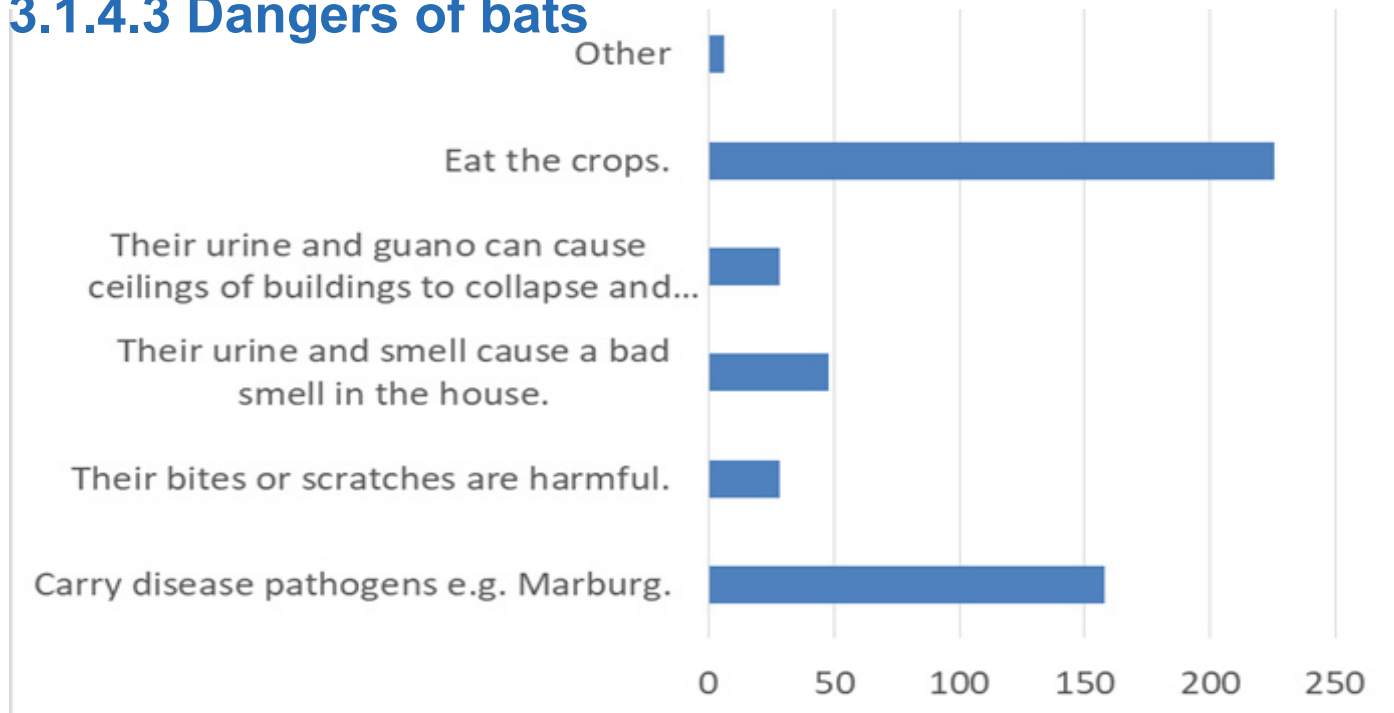


Figure 8. Dangers and disturbances of bats

The three main dangers of bats to humans mentioned by the respondents included consumption of crops, carrying disease pathogens and the bad smell of bats' urine in the house. Other dangers were bites and scratches, destruction to the ceiling, and witchcraft purposes. Noise making at night that was disturbing to families' sleep and rest was also cited.

i. Destruction of fruits: Bats feed on fruits such as mangoes, avocados, guava among others destroying them in the process;

"The bats outside eat and destroy our fruits. You can differentiate a fruit eaten by a bat because of the claws when it's eating the fruits" (FGD 01 – Burondo).

ii. Contamination of water: Bats use the same water sources used by community members to drink water and therefore contaminate water by urinating and defecating in it.

"They contaminate the drinking water (defecate and urinate) even the water in the streams. They normally find bats bathing in the stream" (FGD 05 – Ntandi).

iii. Soiling of clothes: The small bats (locally known as kelibo/kakorokombe) which roosts in the houses urinates or defecates on the clothes and soils them.

"They dirty the clothes inside the house by defecating and urinating on them" (FGD 03 – Burondo).

"When they urinate on the clothes, the stains cannot be washed off" (FGD 06 – Harugale).

iv. Noise: Bats also make a lot of noise which makes people uncomfortable "Bats keep shouting and making noise in the house and disrupt

us from sleeping comfortably" (FGD 02 – Burondo).

v. Witchcraft: Bats are used by witchdoctors to send charms to people or collect their hair and nails to use for witchcraft activities;

"Witches use them so they take things from the houses like they take the houses like they take clothes, nails, hair and I witnessed it when they once cut a bat and found those items in its stomach" (FGD 06 – Ntandi).

vi. Destruction of houses: Bats destroy ceilings of the houses where they roost "they destroy our ceilings when they stay there for long. Their urine can destroy any type of ceiling and we pay for repairs" (FGD 02 – Burondo).

vii. Transmission of diseases: Bats were associated with transmission of diseases such as ebola and Marburg;

"Bats carry diseases to people such as ebola" (FGD 02 – Harugale).

"We were told that if you eat a fruit which a bat has eaten on you can get Marburg" (FGD 08 – Ntandi).

"When there was an outbreak of ebola, we heard that people who had eaten bat were the one who brought it" (FGD 07 – Burondo).

3.1.5 Handling Mechanisms

a) Handling of dead bats

Community members mentioned various ways they use to dispose of dead bats from their homes and communities. These included throwing it in the toilet using a pair of tongs, polythene bags or leaves. Others mentioned burying it in the bush and burning it with fire while others just throw it in the bush.

“Sometimes when I don’t have gloves, I use polythene bag like kavera and pick it and throw it in the pit latrine” (FGD 02 – Burondo).

“Sometimes for keribos, they hit the wall and die and if we find the dead bat, we dig and bury it. Sometimes we throw it in the bush using leaves” (FGD 01 – Ntandi).

“Using a pair of tongs and throwing it on the bush” (FGD 07 – Harugale).

“I get fire and burn it from where it is. If it is in the house, I first sweep it out of the house” (FGD 05 – Burondo).

“I use gloves/polyethene to dispose off from the houses and throw in the toilets” (FGD 03 – Ntandi).

“You can use a hoe to dig a pit and bury the bats. A stick can be used to throw it away to rubbish when found dead in the house” (FGD 02 – Harugale).

b) Measures to chase bats from houses
Using light: Community members explained that bats like darkness and to chase them away they use light such as lamps, solar light and candles; Bats don’t want light, so when the house allows in a lot of light, they fear to enter inside” (FGD 06 – Burondo).

“We put lights on when it enters the house. We have solar and bats hate light. But others use lamps and candles” (FGD 08 – Ntandi).

“Putting lights like electricity and solar bulbs or transparent iron sheets since they do’t like light” (FGD 04 – Harugale).

Physical beating: Physical beating with sticks was another measure employed by the community members to chase bats away from their homes; “I beat them with a stick and kill them” (FGD 01 – Burondo).

“I use a broom to beat it” (FGD 07 – Ntandi).
Pruning: Bats like roosting in the banana and cocoa leaves and therefore community members use pruning as a measure to chase them away since it reduces the leaves on the plantations; “I also prune my banana leaves to reduce on the darkness so that they can run away due to light” (FGD 02 – Burondo).

Spraying: Spraying their roosting area with chemicals such as insecticides which kills them; “I have also ever chased them using insecticides through spraying” (FGD 04 – Harugale).

“Spraying with some chemicals to the places where they are hanging” (FGD 07 – Ntandi).

Using smoke: Using smoke from burnt leaves was another method used to chase bats away since they hate smoke; “Application of burns to create smoke which chases them away” (FGD 04 – Ntandi).
“Use of smoking materials like the mosquito burns” (FGD 03 – Burondo).

Closing early: Bats like entering in the houses in the evenings when it is getting dark and therefore closing doors and windows early was a mechanism applied to chase them away;

“The only way we can chase bats from house is by closing all the doors and windows early in the evening to avoid it from entering” (FGD 01 – Ntandi).

Using wire mesh; Bats also enter houses through ventilators with big holes and therefore to prevent them from entering, they put wire mesh around the ventilators from which they cannot pass; “Sometimes we used nets in the ventilators to stop bats from entering the house. I have also heard of plants people plant around homes to chase away bats from homes” (FGD 05 – Burondo).

Using natural bat repellants such as rosemary flower: It was revealed that some flowers such as rosemary repel bats and therefore, they plant them in their compounds; *“Planting a rose Mary tree in the compound near the house so it chases them away because of the smell” (FGD 08 – Harugale).*

3.1.6 Risky practices

3.1.6.1 Risks through food and water

Exploring path ways through which humans interact indirectly with bats was based on food and water. In this study, it was revealed that the main source of water was taps (piped water). This water is often sourced from mountains (specifically mountain Rwenzori) and transported by

gravity to respective destinations/homes. Next to taps was pond/stream, which included stagnant or flowing water from the iced highlands of mountain Rwenzori. This water is often colder than the surrounding temperatures downstream since it is released by melting ice. Unprotected wells and spring water contributed more than borehole and protected. The chance of spillover is higher in Bundibugyo due to extensive use of pond/stream, unprotected stream waters, which are often shared with bats as presented by the second variable in table 3 below. It should also be noted that from the table 3 that most households (54%) did not do anything to water to make it safe for drinking ie, the members reported drinking unboiled, untreated water. It was further revealed that about 12% of the respondents were engaged in open defecation.

Table 4: Food and water exposure

<i>What is the main source of drinking water for members of your household</i>	<i>Borehole</i>	9 (2.9%)
	<i>Piped</i>	166 (53%)
	<i>Pond/stream</i>	77 (25%)
	<i>Protected well</i>	12 (3.8%)
	<i>Rainwater</i>	1 (0.3%)
	<i>Unprotected well</i>	24 (7.7%)
	<i>Water from spring</i>	24 (7.7%)
<i>Do animals have access to this water source</i>	<i>Yes</i>	118 (38%)
<i>Do you do anything to the water to make it safer to drink</i>	<i>Don't know</i>	4 (1%)
	<i>No</i>	169 (54%)
	<i>Yes</i>	140 (45%)
<i>If yes, what do you usually do to make water safer to drink/</i>	<i>Boil</i>	116 (82%)
	<i>Add bleach/chlorine</i>	19 (13%)
	<i>Leave it to stand and settle</i>	16 (11%)
	<i>Use water filter</i>	7 (4.9%)
<i>What kind of toilet facility do members of your household usually use? (Please observe)</i>	<i>Open pit</i>	39 (12%)
	<i>Pit latrine</i>	267 (85%)

	Ventilated pit latrine (VIP)	7 (2.2%)
Do you cover your drinking water in the equipment listed above?	Yes	251 (80%)
How do you store your cooked food	Covered in container	299 (96%)
	Refrigerated	0 (0%)
	Open containers/ saucepans	10 (3.2%)
How do you store your uncooked food	Covered in containers/ saucepans	52 (17%)
	Refrigerated	0 (0%)
	Open containers/ saucepans	153 (49%)
	Other	117 (37%)

Regarding both cooked and uncooked food storage, there was zero use of refrigeration, and the most common method was covering in containers and open containers for cooked and uncooked food respectively. Since bats reside in the house roofs, this could expose uncooked food to bats, which increases spill over. Furthermore, about 3.2% of the households kept cooked food in open containers. This exposes food to not only bats in the houses, but also other germ carrying insects like housefly, fruit fly, as well as dust.

3.1.6.2 Direct human exposure to bats

From 313 households surveyed, bats were often observed in about 36% of them. About 1.5% of the respondents revealed that children in their households played or touched bats. These are potential pathways for spillover of pathogens from bats to human and vice versa. Further details are presented in table 5 below.

Table 5: Direct human exposure to bats

Variable	Characteristic	N = 3141
Do you sometimes observe bats in your house	Yes	112 (36%)
Do children in your household touch and/or play with bats?	Yes	4 (1.3%)
Do you feel it is safe for children to be around bats?	Yes	19 (6.1%)
Have you seen bats inside any of the schools in this community	Yes	114 (36%)
Have you heard that there are bats at any of the schools in this community	Yes	155 (50%)
Are you aware of bats roosting in the churches in your community	Yes	165(52.7%)
Does the presence of bats in church worry you about your safety and that of others	Yes	99 (32%)
Have you been exposed to bats directly through;		
Bat bites	Yes	15 (4.8%)
Bat scratches	Yes	23 (7.3%)
Slaughtering of bats	Yes	8 (2.6%)

<i>Eating bat meat</i>	Yes	7 (2.2%)
<i>Collection of dead bats</i>	Yes	24 (7.7%)
<i>Preparing</i>	Yes	38 (12%)
<i>Do you know of any trade in live bats and or bat meat in this area?</i>	Yes	10 (3.2%)
<i>Who are the buyers of these live bats or bat meat</i>	Communities in Congo	7 (70%)
	Community here	1 (10%)
	Traditional medicine people	5 (50%)
	Cultural leaders for rituals	4 (40%)

From the 112 people who observed bats in their households, only 58 (51.3%) had tried to devise means to chase the bats away as presented in table 6.

Table 6: Measures to chase away bats

<i>Have you in the past tried any measures to keep bats out of the house?</i>	Yes	58 (51%)
<i>What measures have you used to keep bats out of the house</i>	Lights in the ceiling	5 (8.5%)
	Materials eg thorns	3 (5.1%)
	Plugging up holes	2 (3.4%)
	Smoke	3 (5.1%)
	Use brooms	42 (71%)
<i>Have these measures been successful?</i>	Never	6 (9.8%)
	Partially	33 (54%)
	Yes	22 (36%)

3.1.6.3 Number of households who share accommodation with animals

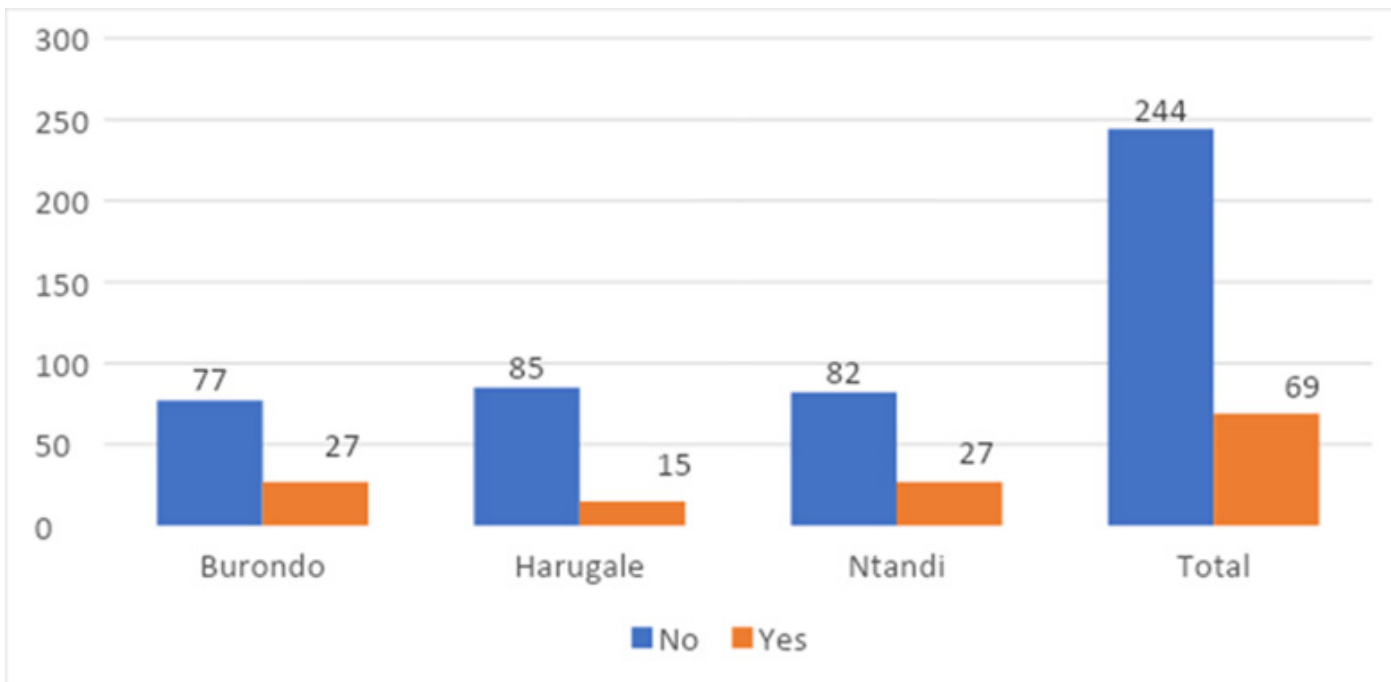


Figure 9: Number of people who share accommodations with animals

A good proportion of households (22%) reported that they share accommodation with animals. This was reported more in Ntandi (27/109) and Burondo (27/104). There were fewer cases in Harugale (15/100). Animals sharing accommodations with the household were mainly goats, pigs and sheep, as well as chickens and ducks. The reasons for sharing accommodation were however not explored.

3.1.7 Presence of Bats in the community

When survey respondents were asked if they have seen bats in the community, a significant proportion of the respondents (112/313) reported having seen bats around their homes and plantations. Bat presences were more reported in Ntandi (46/313) and Burondo (40/313). There were fewer reported cases in Harugale as shown in Figure 10.

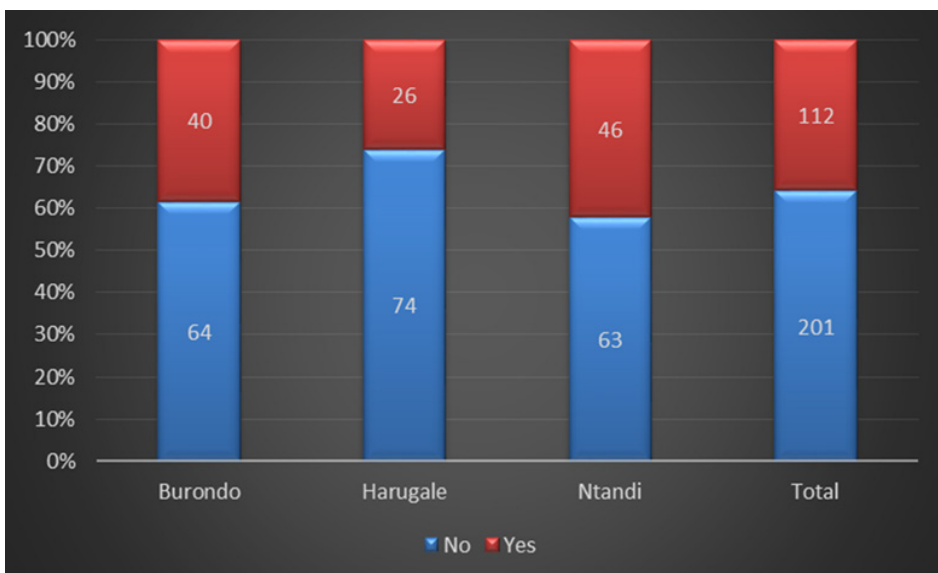


Figure 10: Presence of bats in the community (as reported by respondents in household survey)

Results presented in Figure 11 indicated that the disturbances caused by bats noise, eating food stuff, entering their beds and making them uncomfortable, they forked a habitant in the ceiling, Beliefs that are sent by other people spirituality, Bats play on top of her iron sheets, destroy fruits and food, bad smell and its excreta. The noise was mainly reported at night when people are supposed to rest.

Despite all these disturbances, some community members reported that they feel comfortable living with bats due to the following reasons:

- Bats come and go without harming anyone
- Bats eat mosquitoes
- Bats are used for rituals
- They have lived with bats for a long time

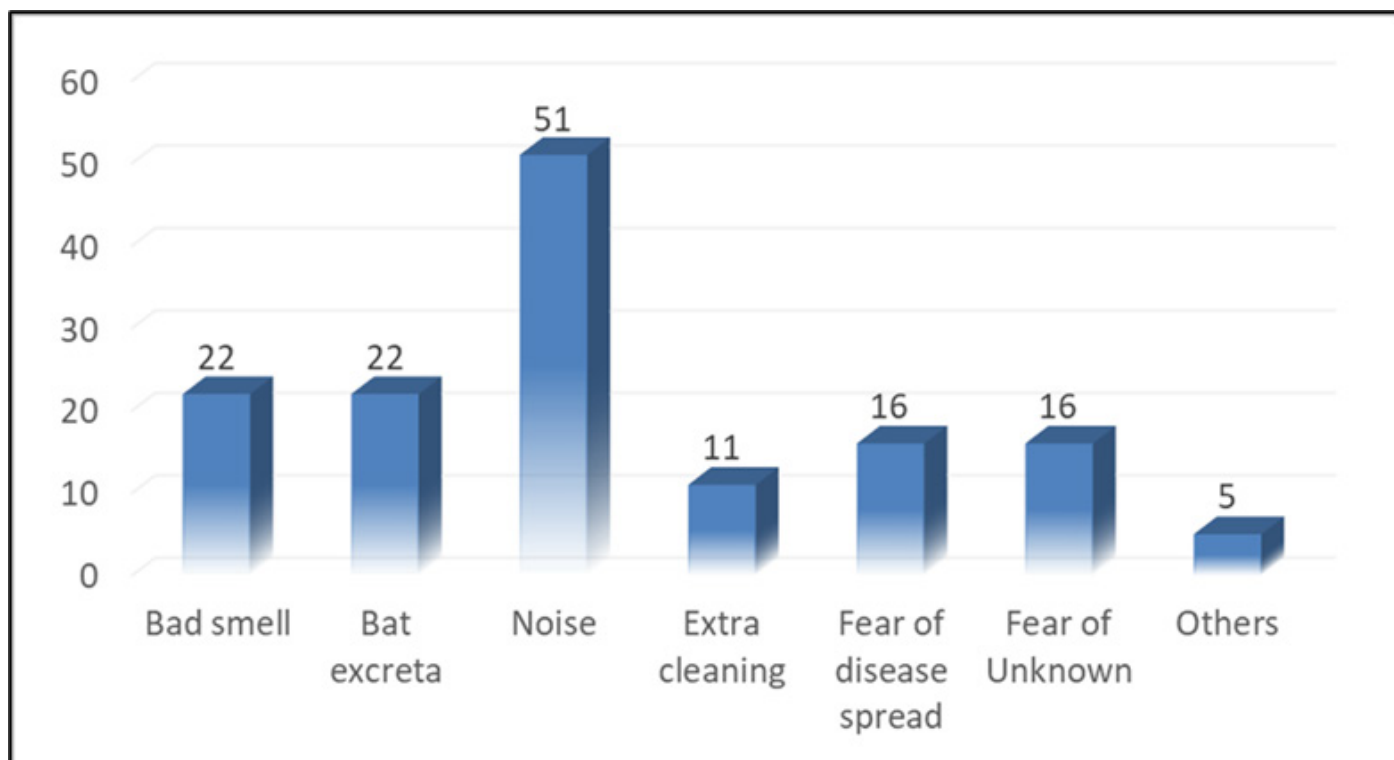


Figure 11: Disturbances caused by bats

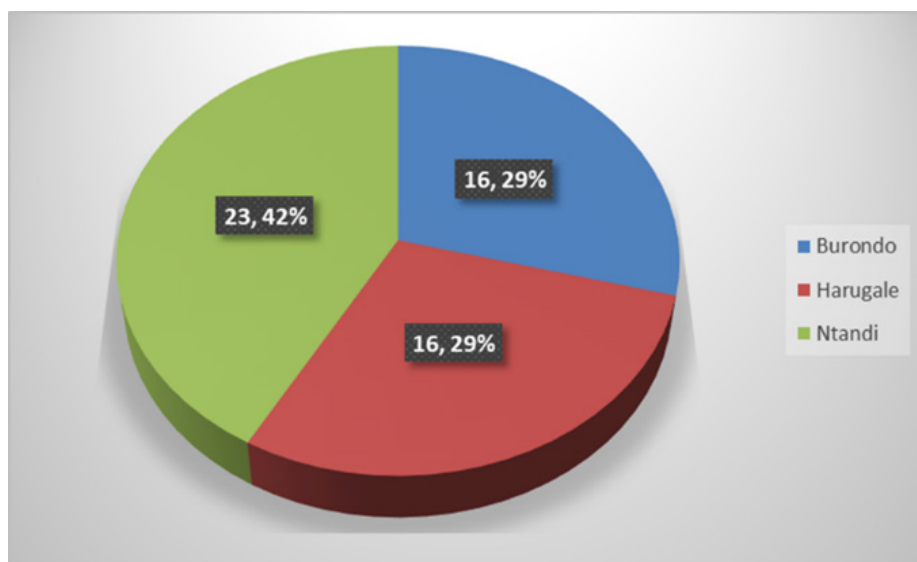


Figure 12: The success of effort to send bats away from the building.

When asked about efforts to keep bats out of their houses, the success rates were higher in Ntandi (42%) as compared to the other two sub counties. During the survey, very few participants (4/313) mentioned that children play with bats. However, when we asked them whether they feel children are safe when playing with bats, the majority of the respondents indicated that it was not safe for children to play with bats (294/313).

Table 7: Areas where the population interact with bats.

<i>Areas of interactions</i>	<i>Counts</i>
<i>National Park during firewood collection</i>	<i>109</i>
<i>National Park during collection of herbs</i>	<i>35</i>
<i>National Park during hunting of other game meats</i>	<i>11</i>
<i>National Park during cave activities</i>	<i>12</i>
<i>At School</i>	<i>90</i>
<i>At church</i>	<i>87</i>
<i>Water sources</i>	<i>48</i>
<i>Gardens and plantation</i>	<i>201</i>
<i>Other</i>	<i>3</i>

Results presented here showed that members of the community interact more with bats when they are in the gardens on plantations, national parks during firewood collections, at schools and churches as presented in Table 7 above.

Sources of information on bats

Community members who had received information about the dangers of bats to humans obtained the information primarily from radio (143/313), as well as from health workers (92/313) and VHTs (79/313). Very few survey respondents reported receiving information through television, social media, hunters, friends, or relatives. We also observed communication through schools, books, community leaders (LC1), NGOs, newspapers, churches, family members, herbalists, elders, and posters.

SECTION FOUR: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Discussion

Based on the results of the study, it is evident that the community members have extensive knowledge about bats, including the different species, their habitats, and the factors that attract them to the communities. This knowledge is rooted in their experiences, with many stating that they have lived with bats for as long as they can remember. The study also revealed that the two most common species of bats in the communities are the big brown or black bats (fruit/frugivorous/mega bats) and the small black bats (insectivorous/microbats), locally known as Omulema and “akakorokombe” /kelibo, respectively. “Omulima” brown or black in colour, have a dog like face, big wings with umbrella like shape, big eyes and sharp teeth, and feed on crops and fruits. These are mainly found hanging upside down in trees. The small bats commonly termed as “akakorokombe” that are black and small in size, nostrils short with split lips, produce rat like sounds, live in dark places and feed on insects like mosquitoes, and are mainly found in houses.

Regarding the factors that attract bats to the communities, the study found that fruit bats are attracted to areas with an abundance of food such as fruit trees like mangoes, guavas, and bananas, while insectivorous bats are attracted by insects, including mosquitoes. They also seek shelter in caves, culverts, and buildings, especially in the ceilings of houses, schools, and churches. The community members explained that bats are attracted to these areas because they offer them shelter and darkness, which is ideal for

their survival.

The study also found that the community members have mixed feelings about bats, with some perceiving them as beneficial due to their role in controlling insect populations, especially mosquitoes, while others view them as a nuisance due to their noise, bad smell, and droppings. Despite the mixed feelings, it was evident that the community members were not fully aware of the risks posed by bats, including the potential for zoonotic disease spillover. The motivations for bat-human interactions varied, with some community members engaging with bats for cultural and medicinal purposes, or a protein source, while others did so for commercial gain, such as selling bat guano as fertilizer. Barriers to bat-human interactions included fear of bats, and negative perceptions about bats.

Community uses of bats and bat products varied across the three sub-counties. Some community members use bats for food, traditional medicine, and as a source of income through the sale of bat guano used as fertilizers in gardens. Others viewed bats as a cultural symbol, with bat-related stories and myths being an integral part of their cultural heritage. The study employed a methodology of community engagement, which involved focus group discussions with community members. The study’s results revealed that community engagement is a vital component in studying human-bat interactions and that involving community members in the data collection process can improve the accuracy and reliability of the data collected. The study

also revealed that socio-cultural, economic, behavioral, and gender-based risk factors in the community contribute to the potential for spillover of zoonotic diseases from bats. These factors include poor housing conditions, hunting and consumption of bats, lack of awareness about zoonotic diseases, poor animal husbandry practices like sharing the same house with animals and gender-based differences in use of bats in traditional medicine and exposure to bats.

The findings of the study are consistent with previous research findings that found that human-animal interaction, lack of knowledge about zoonotic diseases, and improper animal husbandry techniques, such as improper sanitation and vaccination are the key drivers of zoonotic disease transmission (Torgerson et al., 2015; Woldehanna et al., 2018; Adeola et al., 2019; Huang et al., 2019). and in the current study, poor housing condition close interactions with bats particularly in agricultural field were potential risk factors that could trigger spillover of pathogens from bats to humans.

To our findings, many households visited during the field visit were unaware of the risks associated with human-animal interaction. This lack of knowledge together with the recognized poor animal husbandry practices, improper sanitation and low household income leading to minimal or no vaccination increases the risk of zoonotic disease transmission.

In conclusion, the findings of this study highlight the importance of addressing the risk factors associated with human-animal interaction in the target sub-counties of Bundibugyo District, and beyond. Poor housing conditions, lack of knowledge about zoonotic diseases, and poor animal husbandry practices were all identified

as key risk factors for zoonotic disease transmission. In addition, household income size was found to be a significant predictor of human-animal interaction. Addressing these risk factors will require a multi-faceted approach, including education and awareness campaigns, improved animal husbandry practices, and support for households with lower incomes.

4.2 Conclusion

The study highlights the importance of understanding local knowledge, beliefs, and practices related to bats in the context of zoonotic disease spillover. The results underscore the need for targeted education and awareness-raising campaigns to improve community understanding of the risks posed by bats and the importance of taking measures to prevent zoonotic disease spillover. It is also essential to explore sustainable alternatives to the use of bats and bat products, including promoting alternative sources of protein and income, such as mushroom, bee keeping, livestock farming among others for the communities involved in bat-related economic activities.

Additionally, the key identified risk factors of zoonotic disease transmission, namely, lack of knowledge about zoonotic diseases, and improper animal husbandry techniques, such as improper sanitation and vaccination, poor household income among other public health related challenges need to be addressed through One Health Approach. Study found that there is a correlation between household income level and the risk of zoonotic disease transmission, where households with lower income levels are engaged in high-risk behaviors, such as consuming bushmeat and inadequate waste disposal practices. This underscores the importance of addressing poverty as a public health

initiative aimed at reducing the prevalence of zoonotic diseases. It is therefore imperative enough to conclude that:

1. Bats are well-known and commonly found in the communities studied, and people have lived with them for a very long time.
2. Two types of bats, the big brown or black (fruit/frugivorous/mega-) bats and the small black (insectivorous/ micro-) bats, locally known as Omulema and “akakorokombe” /kelibo, respectively were identified across all the FGDs in the study areas.
3. Bats have different habitats in the communities, including banana plantations, mango trees, caves/ stones/culverts, cocoa plantations, houses, church ceilings, and school ceilings.
4. Community members mentioned various factors that attract bats to the places where they live, including comfort, feeding on mosquitoes and cockroaches, darkness in the ceilings, and availability of fruits and bananas in trees and plantations.
5. The community members have different uses of bats and their products, including medicinal use, food, cultural use, income generation, and spiritual use.

4.3 Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Increase knowledge and awareness of zoonotic diseases: Health education campaigns should be conducted in the target sub-counties to increase knowledge and awareness of zoonotic diseases. This will help to promote safe practices and reduce the risk of disease transmission.
2. Strengthen veterinary services: The government should provide adequate resources to support veterinary

services in the area. This will help to improve animal health and reduce the risk of disease transmission.

3. Address poverty: Poverty alleviation measures should be implemented in the target sub-counties. This will help to reduce the prevalence of high-risk behaviors, such as consuming bushmeat and inadequate waste disposal practices.
4. Collaboration and multisectoral approach: It is important to have collaboration between the health, agriculture and environment sectors to address the issue of zoonotic diseases. This will ensure that all relevant stakeholders are involved in the process and will lead to more effective strategies to reduce the risk of disease transmission.
5. There is a need for awareness creation about bats in the communities to help people appreciate their ecological and economic importance, dispel myths and misconceptions, and reduce fear and negative attitudes towards bats.
6. There is a need to educate the community on the potential risks of human-bat interactions, especially the risk of disease transmission, and promote safe practices such as avoiding direct contact with bats and their droppings and using protective gear when handling bats.
7. There is a need to strengthen community-based surveillance and reporting mechanisms for emerging infectious diseases and zoonotic diseases in collaboration with the local health authorities and the wildlife conservation agencies.
8. There is a need for research on the potential of bats and their products for sustainable economic development and alternative livelihoods, including eco-tourism, guano collection, and bat conservation.

9. There is a need to promote gender-sensitive approaches to human-bat interactions, recognizing the different roles and responsibilities of men and women in the use and management of bats and their products and involving women in conservation and livelihood activities.

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