The danger of free roaming dogs in urban settings: A report of two suspected rabid dogs on rampage that inflicted 47 bites to people and domestic animals in peri-urban Uganda

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Research Article

Keywords: Roaming dogs, Dog bites, Rabies, Rabies Post exposure prophylaxis, peri-urban Uganda

Posted Date: October 10th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3399200/v1

Abstract

Background

Human rabies cases associated with bites from rabid roaming dogs are prevalent in Uganda. Unfortunately, there is limited documentation of the circumstances surrounding those bites. Here, we documented dog attacks to humans and animals in two peri-urban areas in Central Uganda.

Methods

We responded to alerts of two suspected rabid dogs on rampage. We traced the dogs responsible for the attacks to diagnose the cause of the aggression and we interviewed the victims and community members to determine the circumstances of the bites and health care sought by the victims. We scheduled follow-up visits after 40 days, to assess compliance of the victims to rabies postexposure prophylaxis (PEP) and to document any challenges encountered in the process.

Results

The two rabid dogs inflicted 47 recorded attacks to 29 humans, mostly children (75.8%) and 18 domestic animals in Matugga and Mawale parishes in Wakiso and Luweero districts, respectively. Two individuals washed the wound with water and 7 individuals reported to the health facility for treatment in accordance with the WHO-guidelines for preclinical management of bites from suspected rabies cases. By contrast, 17 individuals sought treatment from a traditional healer while 5 individuals self-medicated with herbs at home. We advised those individuals to visit health facilities for proper medical care. All the victims started rabies PEP treatment; however, 2 individuals did not complete their prescription. Although rabies PEP at public health facilities was free, regularly the victims paid 3–5 USD to the clinician as an incentive while the cost at private health facilities was 13–15 USD for a single dose. Due to the unprovoked attacks, the victims and local leaders advocated for elimination of roaming dogs, but the roaming dog owners objected.

Conclusions

Overall, our results demonstrate the outsized impact that a single-rabid dog can have on a community. They also reveal how poverty, knowledge gaps, community trust in traditional healers, and barriers to healthcare access negatively affect medical care given to dog bite victims in this setting. Educational campaigns and control of roaming dogs should help improve the situation in Central Uganda, as well as in other socioeconomically similar settings.

INTRODUCTION

Roaming dogs exist in high numbers in many countries across the world, posing health and socioeconomic challenges (1–4). Of the one billion dogs estimated to be present in the world, 75% are roaming (5). Such dogs inhabit underdeveloped countries and densely populated urban centers (i.e., “slums”) (6, 7) because of factors such as poor garbage management, limited infrastructure, and unrestrictive dog ownership practices (8). In Uganda, a population of 729,486 domestic dogs was documented in 2013 (9), however, the exact number of roaming dogs remains unknown.

Roaming dogs regularly interact with livestock, wildlife, and people, often with negative consequences (10, 11). These dogs can attack, injure, or kill people and livestock, causing distress to the communities they inhabit (6, 12, 13). Statistics from the national animal disease surveillance system in Uganda reported 8,240 dog bites from 2013–2017 (12). Data collected from human health facilities in Uganda from 2001–2015 reported 208,720 animal bite cases, of which 57,252 (27.4%) occurred in Central Uganda (14).

Rabies is a fatal zoonotic disease transmitted through contact with saliva or brain material from an infected animal or human (15–18). Although several animal species can transmit rabies, dogs are the most reported vector in sub-Saharan Africa (18, 19). Globally, rabies accounts for 59,000 deaths per year, most of which are reported in underdeveloped countries. Some countries, such as Japan, Australia, and New Zealand, are considered rabies-free. In Africa, where rabies claims at least 25,000 lives per year, none of the countries are rabies-free (16). In Uganda, rabies remains endemic, and claims over 486 human lives annually (14). Since dogs play a significant role in rabies transmission, their control is crucial for the success of the global strategy by the World Health Organisation (WHO), World Organisation for Animal Health (WOAH), Food and Agriculture Organisation of the United Nations (FAO) and Global Alliance for Rabies Control (GARC) to end human dog-mediated rabies deaths by 2030 (20).

Historically, efforts to control rabies in Uganda have focused on vaccination of owned dogs (9, 21) and understanding the knowledge and attitudes on rabies (22, 23) and the health-seeking behaviours of dog bite victims (16). In contrast, relatively little is known about the circumstances resulting in dog bites. Here, we provide an account of 47 dog bites inflicted by two roaming dogs in two distinct locations in Central Uganda. We further document the effects of a single roaming dog on a community, including beliefs and behaviours regarding disease risk and health care.

METHODS

Study design and sites

This was an exploratory case study that used qualitative methods to study circumstances involving rampage dog attacks that occurred in two distinct locations of Matugga and Mawale parishes in districts of Wakiso and Luweero, Central Uganda, respectively in the month of January 2023 (Fig. 1). Briefly, on January 6, 2023, we received communication on WhatsApp social media platform from a resident of Matugga that a violent dog was attacking people in the neighbourhood. We assembled a team, dog

catchers, immobilising drugs, and protective gear and set off to Matugga. On January 21, 2023, we received a phone call from a resident of Mawale who had sustained a dog bite from a roaming dog that was attacking other members of the community. Similarly, we dispatched a team immediately to manage and investigate the case. Matugga and Mawale are approximately 20–30 km north of Kampala, the capital city of Uganda, and 25–30 km from each other.

Figure 1. The location of the dog bites in Matugga and Mawale parishes and respective Wakiso and Luweero districts

Data collection

We visited the two parishes and utilized a multipronged approach: (1) ensure the bite victims receive proper treatment, (2) locate and immobilise the dogs on rampage to confirm or rule out rabies, and (3) obtain community attitudes on roaming dogs.

Bite victims

We visited the home of each dog bite victim to administer an interview and determine the extent of the dog bite injuries and health care pursued, with specific attention to Word Health Organisation (WHO) preclinical guidelines on the management of dog bites for suspected rabies cases. The WHO guide states that a dog bite victim should wash the fresh wound with running water and disinfectant/soap for 15 minutes and then rush to the medical health facility for rabies post exposure prophylaxis (PEP) within 24 hours (24, 25). The interviews were performed following a set of guiding questions. In cases involving minors, their parents were interviewed.

We categorised the dog bite injuries into three forms of exposure to rabies, according to the WHO guidelines (26). Category I involves contact between saliva and intact skin, Category II involves minor scratches or abrasions of the skin without bleeding, and Category III involves single or multiple transdermal bites accompanied by bleeding (27).

We encouraged the dog bite victims to obtain rabies PEP since the dogs involved had shown aggressive behaviour associated with rabies virus infection (28) and the vaccination, ownership, and the health status of the dogs were unknown. We conducted a follow-up visit 40 days later to document compliance with the rabies PEP regimen and the costs and challenges encountered by the dog bite victims.

We conducted key informant interviews with the local leaders, veterinary officers, community health workers, and community members to obtain opinion about the circumstances of the bite and post-bite practices. A total of 49 interviews were conducted with 29 dog bite victims, 10 community members, 5 local leaders, 2 health care workers, and 3 veterinary officers.

Rampaging dogs

We worked with the local leaders to locate the suspected rabid dogs with the intention of immobilisation to prevent further attacks and establishing the cause of the aggression. By the time our team arrived at

the alert areas, the dog in Mawale had been traced, killed by the community, and disposed in the bush. We were unable to locate the rampaging dog in Matugga. From the account of the community members who had mobilised and pursued the dog, it may have been injured in the process and died hiding in the bushes.

Confirmatory diagnosis for rabies

We recovered the carcass of the rampaging dog in Mawale from the bush and conducted a brain extraction and histopathology at the Central Diagnostic Laboratory at Makerere University. We performed the fluorescent antibody test (FAT) for rabies diagnosis on a brain sample from the Mawale dog at the National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) in Entebbe. The FAT was performed with minor modifications as described previously (29). Briefly, a thin impression smear was made on a glass slide, flooded with 100% cold acetone (recovered from – 20^0C) and left to stand for 30 minutes. A drop of conjugate was added to the slide and incubated in a moisturised chamber at 37^0C for 30 minutes. The slide was washed with PBS and a drop of 20% glycerol was added followed by a cover slip. The slide was viewed under a fluorescence microscope. We used reference positive and negative controls archived at NADDEC.

Data management and analysis

Quantitative data such as the age and number of dog bite victims per household were entered into Microsoft Excel. The recordings of the interviews were transcribed manually. NVivo 11.4.1 software was used deductively to code the transcripts and to generate key themes.

RESULTS

Overall, the two dogs caused 47 attacks, 37 in Matugga and 10 in Mawale districts. Of the total attacks, 29 were against humans and 18 were against animals that included goats (6/18), domestic dogs (6/18), cattle (2/18), a sheep (1/16), pigs (2/16) and a duck (Fig. 2). The attacks in Matugga district occurred in three successive days, while those in Mawale occurred in one day.

Figure 2. The injuries inflicted on humans and domestic animals

The behaviour of the dogs

The dog bite victims from both Matugga and Mawale described that the dogs ran restlessly and attacked anything human or animal in their paths without being provoked.

“I was walking to my home; the dog ran from the bush and attacked me. I fought it, and it ran away. Shortly, it attacked another lady who was nearby. That lady was carrying her child, because of the attack, she fell to the ground and dropped the child, the dog also attacked the child.” (Woman, dog bite victim, Matugga)

Laboratory diagnosis for rabies

Histopathological examination of the brain revealed moderate to marked foci of perivascular cuffing by mononuclear inflammatory cells but no significant lesion in the neurons. Morphologically, the lesions were severe non-suppurative encephalitis, suggesting virus-induced encephalitis. The fluorescent antibody test confirmed the presence of rabies in the brain sample (Fig. 3).

Figure 3. Micrographs of histopathology and fluorescent antibody test for rabies diagnosis

The dog bite victims

Twenty-nine individuals were bitten by the rabid dogs (Table 1). Of these, 75.9% (22/29) were children aged 1–11 years. The rest were women aged 32–49 years and a 72-year-old man. The overwhelming majority of dog-bite victims (27/29; 93.1%) sustained category III injuries to various parts of the body. The bites were single (26/29; 89.7%) and multiple (3/29; 10.3%), sustained on the arms and hands (14/29; 48.3%), legs and feet (6/29; 20.7%), trunk (8/29; 27.6%) and head (3/29; 10.3%).

Table 1
The dog-bite victims, category of exposure and health care

ID	Age category, sex	Category of rabies exposure[a], anatomical site	Healthcare interventions sought	
			Primary	Secondary
1	Child, male	III, hand	Traditional healer	
2	Woman	II, back	Wound cleaned with water and soap, stayed home	
3	Child, female	III, thigh	Traditional healer	Private health facility
4	Woman (mother to #3)	III, arm	Traditional healer	
5	Child, male	III, hand	Traditional healer	
6	Child, female	III, arm	Wound cleaned with water and soap, traditional healer	
7	Child, female	III, shoulder	Wrapped wound with cloth, Private health facility	
8	Child, male	III, back	Traditional healer	
9	Man	III, foot	Traditional healer	
10	Child, female	III, hand	Self-medicated with herbs	
11	Child, female	III, shoulder	Self-medicated with herbs	
12	Child, female	III, hand	Public health facility	
13	Child, female	III, head	Traditional healer	Private health facility
14	Child, female	III, shoulder	Self-medicated with herbs	
15	Woman (mother to #16)	III, thigh and hand	Public health facility	
16	Child, female	III, head	Public health facility	
17	Child, male	III, knee	Traditional healer	
18	Child, male	III, both hands	Traditional healer	Public health facility
19	Child, male	III, arm	Traditional healer	Public health facility

ID	Age category, sex	Category of rabies exposure[a], anatomical site	Healthcare interventions sought	
			Primary	Secondary
20	Child, male	III, hand	Traditional healer	
21	Child, female	III, shoulder	Traditional healer	Public health facility
22	Woman	III, thigh	Public health facility	
23	Child, female	III, shoulder	Traditional healer	
24	Woman	III, hands and thigh	Traditional healer	Public health facility
25	Child, male	III, arm	Self-medicated with herbs	
26	Woman	III, trunk	Private health facility	
27	Child, male	III, arm	Traditional healer	Public health facility
28	Child, female	II, trunk	Traditional healer	
29	Child, female	III, head	Public health facility	

Circumstances of dog bites

At the time of the attack, 72.4% (21/29) of the dog-bite victims were either playing or doing household chores in the vicinity of their home, while two women, a child, and an elderly man were attacked on the street. In one scenario, the mother took action to defend her child by confronting the dog, which led to her sustaining a bite in the process.

Compliance with WHO guidelines for preclinical management of animal bites

None of the dog bite victims fulfilled the preclinical guidelines for dog bite cases as recommended by the WHO. Only 6.9% (2/29) of the dog bite victims washed the wound with water and soap after sustaining the dog bite. The most common healthcare intervention sought was a traditional healer (17/29; 58.6%). Fourteen of the 29 individuals (48.3%) sought healthcare from a health facility, while the remainder (5/29; 17.3%) applied herbs at home. Seven individuals sought multiple types of health interventions. We encouraged individuals to seek health care and rabies PEP from reliable health facilities. However, compliance with the rabies PEP regimen was on their own accord. Most individuals were amenable to the advice offered, but we encountered the following challenges.

1. Lack of money for transportation to the hospital

Six individuals reported that they were unable to afford the cost of transportation to the hospital. We worked with local leaders to organise subsidised transportation to a public health facility.

2. Hesitancy among dog bite victims in seeking medical assistance from public health facilities

We encouraged the dog bite victims to utilise the free rabies PEP services at public health care facilities (23), but some of the individuals complained.

"I don't want to go to public health facilities; the doctors there give less attention to people seeking free healthcare services." (Woman, dog-bite victim, Matugga)

3. Most individuals received treatment from the traditional healer

The individuals reported that they paid 40–65 USD to obtain black stone treatment for the dog bite. When asked why they did not seek medical care from the hospital, they responded.

"*I was advised by other members in the community to get treatment from the traditional healer in Kagoma. The 'doctor' has been treating people bitten by snakes and dogs for over 20 years.*" (Woman, dog bite victim, Mawale)

Access to and compliance with rabies post exposure prophylaxis

The dog bite victims in this report received a 3- or 5-rabies PEP injection series at irregular intervals from public or private health facilities. Four individuals utilised the private health facilities while the rest went to public health facilities. Overall, 93.1% (27/29) dog bite victims completed the rabies PEP regimen. Two of the dog bite victims from Matugga, a minor and a woman, did not complete the rabies PEP shots prescribed by the health facility. Interestingly, the woman above received only 2 shots herself but continued to take the daughter (also a dog bite victim) for complete rabies PEP. When asked about this, she replied.

"*For me, my wounds had healed, and I did not have a reason to continue with the treatment. However, I continued to take my child because I cannot take a chance with my child's life, but for me, it is ok even if I stop*" (Woman, dog bite victim, Matugga)

The dog bite victims paid 13–15 USD to receive PEP at private health facilities. Those who went to the public health facilities paid 3–5 USD to access rabies PEP, even though rabies PEP is expected to be free at public health facilities. The cost accrued because the attending clinicians asked the dog-bite victims to pay an incentive before receiving the treatment. Often, others were asked to purchase rabies PEP from privately owned pharmacies near the hospital because the public health facilities were out of stock. In some cases, the individuals who could not pay the demanded sum were asked to pair up and cost share.

"*I was informed that the free medicine provided by the government was finished, but the attending clinician said I could pay some money to receive rabies PEP from his own reserve.*" (Woman, dog bite victim, Matugga)

Community reactions towards the rampaging dogs

Following the attack, the community leaders in Mawale mobilised men to chase and kill the rampaging dog. The men successfully killed the dog on first day and dumped it in the bush. According to the local leader, three other dogs that had instigated similar attacks previously were killed in the same manner.

After registering several dog bites in Matugga, the local leaders mobilised men in the community to chase and kill the dog, but they failed to locate it. As a result, the community autonomously conducted an elimination campaign of roaming dogs hitting them with sticks and stones in a mob. The suspected rabid dog in Matugga was presumed to have died in bushes hiding. During the follow-up visits, a community member reported what may have happened to that suspected rabid dog:

"Our bull encountered the dog in the morning of January 8th, 2023, (3:00–4:00 am). We did not come out of the house due to fear. At daybreak, the bull had several injuries but no sight of the dog. A few days later, we investigated a foul smell in the nearby bush to find a small brown dog with multiple bruises and injuries all over its body. We disposed it under the Jirikiti tree." (Woman, owner of the bull, Matugga)

When queried why she did not report the dog to the authority, she replied:

Traditionally, in Buganda, a dead dog is disposed under the Jirikiti tree to avoid curses.

Community attitudes towards roaming dogs

The dog bite victims wanted the roaming dogs removed from the community by any means possible.

"Some members of our community keep up to 10 dogs which they let to roam; such dogs should be poisoned." (Woman, dog bite victim, Matugga)

Some members of the community wanted the unowned roaming dogs poisoned but had reservations since their domestic dogs roamed.

"*I want all those wild roaming dogs poisoned; however, if they do so, my dog may be killed, since it is a roaming dog. It is better for the authorities to inform the community to chain their dogs before applying the poison.*" (Male, community member, Matugga)

According to a local leader, the Wakiso District Veterinary unit conducted mass poisoning of roaming dogs in Matugga in 2020. The local leader informed us that he had requested the veterinary department to conduct another mass poisoning following complaints from the community. In Mawale, a mass rabies vaccination had been conducted more than 3 years ago.

Reported ownership of dogs

The community members reported four categories of dogs:

1. Confined-owned dogs. Community members with a perimeter fence around their homes confined their dogs. The interviewed community members reported that such people were rich and that they kept exotic dogs that were expensive to acquire and maintain.
"*The rich people keep their dogs in the fences, and they care for them…I have never seen an exotic dog roaming…. however, the local dogs that belong to people who do not care for them are the ones that roam and bite us."* (Woman, dog bite victim, Matugga)
2. Roaming dogs with recognised ownership. These were roaming dogs that were seen emerging or residing at a person's home. In this scenario, the community members assumed that the owner of that home owned the dog(s). However, complainants reported that such owners often denied ownership of those dogs after they attacked people or livestock.

"*My goat was attacked and killed by a roaming dog, but when I contacted the alleged owner, he denied ownership of the dog.*" (Woman, community member, Mawale)
3. Roaming dogs with no recognised ownership (feral). The community members reported several dogs that were not owned by any community member. An example was given for a pack of 5–10 dogs that were resident at a nearby cemetery.

4. Community dogs. Some dogs were identified as community dogs because they were known and cared for by many, but no one claimed absolute ownership.
"*That dog (a.k.a. Danger) has been living in Kiryagonja town for many years. We do not know where it came from, but the people in the town give it food… it is a very peaceful dog.*" (Man, community member, Matugga)

DISCUSSION

In this report, 29 people and 18 animals received bites from two rabid dogs in Matugga and Mawale parishes in Wakiso and Luweero districts in Central Uganda, respectively. The incident in Matugga records the highest number of successive dog bites inflicted by a single rabid dog, and the situation in Mawale could have been similar if the dog had not been killed by the community. The rampage dog in Matugga caused more bites for several possible reasons. Firstly, they were inexperienced handling the rampaging dogs whereas the community in Mawale had an intervention plan to kill rampage dogs, because of previous encounters. Secondly, Matugga is an urbanised residential area compared to Mawale (Fig. 1), which could have made it easy for the rampage dog to encounter people. This finding emphasises the need to control roaming dogs living in the congested settlements (i.e., slums) in Central Uganda or other similar settings.

The incidents in this report are like the 1942 Los Angeles case, where twenty domestic dogs and one cat sustained attacks from a single rabid dog (30). However, our case differs in that the rabid dog attacked both humans and animals in the community. Most of the victims were children and women, consistent with prior studies from Kenya, Nigeria, Trinidad and Tobago, and the United Kingdom (31–34). According

to a previous study, children are at increased risk of dog bites because they attempt to play with the dogs or approach the dogs too closely (17). In contrast, the children in this report did not play with or provoke the dog, in agreement with findings by a study conducted in Trinidad and Tobago (34). Here, there was only one incident where the mother attacked the dog to defend her child. All the other attacks came unprovoked, showing that bites are inevitable when the rampage dog is rabid. Although, the dog in Matugga was untraced, both dogs showed signs like restless movement, unusual aggression, and unprovoked attacks that were coherent with the positive laboratory diagnosis for rabies (28).

The communities reported four types of dogs, namely, confined owned, roaming owned, roaming unowned (feral) and community dogs (roaming dogs under care of several community members), consistent with the classification by WOAH (35). After the attacks, the dog bite victims, local leaders, and non-dog-owners supported the elimination of the roaming dogs by any means possible but the roaming dog owners opposed the suggestion, leading to a standoff. This might explain why the community resorted to killing the roaming dogs in a mob. Previous studies have reported that counterattacks are eminent when animals conflict with humans (36, 37), however, such actions might instigate defensive aggression towards humans as reported previously (38). As an intervention, the veterinary department had previously conducted an elimination campaign by poisoning them with strychnine, however, the ethics and safety of this approach has been questioned (39). Consequently, a desirable approach is needed to solve the issue of roaming dogs in Central Uganda. We think that a sterilisation campaign combined with education of the community to improve dog ownership might yield substantial results in this community.

After killing the rampaging dog in Mawale, the community disposed the dead dog in the bush. This exposed gaps in disease surveillance and practices by the community that contribute to under reporting of rabies cases (40, 41). Fortunately, in this case, we were able to retrieve the carcass from the bush and diagnose the cause of aggression. Even though 18 domestic animals were reported to sustain bites from the rampaging dogs, there is a possibility that other animals could have encountered the rabid dogs. Thus, sustaining the transmission of rabies in this community. It might be no coincidence that the two cases documented here occurred in the same locality, 16 days apart. Therefore, it would be relevant to maintain active community surveillance in this area to track any other incidents of rampaging dogs. Currently, Uganda still relies on animal bite cases reported to health facilities and district veterinary office which overlooks the unreported incidents (42).

We also documented deficiencies in the management of dog bites and adherence to WHO guidelines. We attributed the poor adherence to guidelines to lack of knowledge among the victims which is consistent with previous studies (23, 43, 44). Most of the individuals sought health care from a traditional healer because they were not fully aware of what to do, which might explain why they were eager to start rabies PEP treatment after sensitisation. Interestingly, the traditional healer, who treated the victims with a black stone charged 4 times more than the cost spent to receive rabies PEP from a private health facility. Unfortunately, the efficacy of the black stone is unproven, even though traditional healers in Central Uganda use it to treat dog bite victims (17, 23). Although we acknowledge the importance of traditional

medicine practices in the management of health conditions at grassroot communities, the Ministry of Health should discourage such practices. Some of the victims who had received the black stone treatment sought secondary opinion from health facilities (Table 1), suggesting that education campaigns against unauthorised traditional practices would be successful.

We also note that individuals referred to public health facilities for rabies PEP were hesitant to accept due to perceptions of poor service, especially for persons without money or social influence. Our findings showed that some clinicians at public health facilities obtained money from the dog bite victims as an incentive before administering rabies PEP, which discourages or delays the patients from seeking treatment. Plus, there was no rabies PEP at public health facilities in Matugga and Mawale which meant travelling 30–50 km to access the free rabies PEP at the National- or Regional referral hospitals located in major cities. This explains why the dog bite victims that could not afford the treatment resorted to local herbs. These finding are consistent with previous reports of deficiencies in Uganda's public health care system (46, 47). The Ministry of Health should correct those deficiencies to ensure public health safety of the people living in peri urban areas, where roaming dogs are abundant.

Conclusions

This study demonstrates how a single rabid roaming dog can cause multiple injuries, cascading economic losses and distress to a community. Poverty, knowledge gaps, community beliefs towards traditional healthcare, and barriers to health care access negatively affected the quality of the medical care received by dog bite victims. Until the social factors identified in this study are addressed, it will be difficult to lower the incidence of dog bites and rabies in urbanised areas in Uganda or other similar settings.

Abbreviations

FAO: Food and Agriculture Organisation of the United Nations

FAT: Fluorescent Antibody Test

GARC: Global Alliance for Rabies Control

NADDEC: National Animal Disease Diagnostics and Epidemiology Centre

PEP: Post Exposure prophylaxis

WHO: World Health Organisation

WOAH: World Organisation for Animal Health

Declarations

Ethics approval and consent to participate

This study was approved by the institutional research and ethics committee at the Makerere University School of Veterinary and Animal Resources (SVAR/139/2023). Informed consent was obtained from all participants. For minors, the parents consented on behalf of their children.

Consent for publication

Consent was obtained from all the dog bite victims involved in this study.

Availability of data and materials

The data that support the findings of this study are available from the corresponding author, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of the School of veterinary medicine and animal resources institutional review board.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was funded by the government of Uganda through the Research and Innovation Fund of Uganda (Mak-RIF 4) and the African Small Animal Companion Animal Network (AFSCAN).

Authors contributions

DST, RT, TLG, SB, JOA, DM and JK designed the study. DST, NKR, CS, AK, JM assisted with sample collection, administering interviews, and tracking the rabid dogs. DST, EW, and SAA performed brain extraction, histopathology, and fluorescent antibody test for rabies diagnosis. DST, MK, CS drafted the manuscript. JK, DM, RT, TLG, SB, JOA improved the manuscript draft. All the authors read and approved the submitted version of the manuscript.

Acknowledgements

We would like to thank Ms. Zozianne Hoareau, Mr. Waswa Nsubuga Ishaaq, Mr. Nsubuga Ilyas and the District Veterinary officers that assisted in the data collection process. The authors appreciate the cooperation of all the dog-bite victims and the community.

Foot notes

[a]Classification of category of exposure to rabies from a dog bite. Category I involves contact between saliva and intact skin, Category II involves minor scratches on the skin without bleeding, and Category III

involves bites accompanied by bleeding

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Figures

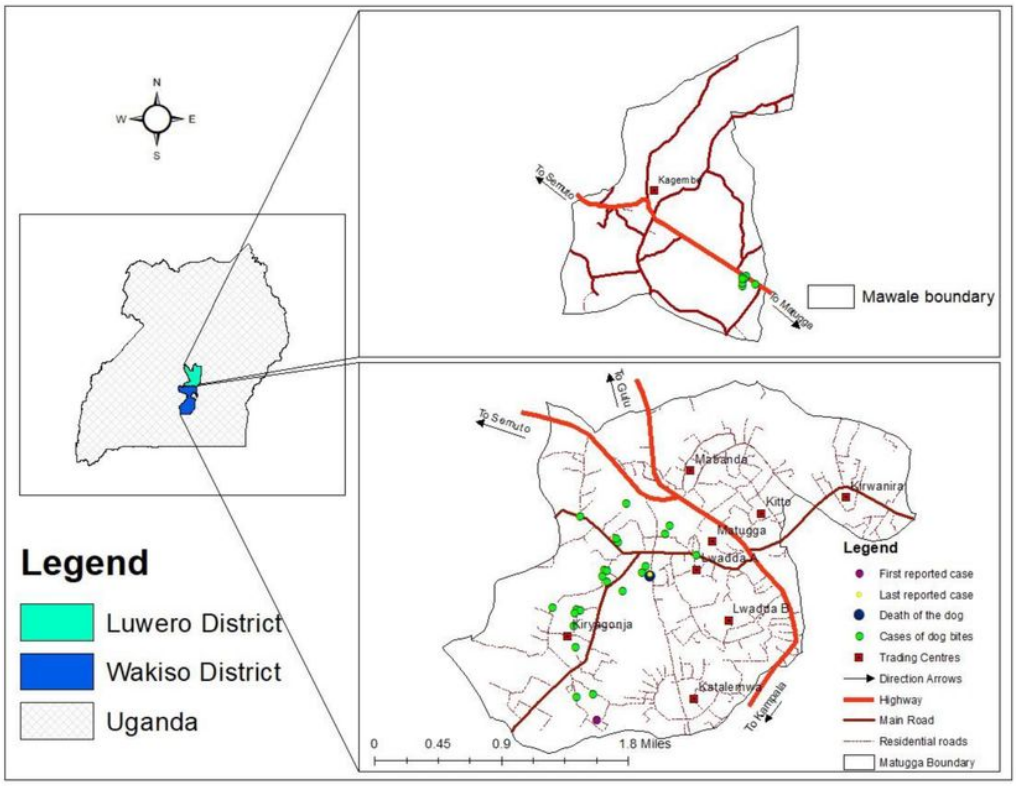
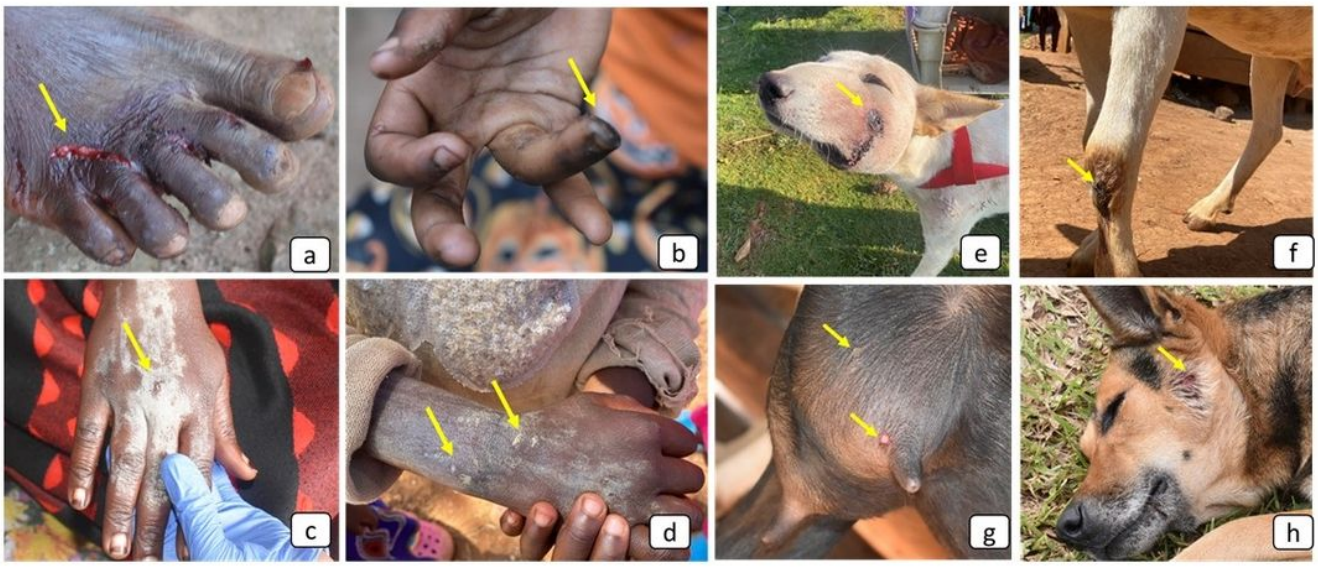


Figure 1

The location of the dog bites in Matugga and Mawale parishes and respective Wakiso and Luweero districts

The green circles show the location where the dog bites occurred, the points for the first and last reported cases are marked by the red and yellow circle, respectively. The locations of the dog bites Matugga are scattered over a wide area while that in Mawale are clustered.

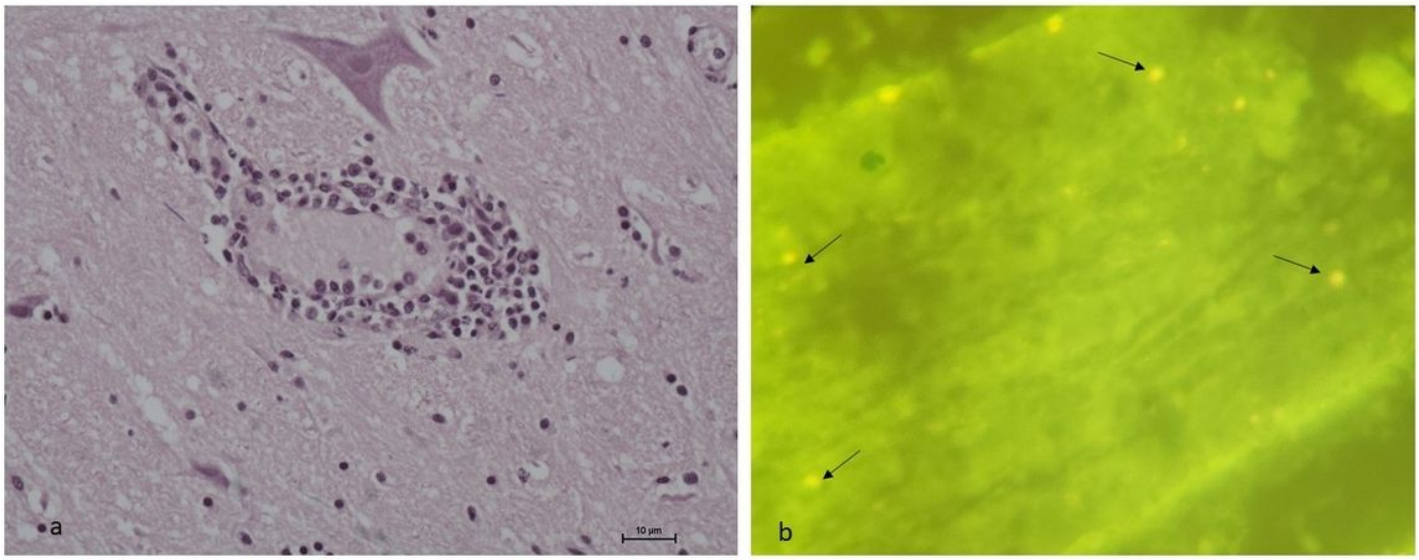


Arrows show the points of broken skin due to the dog bite

Figure 2

The injuries inflicted on humans and domestic animals

The arrows show tears through the skin sustained by the dog bite victims (images a-d) and domestic animals (imaged e-h). Local herbs that were applied to the wounds of some dog bite victims appears as whitish substance smeared on the hands (image c & d).



Micrographs showing histopathology of the brain stem **(a)** and the FAT positive test for rabies **(b)**

Figure 3

Micrographs of histopathology and fluorescent antibody test for rabies diagnosis

The micrograph taken from the histopathology of the brain stem revealedmoderate to marked foci of perivascular cuffing by mononuclear inflammatory cells (image a), suggesting virus-induced encephalitis. Apple green florescent granules were seen in the brain sample from Mawale, indicating presence of rabies viral antigen.