Knowledge, Perceptions and Effects of Ebola Virus Disease Outbreak on the Pig Value Chain in the Agro-pastoralist District of Luwero, Central Uganda

Samuel Majalija (✉ saraali67@covab.mak.ac.ug)

College of Veterinary Medicine, Animal resources and Biosecurity of Makerere University

https://orcid.org/0000-0001-6445-9070

Doreen Birungi

College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University

Gabriel Tumwine

College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University Vishwavidyalaya

Charles Drago Kato

College of Veterinary Medicine, Animal Resources and Biosecurity

Tonny Ssekamatte

School of Public Health, Makerere University

Michael Ocaido

College of Veterinary Medicine, Animal resources and Biosecurity

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Abstract

Background: Ebola outbreaks have continued to affect the health, wellbeing and livelihoods of communities. In particular, Ebola response interventions affect food value chains, food and income security of pig farming communities. There is paucity of information on the effect of Ebola outbreak on the pig value chain as well there is a gap on the knowledge and perceptions of those engaged in the pig value chain on Ebola. Therefore, this study aimed at assessing the knowledge, perceptions on the occurrence of Ebola and its effects on the pig value chain in the agro-pastoral district of Luweero, Central Uganda.

Methods: A cross sectional study was conducted in two parishes of Ssambwe and Ngalonkulu, Luwero district. A total of 229 respondents were included in the study. Structured questionnaires, key informant interviews and focus group discussions were conducted to collect data. Quantitative data was analysed using SPSS version 22 while qualitative data was analysed using thematic content analysis.

Results: Of the 229 respondents, 95.6% could recall the occurrence of the last Ebola outbreak in their locality. The proportion of respondents that associated touching pigs or eating pork with acquisition of Ebola virus was 24.5%. Ebola was perceived as a spiritual manifestation of witchcraft activities. Traditional healers were among the first line of health care providers to Ebola patients in the outbreak. There was no significant association between the perceived human practices such as bush meat consumption, contact with wild animals and acquiring of Ebola virus. The number of pigs sold during the outbreak was significantly reduced (p= 0.001) and this normalized 2 months after the area was declared Ebola free. There was a significant reduction (p= 0.03) in consumption of pork, as well as the unit cost per kilogram of pork during the Ebola outbreak due to fear of acquiring the disease from pork.

Conclusion: The study showed that the pig value chain was negatively affected by Ebola outbreak. Therefore, there is need to sensitize the stakeholders on Ebola in order to minimize the negative economic impacts associated with EVD outbreaks.

Background

Ebola Virus Disease (EVD) remains a serious public health problem of global concern. Since the first occurrence, 44 years ago in the Democratic Republic of Congo (formerly Zaire), over 38 Ebola outbreaks have been reported [1]. Ebolavirus is a filovirus in the family Filoviridae consisting of four species that cause human illness; *Zaire ebolavirus*, *Bundibugyo ebolavirus*, *Sudan ebolavirus* and *Taï Forest ebolavirus* (also known as *Cote d'Ivoire ebolavirus*) [2]. While *Reston ebolavirus* is only known to cause infection in domestic pigs [3, 4] and possibly pigs could amplify this virus and potentially transmit it to humans in future. Ebola seropositive samples have been detected from bats, making them the most probable reservoir species of virus, although no virus has been isolated [5]. Similarly, viral antibodies have been identified in gorillas, chimpanzees, and duikers as other possible sources of infection [5, 6].

Ebola outbreaks have occurred in sub-Sahara Africa, largely in the West African countries of Guinea, Liberia, Senegal, Sierra Leone and Nigeria, as well as Uganda, Sudan and Democratic Republic of Congo in east and central Africa [1]. Between 2014 and 2016, the largest EVD outbreak to date, occurred in West African countries causing death to over 11,000 people and severe economic damage [7]. Uganda and her neighbours (Democratic Republic of Congo and Sudan) continue to experience frequent Ebola outbreaks [6]. In the past two decades,

Uganda alone has had six outbreaks in different districts: Gulu in 2000, Bundibugyo (2007), Kibaale (2012), Luwero in 2011 and 2012 and Kasese in 2019 [8]. The first and biggest Ebola outbreak registered 425 cases with a case fatality rate (CFR) of 53%, while the central district of Luwero experienced two outbreaks in 2011 and 2012, respectively [9]. Considerably, Uganda remains vulnerable to Ebola outbreaks particularly in the wake of frequent outbreaks and possible spill over from her neighbours [6].

Besides human health, Ebola outbreaks affect agricultural production in the country. Ebola epidemics are associated with movement restrictions of people and their animals in and out of the affected communities, and disruption of the food value chain from the farm to consumers [10–12]. Considerably, families face below-average production levels, coupled with market disruptions lead to low purchasing power and reduced incomes [13]. In consequence, food insecurity, fear, social, political and economic turmoil escalate in the affected and at-risk communities.

Agriculture and specially, the pig industry in Uganda, is crucial role in supporting livelihoods by providing nutritional and income security for 1.1 million smallholder farmers [14]. The country's rapid growth of the pig population, at present standing at 1.1 million, is attributed to the high financial returns, low cost of production and increased demand for pork [15]. On the whole, urban and peri-urban consumers account for 70% of consumed pork, accessed through the informal local butcheries and pork eateries referred to as 'pork joints' [16].

Evidently, the zoonotic epidemics such as Ebola cause wide economic impacts beyond the health sector. At present, information on the effect of Ebola outbreaks on the pig value chain in Uganda in general and Luwero district in particular is scanty. Likewise, little is known about the knowledge and beliefs of the rural communities along the pig value chain in Luwero with regard to Ebola outbreaks. Thus, this study assessed the knowledge, perceptions and effects of Ebola outbreaks along the pig value chain in Luwero District. In essence, this study results will guide future plans to mitigate food insecurity and other consequences associated with Ebola outbreaks in communities that rely on pig production.

Materials And Methods

Study design

This cross-sectional study was conducted in Luwero district, located at 0.8271° N, 32.6277° E in the Central Region of Uganda (Figure.1) from May to July, 2014. Largely, the district's economic activity is based on rain-fed agriculture and agro-pastoral livestock husbandry practices for 85% of the population. Pig husbandry practiced by small holder farmers is mainly the traditional free range combined with tethering of the animals [17]. The district consists of thirteen sub-counties, of which Ebola occurred in Kakute village, Ssambwe parish, Nyimbwa sub-county in May, 2011 and Nakisamata village in Ngalonkulu parish, Zirobwe sub-county in December, 2012, [18]. One case was reported in Ngalonkalu parish involving a 12-year-old girl who later died of the disease [19]. In Ssambwe parish, the index case was a 32-year-old motorbike taxi rider Islamic man [20]. He died in hospital and was buried without following safe burial practice because the cause of death has not been established. In total six Ebola cases were confirmed, including four deaths [21].

Eligibility criteria

The study population involved actors along the pig value chain who fulfilled the eligibility criteria. These were small holder farmers with at least 2 pigs. Pig traders involved in sale of pigs, owners of pork-eateries and consumers of pork. Also, households that had registered Ebola related illness or death were included in the study. While small holder farmers with 2 pigs or less, had other livestock other than pigs, and respondents that did not consent or did not report Ebola related illness/death were not considered for the study.

Sampling strategy of study respondents

This study used both qualitative and quantitative methods. A structured questionnaire was used to collect quantitative data from individual respondents along the pig value chain. From each parish of Ssambwe and Ngalonkalu, an index villages where Ebola outbreak occurred, were purposefully selected. The criteria for selecting the remaining three villages in each parish was basing on a shared common border(s) with the index villages for Ebola and having a major road connecting the index to other villages. The adult population (> 18 years) in the two parishes was estimated at 6000 persons with 60% engaged in any form of livestock farming, and 40% (1440 persons) in the pig value chain [15]. A total of 227 respondents was targeted representing about 16% of population actively engaged in the pig value chain. The key aspects considered included respondents' socio-demographics, level of knowledge on Ebola, perception, and effects on pig production, trade and consumption of pork.

The qualitative study utilized focus group discussions (FGDs) and key informant interviews (KIIs) to get an in-depth understanding of the provided data. A total of eight key informants that were conversant with the chronology of Ebola outbreaks in Luwero district were selected for in-depth interviews. These included the community development officer, animal husbandry officers, local council leaders, the district health officer, and village health team members.

A total of four FGDs, two in each parish, composed of 8–10 respondents were conducted for the pig farmers, pig traders (butchers and pork eateries) and pork consumers. An open-ended interview guide was used by a moderator in the local language. FGDs were used to explore the knowledge, possible risk factors and effects of Ebola virus disease along the pig value chain. Deliberately, respondents from the two index villages, and women were among the participants. A digital recorder was used to capture the discussions which were later transcribed into English. An informed verbal consent was obtained prior to this. Each session lasted ninety minutes and ended when subsequent discussions produced no new information [22]. Each FGD was comprised of different categories of respondents which was anticipated to obtain contrasting perspectives that could enrich the discussion. Deliberate efforts were made to include females in the FGDs in the male-dominated community. Mixed gender groups tend to improve the quality of discussions and its outcomes [23].

Data management and statistical analysis

Qualitative data from recorded audios was transcribed verbatim and cross-checked to ensure completeness of data by experienced research associates. A thematic content analysis approach was used for analysis of key emergent themes [24].

Quantitative data was entered in Microsoft Excel and exported to SPSS version 22 for statistical analysis. Descriptive analysis was used to summarize demographic characteristics of respondents.

Respondents' knowledge about Ebola Virus Disease was categorised as agree, disagree or I don't know.

Univariate analysis of categorical data was used in identification of potential risk factors to Ebola. The Chi-square test and Fischer's exact tests were used for cross tabulations. Co-efficient regression was used to investigate associations between the variables and the outcomes. Variables were considered significant at p-value < 0.05. Graph Pad Prism version 6 software was used to carry out repeated measures of analysis of variance (ANOVA) to test the effect on the pig sales at various levels in the pig value chain. Variables were considered significant at p-value < 0.05.

Results

Respondents' socio demographic characteristics

Table 1 summarizes the socio-demographic characteristics of 229 respondents that were involved in the study. Slightly more respondents 121 (52.8%) were from Ssambwe parish, almost half 115 (50.2%) were males, most 141(61.6%) attained at least primary level education and majority 184 (80.4%) were farmers. Regarding involvement in pig value chain, most 142 (62%) of the respondents were pig farmers, and few 20 (8.7%) were pig traders.

Table 1
Summary of the respondents' demographic characteristics

| Variable | Attribute | Parish (N = 229) | | Total |
		Ngalonkulu n = 108	Ssambwe n = 121	
Sex	Male	52(48.1%)	63(52.1%)	115(50.2%)
	Female	56(51.9%)	58(47.9%)	114(49.8%)
Household Head	Husband	53(49.1%)	52(43.0%)	104(45.4%)
	Wife	41(38.0%)	46(38.0%)	87(38.4%)
	Child	14(13.0%)	23(19.0%)	37(16.2%)
Level of Education	None	15(13.9%)	11(9.1%)	26(11.4%)
	Primary	71(65.7%)	70(57.9%)	141(61.6%)
	Secondary	22(20.4%)	37(30.5%)	59(25.7%)
	Tertiary	0(0%)	3(2.5%)	3(1.3%)
Occupation	Farmer	97(89.8%)	87(71.9%)	184(80.4%)
	Employed	2(1.9%)	15(12.4%)	17(7.4%)
	Non-employed	2(1.9%)	6(5.0%)	8(3.5%)
	Business (trader)	7(6.5%)	13(10.7%)	20(8.7%)
Role in the pig value chain	Pig farmers	71(65.7%)	71(58.7%)	142(62%)
	Pig traders	7 (6.5%)	13(10.7%)	20(8.7%)
	Pork consumers	30(27.8%)	37(30.6%)	67(29.3%)

Respondents' knowledge about Ebola Virus Disease

Respondents were assessed on their ability to recall the occurrence of an Ebola outbreak in the parish or neighbouring village; knowledge of transmission; clinical manifestation and treatment of the disease. Out of the 229 respondents, 219 (95.6%) could recall the occurrence of an Ebola outbreak in their locality (Table 2).

On transmission, a significant number (p < 0.001) of correctly associated Ebola transmission with handling Ebola infected persons 194 (84.7%), migration of people from endemic areas 191 (83.4%), eating monkey meat 148 (64.9%), eating bats 127 (55.5%) and conducting public meetings where there is an Ebola infected person 198 (64.9%). It was also noted that 56 (24.5%) of respondents associated eating pork or touching pigs to Ebola transmission (Table 2).

Table 2
Respondents knowledge of Ebola virus disease transmission

Knowledge assessment	Response (%)			
	Agree	Disagree	I don't know	p- value
i) Ability to recall				
Ability to recall occurrence of Ebola outbreak	219 (95.6%)	8 (3.5%)	2 (0.9%)	< 0.001
ii) Transmission mode				
Handling Ebola Infected persons	194 (84.7%)	9 (3.9%)	25(11.4%)	< 0.001
Eating Bush meat	115 (50.2%)	45 (19%)	69(30.1%)	< 0.001
Eating monkey meat	148 (64.9%)	15 (6.6%)	65(28.5%)	< 0.001
Migration of people from Ebola endemic areas	191 (83.4%)	6 (2.6%)	32 (14%)	< 0.001
Public meetings with Ebola infected persons	198 (86.5%)	6 (2.5%)	25(10.9%)	< 0.001
Eating pork/ touching pigs	56 (24.5%)	169(73.8%)	4 (1.7%)	< 0.001
iii) Ebola clinical signs				
Fever	142 (62.3%)	5 (2.2%)	81 (35.5%)	< 0.001[a]
Vomiting Blood	160 (71.1%)	3 (1.3%)	62 (27.6%)	< 0.001[a]
Diarrhea	171 (75.3%)	3 (1.3%)	53 (23.3%)	< 0.001[a]
Hemorrhage	168 (74.0%)	4 (1.8%)	55 (24.2%)	< 0.001[a]
Muscle Pain	84 (37.0%)	7 (3.1%)	136 (59.9%)	< 0.001[b]
Headache	85 (37.1%)	10 (4.5%)	177 (79.7%)	< 0.001[b]
Skin rash	21 (9.6%)	5 (2.3%)	192 (88.1%)	< 0.001[b]
Sore throat	35 (15.8%)	10 (4.5%)	177 (79.7%)	< 0.001[b]
iv) Seeking treatment for Ebola virus disease				
Traditional healer/witchdoctor	63 (30.1%)	131 (62.7%)	15 (7.2%)	< 0.0001
Clinics/Hospital (Doctor)	97 (49.2%)	78 (39.6%)	22 (11.2%)	< 0.0001
Pharmacy (drug shops)	60 (30.5%)	112 (56.9%)	25 (12.7%)	< 0.0001
Local herbs (Home treatment)	5 (2.6%)	169 (86.7%)	21 (10.8%)	< 0.0001
Village Health team	3 (1.5%)	171 (87.7%)	21 (10.8%)	< 0.0001
[a] Significantly "agreed"; [b] Significantly "didn't know"				

Respondents' knowledge of clinical signs associated with Ebola

Regarding clinical manifestation, bleeding from body openings, fever, vomiting blood and diarrhoea were the signs that most respondents highly associated with Ebola. However, other signs such as muscle pain, headache, rash and sore throat were not associated with Ebola (Table 2).

Knowledge on seeking treatment for Ebola virus disease

A majority of the study respondents preferred seeking Ebola treatment from clinics and hospitals. However, 63(30.1%) respondents suggested that an Ebola patient could be treated by a traditional healer. This was supported by the FGDs as quoted *'I always consult our traditional healer before taking my patient to hospital. I have learnt that traditional healers have divine powers to guide us, and most times what they tell us is what comes out'.*

Respondents' perception of pigs as the source of Ebola virus disease

As shown in Table 3 the perception about the source or ways through which Ebola virus disease can be transmitted was assessed. Of 229 respondents, 56(24.5%) associated occurrence of Ebola to eating or touching pigs while 173(75.5%) did not associate Ebola virus disease to pigs. Significantly more respondents from Ssambwe (37.2%) than Ngalonkulu (10.2%) associated pigs with Ebola in Luwero

Table 3
Respondents' perception of Ebola Virus Disease

Variable	Response	Parish		Total	p- value
		Ngalonkulu	Ssambwe		
Association of pigs with Ebola	Yes	11 (10.2%)	45 (37.2%)	56 (24.5%)	
	No	97 89.8%)	76 (62.8%)	173(75.5%)	< 0.001

Table 4
Perceived risk factors and practices that may lead to the occurrence of Ebola

Variable	Attribute	Presence of Ebola			
		With case (%)	With no cases (%)	Correlation coefficient	p-value
Bush meat consumption	Yes	4 (1.7)	111 (48.5)	-0.005	0.933
	No	4 (1.7)	110 (48.0)		
Consumption of Pork	Yes	7 (3.1)	92 (40.2)	0.105	0.11
	No	1 (0.44)	129 (56.3)		
Monkey meat consumption	Yes	7 (3.1)	142 (62.0)	0.059	0.37
	No	1 (0.44)	79 (34.5)		
Eating Bats	Yes	5 (2.1)	124 (54.1)	0.083	0.21
	No	3 (1.3)	97 (42.4)		
Bats in houses	Yes	4 (1.7)	93 (40.6)	0.025	0.703
	No	4 (1.7)	128 (55.9)		
contact with wild animals	Yes	0 (0.0)	4 (1.7)	-0.022	0.74
	No	8 (3.5)	217 (94.7)		
Working in a pig enterprise	Yes	3 (1.3)	17 (7.4)	0.214	0.132
	No	5 (2.1)	204 (89.1)		
Farming system	Yes	0 (0.0)	5 (2.1)	-0.052	0.511
	No	8 (3.5)	216 (94.3)		

With reference to the perceived risk factors and practices of acquiring Ebola virus, there was no correlation to all factors (Table 4). This was also in concurrence with one of the respondents quoted as in the FGD,

"……………we don't believe that one can contract Ebola from eating monkey meat, we have eaten bush meat for years and none of us has contracted Ebola."

Effect of Ebola outbreak on the demand and sales of pigs and consumption of pork

Out of 142 farmers, 55 (38.7%) believed that Ebola outbreaks affected demand of pigs (Table 5). Similarly, from a Focus Group Discussion, where a study participant was quoted,

"…….. Ebola outbreaks greatly affected demand for pigs and other farm products. Traders from Kampala did not come to buy pigs during that Period, they feared to acquire Ebola disease."

Out of the 20 traders, 17 (85%) were in agreement that Ebola reduced pig sales (Table 5). There was a significant reduction (P<0.001) in pork consumption during Ebola outbreaks. Out of the 67 consumers in this study, 15 (22.4%) did not consume pork during the Ebola outbreak (Table 5).

In concurrence with FGD, one respondent was quoted as,

"……I feared to consume pork because I thought I would contract Ebola disease; we were told to avoid consuming any meat during that period."

Table 5
Effect of Ebola outbreak on the pig value chain

Variable	Attribute	Frequency (N) (%)
Reduced Demand (farmers)	Agree	55 (38.7%)
	Disagree	75 (52.8%)
	I don't know	12 (8.5%)
Reduction in pig sales (Traders)	Yes	17 (85%)
	No	3(15%)
Consumed Pork during Ebola outbreak	Yes	52 (77.6%)
	No	15 (22.4%)

As in Table 6, there was a significant reduction (P = 0.001) in the average number of pigs sold during Ebola outbreak period. There was also a significant reduction (P = 0.04) in the average number of pigs bought by traders during the Ebola outbreak. Similarly, it is clearly seen that the number of pigs sold/ slaughtered by butcher men at pork eating places reduced significantly (P = 0.03).

Table 6
Pig sales and price indices during Ebola outbreak period in Luwero district

Mean SD (Pigs sold per period)				
Persons involved in pig sales	Before	During	After	P-value
Farmer N = 142	4 ± 3	3 ± 1	3 ± 2	0.001*
Trader N = 20	4 ± 3	4 ± 2	5 ± 3	0.04*
Pork butchers N = 9	7 ± 3	5 ± 3	6 ± 3	0.03*
Price indices	Estimated average kg SD)	Price per Kg (USD	USD	
Price	426 + 255	353 + 237	326 + 250	
Price/kg (US$)	2.5	1.6	1.8	
Total US$	1065.00**	564.8*	684.00**	
*Significantly lower during the Ebola outbreak (Repeated measures ANOVA, P < 0.05)				
**statistically significant when compared before, during, and after Ebola outbreak.				

The unit cost of a kilogram of pork reduced during the outbreak. The income generated from pork sales reduced significantly during the outbreak when compared to the period before and after the outbreak (Table 6)

Discussion

Highly infectious emerging zoonotic diseases such as Ebola are a major cause of morbidity and mortality in Africa [25] as shown by the recent outbreaks in West and Central Africa [7, 26]. The past six Ebola outbreaks in Uganda accentuate the country's vulnerability to further outbreaks, especially due to spill-over from the Democratic Republic of Congo, a neighbouring country prone to frequent Ebola outbreaks [27, 28]. Also, Uganda's location in an area with great biodiversity, together with a fast-rising population density that comingle closely with animals are high risk factors for Ebola and other emerging zoonotic diseases [27, 29].

Our focus on the Ebola outbreak with respect to the pig value chain, was prompted by Uganda's fast growing pig sector, that continues to register increasing pork consumption rates (average of 3.4 kg/person per year), the highest in East Africa [30]. Primarily, the national Ebola control programs are designed to protect the human health and remotely consider enterprises that support farmers' livelihoods. However, the neglect of the community's survival and sustenance options, especially the pig value chain could lead to adversative effects on livelihoods. With the recent zoonotic disease prioritization [31] and having the multi-sectoral-multi-agency One health strategic plan in place [32], Uganda has the opportunity to embrace a One Health approach while handling Ebola and other priority zoonotic diseases for the benefit of the community. Effective post-Ebola intervention plans in Uganda and elsewhere, must encompass the primary sources of livelihoods for such agro-pastoral communities in order to mitigate the negative impacts of the disease. For instance, farmers could be provided with breeding pigs, access to credit, and training for the small holder pig enterprises. This is in concurrence with strategies put in place in West Africa in lieu of efforts to stimulate social and economic recovery of vulnerable

communities affected by Ebola [33]. Ebola control programs cognisant of the inter-sectoral collaboration that would assure sustainable pig production, supply and marketing for the small holder pig farmers in Uganda.

With regards to knowledge, a majority of the respondents were able to recall previous Ebola outbreaks in Luwero that occurred more than two years ago. This was contrary to common health care events, often not recalled accurately within a few months of occurrence [34]. Most likely, the impact of Ebola outbreaks associated with economic turbulence and social stigma in communities appear to last longer. Indeed, people tend to remember disastrous events associated with excessive changes in routine life, even after several years of the incident [35]. One such event was the introduction of 'safe burial' practices for Ebola victims [36]. Whereas this was needed to prevent disease spread, the communities misconstrued the practice as being disgraceful and demeaning to the dead. This is because the bereaved family members were denied a chance to pay their last respect to their dead, (pray, wash, dress, perfume the corpses) and mark the graves of the deceased [36]. In effect, this caused psycho-social trauma among relatives and community members that might have led to long-term memories which lasted for several years, even after the Ebola outbreak.

The fact that respondents were able to identify the major signs and symptoms of Ebola such as fever, vomiting, bleeding and diarrhoea was not unexpected. These were frequently shared on the information education and communication materials that were available in the community health centres and public spaces in Luwero [37]. Communities that are able to identify the main signs of Ebola can ably avoid the infections when such cases occur. However, other important signs which are frequently associated with common ailments such as malaria could not be identified, suggesting that the community could mistakenly handle Ebola patients with minimal or no precautionary measures. This is particularly possible if Ebola presents with nonspecific symptoms that can easily be mistaken for other endemic diseases like malaria, typhoid fever, yellow fever or, even measles or meningococcemia in children [38]. Efforts should be put in place to educate the public to consider patients with such signs as suspected cases, especially when there is an Ebola outbreak in the community.

Besides, the health centres, a significant proportion of patients suspected to have Ebola could be treated by traditional healers or witchdoctors. A number of communities in Uganda and elsewhere in Africa still associate Ebola outbreaks with witchcraft [20]. Traditional healers have evolved with communities in Africa, and continue to offer first line of health care services in Uganda for unknown ailments believed to be associated with witchcraft to appease the spirits [20, 39]. Nonetheless, escalation of Ebola infections in West Africa and DRC was linked to traditional healers due to inability to adhere to preventative measures [40]. Training traditional healers on the basic preventive measure for Ebola and closely monitoring their operations would minimize spread of the disease in the community.

This study observed mixed perceptions on the transmission of Ebola with a majority linking transmission with eating of bats, monkey and bush meat. This was in conformity with the study conducted by [5, 41, 42], who noted that consumption of bush meat could contribute to infection. Conversely, the respondents did not consider eating of game meat as a high risk factor, probably because in earlier outbreaks that occurred in Kibaale district [43] and also in Luwero district [20] the victims could not be linked to eating of wild animals such as monkeys before falling ill. Meanwhile, as eating of bats or other wild animals could not be regarded as a high risk for acquiring Ebola, hunting and eating of game meat continues unabated, exposing the vulnerable communities to future Ebola infections. Besides hunting game meat for authentic values, most communities depend on wild game as

source food and income security. Efforts to provide alternative livelihoods and food security could protect vulnerable communities from Ebola.

Our findings showed that the unit cost of pork was significantly reduced during Ebola outbreak. Also, the average number of kilograms of pork sold as well as the final income significantly reduced during the outbreak. This was in conformity with the assertions that beyond the public health impacts, emerging global infectious cause wider socioeconomic consequences often disregarded in impact assessments [44]. This could be attributed to the human health sector-based Ebola preparedness and prevention practices and the public behaviour of stigmatizing the pigs as the source of Ebola that led to avoidance of eating pork. Evidently, zoonotic infectious disease outbreaks have been associated with substantial economic impacts due to disruption of the livestock markets (44). In consequence, the reduced sales and incomes negatively impacted the household incomes. In accord with prior reports from West Africa, household and community incomes dropped significantly during the Ebola outbreak [45] leading to increased food insecurity and household vulnerability.

A plausible explanation for the reduced sales of pigs/pork was due to the misconception that pigs were the source of Ebola, creating fear of contracting the disease and avoiding eating of pork by the consumers. It was not clear why the community associated pigs with the Ebola. However, the two Ebola outbreaks in Luwero were apparently preceded by African swine fever (ASF) epidemics with wide spread mortalities of pigs in the community. Besides, pigs with ASF show signs of haemorrhages on the skin and in internal organs, labored breathing with frothy nasal discharges mixed with blood, and death of most affected animals within 2-5days [46]. Farmers have frequently observed reddening of the ears, clinical signs consistent with of ASF [47, 48]; but more less the same sign (bleeding) is observed in human cases with Ebola. As a result, the ASF in pigs and Ebola in humans are erroneously believed to be caused by the same agent that originates from pigs. To clear this misconception, a deliberate social-anthropological understanding of the agro-pastoral communities with regard to such diseases should be given priority attention to minimize losses to the pig industry in future.

Conclusion

There was a significant reduction in pig sales, price per unit cost of a kilogram of pork and pork consumption. On health seeking behavior, traditional healers were preferred as the first line of health care providers to Ebola patients. These may in the long run escalate the outbreak of Ebola since they do not adhere to preventative measures during their ritual practices. There was no correlation of the perceived risk factors to Ebola outbreak and therefore this indicated that probably another unknown factor may have led to Ebola outbreaks in Luwero district. However, the association of Ebola Virus Disease with pigs is detrimental and could affect the entire pig value chain in terms of pig production, pig sales and pork consumption.

Recommendations

There is need for a One health inter-sectoral collaboration of agricultural and health sectors to while designing preparedness and prevention programs for Ebola and other emerging zoonotic diseases in Uganda. Farmers should be sensitized that pigs are not a source of Ebola. Traditional healers should be trained and their role monitored during future Ebola virus disease outbreaks. Socio-anthropological studies need to be conducted in order to understand the way communities perceive Ebola Virus disease.

Abbreviations

ANOVA: Analysis of Variance

ASF: African Swine Fever

CFR: Case Fatality Rate

EVD: Ebola virus disease

FGD: Focus Group Discussion

KII: Key Informant Interview

Declarations

Ethics approval and consent to participate

This project was part of the on-going study under the project Capacity Building in Management of Integrated Trans-Boundary Animal Diseases and Zoonoses (CIMTRADZ) for which approval had been granted by the Institutional Review Board. Permission was sought from Luwero District Local Government. We sought verbal informed consent in the local language from respondents (survivors, close relatives of the deceased, and local leaders). The respondents had to be 18 years old and above and willing to be interviewed. They were informed that their participation was voluntary and their refusal would not result in any negative consequences. During data analysis, we used unique identifiers to ensure confidentiality.

Consent for publication

All others have given their consent to publish the manuscript

Competing interests

The authors declare that they have no competing interest.

Funding/ Disclaimer

This study was funded by the Capacity Building in Integrated Management of Trans boundary Animal Diseases and Zoonoses (CIMTRADZ) – HED project. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. Data and any relevant material required will be available.

Author Contributions

All authors contributed substantially to the write-up and review of the manuscript. DB wrote the drafts of the manuscript and revised the paper for substantial intellectual content. TS and DB were involved in field data

collection and writing the manuscript. GT and CDK participated in the conceptual design and analysis of data. MO and SM supervised the process of data collection, write up and reviewed the paper for substantial intellectual content. All the authors read and approved the final version of the manuscript.

Acknowledgements

Data Availability statement

Primary data was used to support the findings in this study. The dataset used in this investigation are available from corresponding author upon request.

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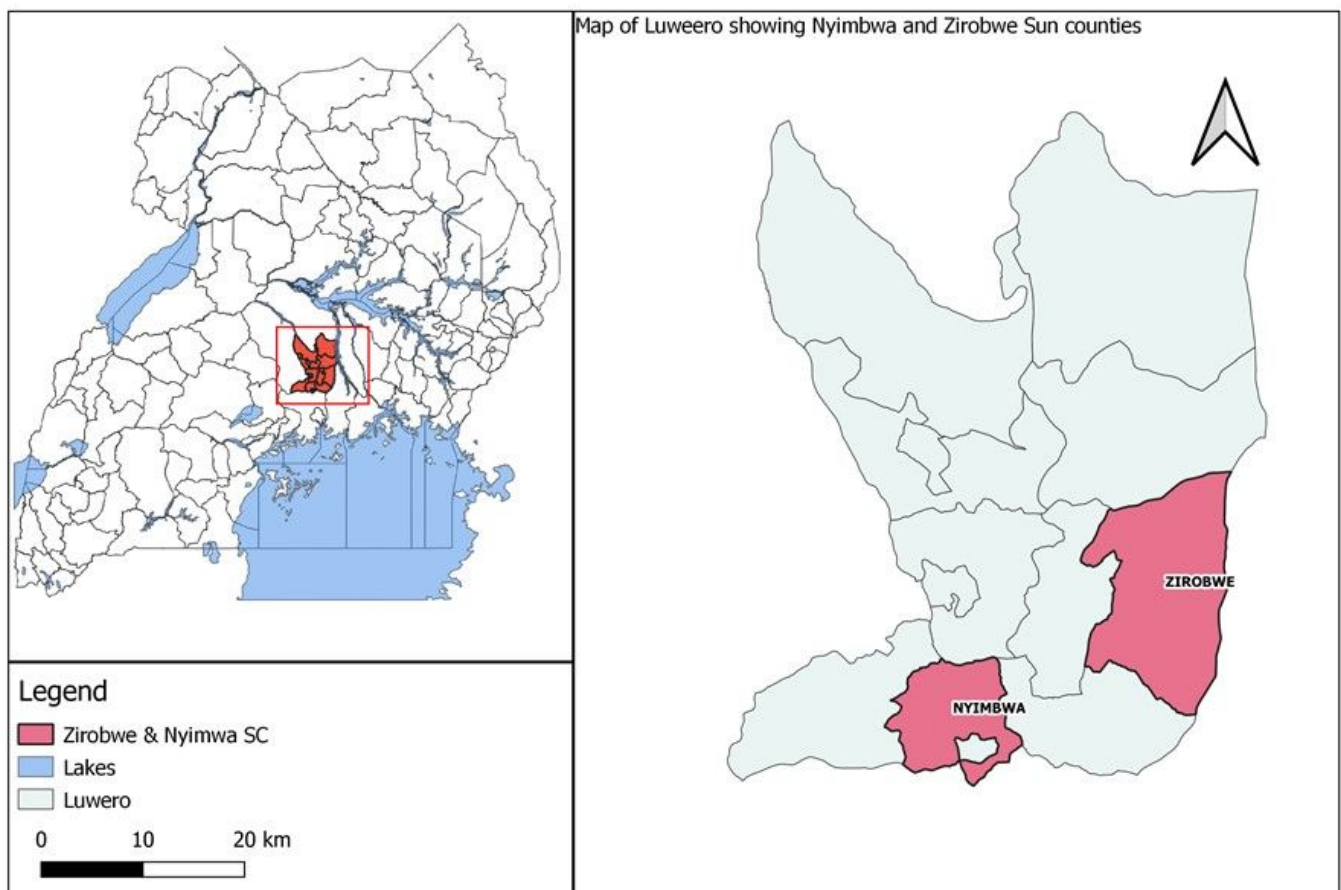
Figures

Figure 1

Map of Uganda showing Zirobwe and Nyimbwa sub-counties in Luwero District. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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