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Knowledge, Attitudes and Practices regarding Anthrax among affected communities in Kazo District, South-western Uganda, May 2022

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Summary

Background: *Anthrax is a priority zoonotic disease in Uganda. Despite health education about the risks of anthrax from eating meat from carcasses, some districts in Uganda, including Kazo District, experience repeated anthrax outbreaks associated with this risk factor. We assessed knowledge, attitudes, and practices (KAP) around anthrax in previously-affected communities in Kazo District.*

Methods: *We conducted a mixed-methods study in six villages in Kazo District from May 23–June 4, 2022. We administered structured questionnaires to 200 systematically-sampled community respondents aged ≥18 years about anthrax-related KAP and experiences with livestock loss. We conducted three KAP-based focus group discussions with community members identified as anthrax case-patients in previous outbreaks and those whose animals died suddenly in the previous year. We assessed overall knowledge through a set of eight questions on anthrax; species affected, signs and symptoms, transmission and prevention in humans and animals. We scored participants' responses to KAP questions as "1" (correct) or "0" (incorrect); adequate knowledge score was ≥4. Qualitative data were analyzed using content analysis.*

Results: *Among respondents, 65% were female; mean age was 45 years. In total, 94% had heard of anthrax and 73% knew transmission could occur through eating meat from carcasses. Overall, 77% of respondents had adequate knowledge about anthrax. Only 16% had lost their livestock suddenly in the last year; of these, 21% consumed the meat and 53% buried the carcasses. Qualitative data indicated that farmers did not vaccinate livestock against anthrax due to cost and difficulty accessing vaccine and veterinary services. Poverty and limited access to protein were cited as drivers for consuming meat from carcasses despite the risk.*

Conclusion: *Good awareness about anthrax among residents of a repeatedly-affected community in Uganda did not translate to safe practices. It may be difficult for communities in affected areas to forego opportunities to eat meat from animals they find dead, even when they suspect possible danger. Consideration of alternate preventive approaches and messaging, such as compensating farmers for anthrax-positive carcasses in exchange for permitting safe animal disposal, might reduce risk in high-risk communities.*

Introduction

Anthrax is a bacterial disease of public health and economic importance endemic in many agricultural parts of the world(1) . It is a zoonotic disease caused by *Bacillus anthracis*, an aerobic, gram-positive and spore forming bacterium that belongs to the family Bacillaceae (2).The disease affects herbivorous animals (wild and domestic) and humans (3), (2). Livestock get infected through ingestion or inhalation of spores from contaminated soil, water, or pastures with the clinical course of the infection ranging from acute to chronic (3) Ingested spores are transformed in vivo into vegetative bacilli that cause disease. When the animal dies, the contaminated carcasses and infectious fluids re-contaminate the environment. The sporulation makes *Bacillus anthracis* resistant to degradation in the environment, and spores can persist for extended periods of time, even under adverse conditions (4).

Human infections often result from handling and/or consuming meat of infected livestock(5). There are three main forms of human anthrax infection, depending on the route of exposure: cutaneous, gastrointestinal, and pulmonary (inhalational) anthrax. Cutaneous anthrax is the most common and accounts for approximately 95% of cases (6). Between one and 12 days after exposure, clinical signs of cutaneous anthrax infection appear as one or more painless, itchy papules or vesicles on the skin, typically on exposed areas such as the face, neck, forearms, or hands. Within 7-10 days of the initial lesion, the papule forms an ulcer, which subsequently crusts over, forming a painless black eschar that is the hallmark of cutaneous anthrax. Localized swelling, painful swollen regional lymph nodes, and systemic symptoms may also be present (7). Without treatment, the case-fatality rate of cutaneous anthrax is 20% (6); however, it can also self-resolve.

In Africa, anthrax remains a major problem except in South Africa where it continues to be at a low sporadic incidence probably as a result of the livestock owners taking the central role of control (8). Continuous sporadic outbreaks of the disease have been reported in a number of countries in the sub-Saharan Africa including Uganda in the recent years (3). Anthrax is among the top seven priority zoonotic diseases in Uganda and neighbouring East African countries (9), (10). Uganda is particularly susceptible to zoonotic diseases due to its exceptional biological diversity and escalating population density that brings humans and animals into increasing interaction (11). Uganda has been reporting anthrax cases and deaths

in humans and animals, including wildlife, since at least 1959 (12). Outbreaks have been reported from every region of Uganda, mostly among communities that rear cattle (13) . Surveillance data in Uganda in 2018 revealed 186 reported human cases and 721 reported livestock deaths due to anthrax (13).

Anthrax is known to cause devastating socio-economic impact in various ways, including animal disease, loss of productivity, loss of income for livestock dependent populations, human morbidity and mortality (14). The disease perpetuates poverty and causes emotional trauma, especially among the poor populations whose livelihoods depend on pastoral farming (15). In addition, due to destruction of infected animals, household food security is often affected and farmers experience large financial losses (16). In addition, most households, and families may consume and sell some of the meat from anthrax infected animals in order to minimize losses associated with death of animals that should ideally be safely disposed off (17), (18). This is worsened by the absence of compensation schemes for livestock losses in resource-limited settings.

A number of factors such as changing rainfall patterns, soil disturbance, increased animal and human populations, poor grazing systems and human behaviour, poor anthrax surveillance and weak control programs have been reported to be associated with outbreaks of anthrax (19). Interaction of wildlife with livestock and humans has also been reported as a key predisposing factor of anthrax among humans and livestock. The disease usually reoccurs in areas where there has been a previous outbreak, making vaccination one of the recommended form of control (1), (20). Previous studies have shown that poor perceptions, cultural norms, beliefs, and practices of local communities play key roles in the persistence of anthrax outbreaks.

During January 2017 – December 2018, recurrent outbreaks of anthrax in both animals and humans were reported in four districts, namely: Zombo and Arua in Northen Uganda, Kween in Eastern Uganda and Kiruhura in Western Uganda (21). Recommendations following these investigations frequently focus on health education to the community about not eating meat from animals found dead. However, given the repeated and consistent outbreaks, the knowledge around the rationale for this recommendation as well as the willingness and feasibility of implementing this recommendation is unclear.

This study assessed the knowledge, attitudes, and practices regarding Anthrax among the affected communities in Kazo District to improve our understanding of what people know about anthrax and conduct a deeper investigation into why the affected communities eat meat from animals that they find dead.

Methods

Study area

The study was conducted in Kazo District, located in South-western Uganda. It was curved out of the greater Kiruhura District as of financial year2019/2020.The district covers a land area of 1551 sq. km with a population of 217,600. It is in the Masaka-Ankole cattle corridor. The predominant economic activity is livestock keeping and crop growing. It is bordered by Kyegegwa District in the North, Ibanda District in the West, Kiruhura District in the East and South, Kamwenge in the North West and Sembabule in the North East, all of which are located in the cattle corridor of Uganda (22). The cattle corridor covers approximately 40% of Uganda's land surface, stretching from north-east, through central to southwest Uganda. It is characterised by livestock production, scarce water and pastures. Although it is one of the country's most fragile ecosystems and vulnerable to climate change, it remains relevant to national and local food security (23).

Study design

We utilized a mixed-method design employing both quantitative and qualitative methods. We conducted Focus Group Discussions (FGDs) and house-to-house surveys during May 23 to June 4, 2022. We conducted three FGDs, with 6-12 persons targeted per group. The first two FGDs comprised of persons who were confirmed or probable cases in previous anthrax outbreaks. The purpose of these FGDs was to assess if these people were aware of the risks of eating animals that were found dead, and if so, reasons they or their relatives continue to consume meat from animals that are found dead.

For the third FGD, we included a random sample of persons who had animals that had died suddenly during the previous year. The purpose of this FGD was to understand specifically what was done with the animal carcasses, if they perceived any risk associated with slaughtering or eating them, and how that risk influenced what they did with the carcasses.

For the community survey, sample size was estimated based on knowledge about health risks from eating meat from animals that they found dead. We purposively selected six villages that experienced an anthrax outbreak in humans linked to consumption and/or preparation of meat from an animal found dead during the last outbreak in 2018. We worked with Village Health Teams (VHTs) to develop a full list of households and performed systematic sampling to select and interview 200 households in six villages in Engari Sub-county, Kazo District (estimated based on 87% of persons knowing that there is a risk of illness when they eat animals that they find dead, 95% confidence interval). Heads of households were sought on the day of the visit to the village and were replaced by the household next door if not available at the time of the visit. If replacement occured, the subsequent household was the one that would have been sampled had the original household *not* been replaced. The study investigators trained two data collectors from the community to conduct the surveys and FGDs in the local language with support from VHTs.

Using an interviewer administered structured questionnaire, we collected information on socio-demographics (age, sex, marital status, religion and occupation), information on knowledge (causes, species affected, transmission, signs and symptoms, prevention and control); attitude (opinion about anthrax disease) and practices (meat consumption, slaughter and butchering carcasses, carcass management and vaccination of animals).

Data analysis

Survey data were entered, cleaned and analyzed using Microsoft® Excel and STATA. We performed univariate analysis for socio-demographics and characteristics associated with knowledge, attitude and practices. Data from the knowledge, attitudes, and practices survey was reported quantitatively using frequencies for each of the questions. Responses for each domain were summarized into categories to represent different levels of knowledge, attitudes, or practices around anthrax-related issues.

Overall knowledge on anthrax was assessed through a set of eight questions related to knowledge on anthrax (heard of anthrax, species affected, signs and symptoms in animals, transmission in animals, prevention in animals, signs and symptoms in humans, transmission in humans, prevention and control in humans). We allotted participants´ response as “1” for a correct response and “0” for an incorrect response. To assess for knowledge on anthrax, individual respondent scores were summed for variables pertaining to these items. The

median was calculated and used as the cut off score. Respondents with a score less than the median for knowledge were considered to have inadequate knowledge.

We performed bivariate and multivariate analysis and ran logistic regression to explore association between socio-demographic characteristics, attitudes and practises and knowledge scores. Statistical significance was set at p-value < 0.05. Variables that were found to be significant at bivariate analysis were entered into the model for multivariate analysis.

Variables with p<0.1 in bivariate analysis were included in the logistical regression model using a backward stepwise method. At the multivariate analysis level, p<0.05 showed statistically significant associations between Knowledge and the independent variables. We tested the model using Hosmer–Lemeshow goodness of fit test.

Qualitative data were transcribed and coded in Microsoft® Word (Ms Word) and analysed for content along thematic areas. In transcribing the FGDs, the narratives were re-read, compared to audio files and group consensus of investigators was reached for verification of themes. Illustrative comments and quotations that clearly represented themes were quoted verbatim.

Ethical approval

This activity was a response to a public health emergency thus approved as a non-research by the Office of the Associate Director for Science, United States Centers for Disease Control and Prevention, (US CDC). We obtained verbal informed consent from respondents 18 years and above. In addition to the parent's consent, we obtained a verbal assent from respondents aged below 18 years. We stored all completed questionnaires in a secure location and stored the electronic data in a password-protected laptop to avoid disclosure of respondents' personal information. Data were shared strictly with the investigation team.

Results

Socio-demographic characteristics

In total, 200 people participated in the community survey. Most of the participants (129; 65%) were female, 132 (40%) were between the ages of 31 and 50, and 110 (55%) were both livestock and crop farmers (Table 1).

Table 1: Socio-demographic characteristics of study participants in Kazo District, May 2022

Characteristic	Frequency (n=200)	Percent
District		
Kazo	200	100
Subcounty		
Engari	200	100
Parish		
Kantaganya	122	61
Kyengando	48	24
Engari	30	15
Village		
Rupyani cell	76	38
Kashitamo cell	48	24
Kihumuro cell	31	16
Bukiro 1 cell	15	8
Kantaganya cell	15	8
Kitongore cell	15	8
Age group of respondents (years) *		
18–30	51	26
31–50	80	40
≥51	69	35
Sex		
Female	129	65
Male	71	36
Marital status of respondent		
Married	141	71
Singe	52	26
Separated	7	4
Religion of respondent		
Protestant	107	54
Catholic	70	35
Born Again	15	8
Moslem	6	3
SDA	2	1
Occupation of household head		
Only livestock farming	4	2
Only crop farming	78	39
Both livestock and crop farming	110	55
Others	8	4
Animals kept		
Goats	71	62
Cattle	45	40
Pigs	43	38
Sheep	16	14

* mean age of respondents is 45 years

Participant's knowledge about anthrax

One hundred eighty-eight (189; 94%) of respondents knew/had heard about anthrax. Of those who knew/had heard about anthrax, 81 (43%) had received information from other farmers, 76 (40%) from either friends, colleagues or relatives. One hundred thirty-one (70%) knew that anthrax affects both animals and humans, and 119 (63%) didn't know any sign of anthrax in animals. One hundred thirty-nine (139; 74%) participants did not know how animals get infected with anthrax, while 42 (22%) knew that animals can get infected with anthrax while grazing in contaminated environment. Most participants (82; 44%) didn't know how anthrax can be prevented in animals, however, 56 (30%) reported that vaccinating animals and not grazing them in contaminated pastures can prevent them from contracting anthrax. Most (136; 73%) respondents knew that anthrax can be transmitted to humans by eating meat from an animal that died suddenly, and 102 (54%) reported eschar and body swelling (100; 53%) as signs of anthrax in humans.

The overall assessment of knowledge regarding anthrax revealed that 154; 77% had adequate knowledge about anthrax (Table 2).

Table 2: Score of participant's knowledge about anthrax in Kazo District, May 2022

Variable	n (200)	Percent
Heard of anthrax		
Yes (1)	188	94
No (0)	12	6
Species affected		
Knowledgeable (1)	131	65.5
Not knowledgeable (0)	69	34.5
Signs and symptoms animals		
Knowledgeable (1)	51	25.5
Not knowledgeable (0)	149	74.5
Transmission Animals		
Knowledgeable (1)	48	24
Not knowledgeable (0)	152	76
Prevention Animals		
Knowledgeable (1)	94	47
Not knowledgeable (0)	106	53
Signs and symptoms Humans		
Knowledgeable (1)	122	61

Not knowledgeable (0)	78	39
Transmission in humans		
Knowledgeable (1)	157	78.5
Not knowledgeable (0)	43	21.5
Prevention in Humans		
Knowledgeable (1)	147	73.5
Not knowledgeable (0)	53	26.5
Total knowledge score		
0	12	6
1	10	5
2	9	4.5
3	15	7.5
4	33	16.5
5	46	23
6	35	17.5
7	27	13.5
8	13	6.5
Knowledge composite		
Adequate (Total score ≥4)	154	77
Inadequate (Total score <4)	46	23

Participant's attitudes and practices towards anthrax

Of the 188 respondents who knew or had heard about anthrax, 179 (95%) thought that anthrax is a serious disease. One hundred fifty-five (155; 83%) thought that vaccination of animals could prevent anthrax in animals. Eighty-six (64%) of the respondents reported to have never vaccinated their animals against anthrax. Nearly all respondents (186; 93%) thought it was not safe to eat meat from animals that died suddenly, nor cut up the carcasses of animals that have died suddenly (188; 95%). Of the respondents, 36 (26%) reported that animals die suddenly once a year in their community. A small number of respondents (19; 16%) reported having lost their animals suddenly in the last year; of these, 4 (21%) reported consuming the meat. Nineteen (10%) respondents reported having suffered from anthrax before; among these, eschar was the most reported sign they presented with (11; 58%), and 13 (68%) said that it occurred after eating meat from an animal that died suddenly, and cutting up an animal that died suddenly (19;100%) (Table 3).

Table 3: Participant's attitudes and practices towards anthrax, Kazo District, May 2022, (n=200)

Characteristic	Frequency	Percent
Do you think anthrax is a serious disease? *		
Yes	179	95.2
Not sure	8	4.3
No	1	0.5
Do you think that vaccination of animals can prevent anthrax in animals? *		
Yes	155	82.5
Not sure	25	13.3
No	8	4.2
Have any of your animals died suddenly in the last 1 year? ¶		
No	98	83.8
Yes	19	16.2
If yes to having any of your animals that died suddenly, what action did you take? **		
Buried the carcass	10	52.6
Consumed meat from the dead animal	4	21.1
Reported to the area veterinarian	4	21.1
Other	1	5.3
How often do other people's animals die suddenly in your community? ††		
Once a year	36	25.9
Twice a year	10	7.2
Once a month	3	2.2
Others	12	8.6
Not sure	78	56.1
Do you think it is safe to cut up the carcasses of animals that have died suddenly? ‡‡		
No	188	94.5
Yes	9	4.5
Not sure	2	1.0
Do you think it's safe to eat meat from an animal that died suddenly?		
No	186	93.0
Yes	11	5.5
Don't know	3	1.5
Have you ever eaten meat from an animal that died suddenly?		
No	143	71.9
Yes	41	7.5
Not sure	15	20.6
How often do you eat the meat of animals that died suddenly?§§		
Once a year	9	32.0
Twice a year	4	14.0
Others	15	54.0

Have you/any of your family members suffered from anthrax before?		
No	177	88.5
Yes	19	9.5
Not sure	4	2.0
What symptoms/signs did you/the person present with?**		
Eschar	11	57.9
Itching	6	31.6
Vomiting	2	10.5
Others	13	68.4
How did you/ the person contract anthrax?**		
Cut up a dead animal that died suddenly	19	100.0
Ate meat from an animal that died suddenly	13	68.4
Carried meat from an animal that died suddenly	5	26.3
Other	1	5.3
What action did you take when the person was ill?**		
Took myself /the patient to the nearest health facility	17	89.5
Bought medicine from a drug shop	3	15.8
Took myself/patient to the traditional healer	1	5.3
What grazing method do you practice?¶¶		
Tethering	58	55.8
Paddocking	44	42.3
Communal grazing	15	14.4
Others	1	1.0
Where do you graze your animals/get your fodder from?***		
From my private pasture area	87	76.3
From a communal grazing area	23	20.2
I buy fodder from a commercial dealer	1	0.9
Others	3	2.6
Where do you water animals from?		
At home in a water trough	62	53.9
From my private watering point	27	23.5
From a communal watering point	23	20.0
Others	3	2.6
Can you identify meat from an animal that has died suddenly?††		
Yes	92	66.2
No	47	33.8

*Sample size is188, †Sample size is 16, ‡Sample size is 135, §Sample size is 31, ¶Sample size is 117

**Sample size of 19, ††Sample size 139, ‡‡Sample size 199, §§Sample size 28, ¶¶ Sample size 104

*** Sample size 114

Results from the qualitative part of the community assessment on anthrax

Our results focused on six major themes; Participants' prior knowledge of anthrax; Actions after animals died suddenly; Perceived risk of eating meat from animals found dead; Reasons for eating meat from animals found dead; Vaccinating against anthrax; Prevention.

Participants' prior knowledge of anthrax

Participants were knowledgeable about the existence of anthrax in the community, its nature and how it presents. Their knowledge of anthrax comes from previous/past experiences for those who had contracted anthrax. The signs of anthrax in humans most noted were skin lesions, fever, headache, loss of appetite and black scabs (eschars). Knowledge of the symptoms of anthrax in animals was limited but for those with knowledge, discharge of blood through body orifices, difficulty in breathing, and sudden death were the known signs; "When I got infected, I first felt a fever, then I got a skin lesion. The skin lesion became a small hole that turned into a fluid filled blister on the finger. The skin peeled off then there was a small black thing inside. I also lost my appetite…." reported by a respondent in FGD2. Another respondent from FGD 3 revealed that: "…..for you to know that the cow is sick, it fails to eat, it has difficulty breathing, and dies in a few days….". Additional reports from a respondent in FGD 2 were: "the cow after dying has blood in the nose and anus, the meat is too red and the intestines do not look normal; they look burnt….".

Participants were knowledgeable about the transmission of anthrax, reporting that it is through touching or eating meat from an animal that has died suddenly; "Touching the meat or eating the meat of a cow that died suddenly without protection" reported by a respondent in FGD3. Another respondent from FGD 2 revealed that: "I slaughtered the animal and ate it. That is how I contracted the disease". A deeper discussion also brought up the concept of external transmission by moving infected animal across border districts; "Our biggest challenge is with business people who move animals from various places at night stealthily. Before you know it there is another outbreak" as reported by a respondent in FGD3.

Participants had varied responses regarding the seasonality of anthrax. Most participants reported that animal deaths occur during the dry seasons in the months of June/July. A respondent from FGD2 reported that: "Anthrax usually breaks out during the month of July.

When pastures dry up, cows easily pick up the bacteria from the soils". Some respondents argued that it was during the wet season; "From June to September when rains become heavy" as reported by a respondent from FGD3.

Actions after animal died suddenly

Participants had varied actions towards an animal that died suddenly, some of which were protective, while others were risky. For the risky actions, participants mentioned that such meat will end up at the market, the animal is butchered and the meat sold; "When a cow dies even if the owner knows that it has died of anthrax, he/she refuses to eat it and calls other people to sell it to them so they can benefit a little" as reported by a respondent from FGD3. In some cases, fed to the dogs; "I slaughtered an animal. It's not that it was appealing to eat, so after slaughtering it, I carried the meat home. I had taken it for the dogs" reported a respondent from FGD1.

For protective actions, they reported digging a pit of 5ft and burying the carcass and in some cases burning the carcass; "We were trained to dig a deep hole of 5ft, put tarpaulin and then bury the cow" reported a respondent from FGD2. Additional reports from a respondent in FGD2 were; "We are advised us that if one doesn't want to bury the dead cow, they can buy petrol and burn it".

Perceived risk of eating meat from animals found dead

Participants had varied perceptions regarding the risk of consuming meat from dead animals. Some participants especially those in the group which had previously confirmed/ probable cases, were worried about contracting anthrax. "…From that time, I told myself, a dead cow is not something to eat" as reported by a respondent from FGD1. Additional information reported from a respondent in the same group were: "…So, I want to encourage my fellows here to stay away from dead cows".

Other participants were not worried about contracting anthrax because they have learnt how to prepare it before eating to reduce the risk. "We are advised to first roast it very well before cooking. However, as village people, we don't usually do that, we roast a bit and cook and eat" as reported by a respondent from FGD2.

Reasons for eating meat from animals found dead

Participants pointed out that low income levels and poverty were the major drivers for consumption of meat from animals that die suddenly. “Low-Income levels and poverty is the reason why we eat that meat” reported by a respondent from FGD2. The participants revealed that the meat from a dead animal is often sold at a reduced price compared to ‘normal’ meat. “That meat is cheaper” as reported by a respondent from FGD3.

The participants also pointed that that sometimes consumers end up eating such meat without their knowledge, stating that this meat makes its way to the market with the knowledge of the butchers. Additional reports by a respondent from FGD3 were: “Butchers mix the normal meat and the meat of the cow that has died suddenly. So customers buy bad meat without their knowledge”.

Vaccination of animals

Most participants reported knowing about the anthrax vaccines, and that most animals were vaccinated in 2018. The participants reported that the vaccines are costly and not readily accessible. “With vaccination as a farmer you cannot access the vaccine and administer it individually. You have to call the authorities to come and do a vaccination” as reported by a respondent from FGD3. Another respondent from FGD2 reported that: “There was an announcement that whoever has cows and even asked for money UGX 3,000 per cow to vaccinate the cows. The vaccine was coming from the District in Kazo. So yes, we did it”. Additional information reported from a respondent from FGD3 revealed that: “Vaccination took place, but when they started asking for money, some people stopped vaccinating”.

Whereas most participants agreed that vaccination can prevent anthrax in animals, there was a lack of knowledge as to how often these vaccines are to be administered to their animals. “We were told that we should vaccinate every 3 months” as reported by a respondent from FGD2.

Prevention

Participants made suggestions on anthrax prevention that were mainly directed to the government. They included;

Community training and sensitization through area veterinarians. “I request that you continue training us more in anthrax on how it is spread, its symptoms and to handle a dead cow sot that we can also go and spread the news to other people” as reported by a respondent from FGD2.

Provision of free vaccination and mechanism to ensure all animals are vaccinated. “…So we request the government to put in place mechanisms to ensure that all animals are vaccinated” as reported by a respondent from FGD1.

Strict measures with local authorities to ensure proper carcass management. “I would like the government to arrest and prosecute the people whose animals die suddenly and go ahead and sell them for human consumption” as reported by a respondent from FGD1. Another respondent from FGD2 revealed that: “…report to the Chairman LC 1 or the veterinary doctor so they can bury it after testing to know the cause of death”.

Compensation schemes for farmers who have lost their animals to such outbreaks. “I am of the view that the government through programs like National Agricultural Advisory Services (NAADs) should always come in to support farmers who have lost their cows to disease outbreaks like anthrax. For example, when one loses two animals, at least government should give back one cow” as reported by a respondent from FGD3.

Discussion

Human behaviour has a significant role in influencing anthrax transmission. This behaviour is influenced by the knowledge, attitudes and practices of affected communities. This study aimed to assess the knowledge, attitudes, practises and consumption of meat of animals found dead in communities previously affected by anthrax in Kazo District, South-Western Uganda. The survey results indicated good awareness about anthrax among respondents. Even though 94% stated that they knew/had heard about anthrax, 43% had received information from other farmers, 40% from either friends, colleagues or relatives. This means that the most respondents are more likely to have poor access to media information and poor comprehension and compliance to health education messages. The study showed that most respondents accessed information from friends rather than public media.

This is likely to interfere with public health messages as community members share misconceptions and myths surrounding the disease. This is as observed by Taverne (24) who postulated that disease epidemics arrive `ahead of themselves since interpretations and the social effects usually precede the disease itself.'

Even though 70% of the respondents knew that anthrax affects both humans and animals, there was a better understanding of anthrax in humans; susceptibility of humans to anthrax, signs of anthrax in sick human beings and common routes of transmission. The survey revealed a poor understanding of anthrax in animals; 63% didn't know any signs of anthrax. Most respondents also didn't know how animals get infected with anthrax; however, they reported on the importance of vaccination as a preventive measure. The qualitative results demonstrated a poor understanding of the disease overall in the community, especially regards signs and symptoms in animals and the seasonality of anthrax. These study findings are consistent with those of Gombe *et al (18)* and Mebratu *et al (25)*. On the contrary, Opare`s study (26) showed that most respondents did not know the causes of anthrax but recognised the signs and symptoms of anthrax and the potential effectiveness of vaccinations.

Among human population, veterinarians, livestock farmers, any person that handles animal products (such as butchers, wool sorters, tannery workers, etc.), and laboratory personnel are the highest risk group (27). Predominantly, most houses kept livestock. Correspondingly, the high levels of knowledge were not found to be consistent with the attitudes and practices of respondents in this study. Case in point; while quantitative data indicated that most respondents (73%), knew that anthrax could be transmitted to humans by eating meat from an animal that died suddenly, 21% of the respondents who lost their animals in the past year consumed the animal. The qualitative data revealed that the majority of community members believed that when meat is smoked and cooked for a long time, the bacteria die and the meat is safe for consumption. Contrary to this finding, the study done by Gombe *et al* in Zimbabwe revealed that respondents disagreed with statements that overcooking infected meat kills anthrax bacteria (18).

From the qualitative survey, respondents indicated that they did not think eating meat from an animal that has died suddenly was risky because of how they prepare the meat, but also

because they usually do not see any symptoms among themselves whenever they consume meat from diseased carcasses. This perceived low susceptibility to anthrax is likely to lead to risky meat consumption behaviours. This perception seems to be consistent with the propositions of the Health Belief Model, which proposes that persons who perceive a low risk of developing a health problem are unlikely to engage in behaviours to reduce their risk of developing the particular health problem (28).

According to qualitative data obtained, practises such as selling and consumption of meat from animals that have died suddenly were perpetuated by poverty and limited access to meat protein. The quantitative data indicated that livestock and farming were the main source of livelihood for the people of Engari Sub-county. Therefore, loss of cattle leads to economic losses and increases the likelihood of selling infected meat in order to make financial recoveries. This is worsened by the fact that farmers are not compensated for cattle losses. Consumption and selling of carcasses in which the animals died from anthrax was reported by other studies; this is not only to make financial return but also as a source of protein (29), (26), (19), (18).

Routine vaccination policy is one of the better strategies for prevention and control of anthrax (6). The “greater Kiruhura District” is endemic for anthrax but the vaccination status in Kazo district was not satisfactory. Majority of respondents, 95% felt that anthrax was a serious disease and 83% of them believed that vaccination could prevent the disease in animals; however, 64% have never vaccinated their animals. This is supported by a study conducted in Ghana which indicated that high levels of knowledge about vaccination had not been actualised into practices by farmers in Tamale Municipality.

Qualitative information suggested that very few farmers had their animals vaccinated. Participants in the focus group discussions cited various reasons for failure to have their animals vaccinates; inability to pay for vaccination, difficulty in accessing the vaccine and inadequate access to veterinary services in their communities. Likewise, in a review paper by Siamudaala et al (2006), inadequate technical and administrative support, erratic funding and supply of logistics were cited as major constraints of anthrax control in Zambia (17).

Disposal of the carcass of animals is a source of concern for anthrax transmission. According to the World Health Organisation, in most countries, the preferred method of disposal of an anthrax carcass is incineration(2). Controlled heat treatment or "rendering" has been proposed, and where neither of these approaches is possible, for example owing to lack of fuel, burial is the remaining less satisfactory alternative. Of the farmers who lost their animals suddenly, only 53% buried their animals.

From the qualitative data, it was still common for community members to slaughter and eat meat from animals that have died suddenly. Therefore, when cattle died, it was butchered and shared right from where it died. Incineration was rarely practiced. However, history has many examples of new outbreaks following disturbance of old burial sites. Periodic reports of viable anthrax spores at burial sites of animals that died many years previously, and incidents and outbreaks in animals associated with such sites, have testified to the unreliability of burial procedures for long-term control of the disease.

Disturbance of such sites, for example by ploughing or laying drainage presumably brings the spores to the surface. Carnivores and birds play a vital role to drag contaminated meat over the areas, thus, increasing ground contamination with anthrax spore. Dog themselves are resistant to anthrax but acts as a mechanical vector from field to household (30). In general, regarding the KAP of the respondents on anthrax, we observed that knowledge was better than attitude, and attitude was better than practise.

Study limitations and strengths

The study could be prone to recall bias because participants were asked about knowledge, attitudes, practices, exposure to deceased animals, as well as disease symptoms that occurred about 4 years prior to the interview date. Our findings may contain information errors related to desirability bias in which knowledgeable respondents may have stated what was desirable rather than what they engaged in. Adherence to good practice in livestock production and anthrax control was self-reported by the respondents rather than observed by the investigators. Despite the limitations, by triangulation of quantitative and qualitative findings, we strived to ensure internal validity and reliability. Our investigation therefore highlights elements that would expose the community to anthrax in the event of an outbreak.

Conclusion

In general, the KAP of the participants towards anthrax was low. Though there was good awareness about anthrax among the respondents, this did not translate to good practice. Although majority of the community members had an idea about anthrax and its symptoms in humans, there was a knowledge gap about anthrax in animals. There was no consistent understanding of the disease among the participants because they did not get consistent, adequate, and continuous health messages regarding the disease. Meat consumption practices were found to be high risk for anthrax as it is still common for community members to either slaughter, consume, sell, or share meat from animals that have died suddenly. These practices are mostly driven by social factors such as poverty and socio-economic losses incurred by loss of cattle and cultural practices.

Recommendations

We recommended enhanced public health education and targeted interventions with one health approach by relevant government bodies is highly recommended for effective prevention and control of anthrax. We recommend that community sensitisation campaigns and messaging could be improved to not only the health hazards of consuming meat from animals that have died suddenly, but also avoiding slaughtering/handling of carcasses.

For persons in the animal industry involved should be educated on the importance of wearing personal protective equipment during the process, especially when dealing with dead animals from unknown causes. Animal owners should ensure sick and or dying animals are not skinned, slaughtered or butchered for meat consumption. Animal meat inspectors would play a key role in ensuring that the meat supplied at the butchers is clean and safe for human consumption.

Controlling infection of anthrax in animals is key to control of human anthrax. Good veterinary practice, burying of animal carcasses, use of effective decontamination and disinfection procedures and educating animal owners on anthrax in animals, say, identifying the disease in animals, what to do and what not to do, actions to take when an animal dies suddenly, will improve outcomes in the area. This includes notifying the area veterinarian to guide on how to dispose of the dead animal properly. The district health office should

identify a focal point, such as a trained VHT or community animal health worker, to whom community members can report when animals die suddenly and who can guide them on the proper actions to take to prevent anthrax exposures.

It is necessary to ensure increased public awareness on the importance of vaccination of the livestock population along with sufficient coverage of the anthrax vaccine that will make a large contribution to the control of anthrax outbreaks. There must be targeted and strategic annual vaccination campaign of animals in previously affected communities, coupled with improved public health awareness campaigns aimed at promoting active participation by the general public in the control of the disease.

Conflict of interest

The authors declare that they have no conflict of interest

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