

Full Length Research Paper

Knowledge, attitudes and practices of communities towards neurocysticercosis in the districts of Amuru and Gulu, Northern Uganda

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Neurocysticercosis (NCC) is the hematogenous invasion of brain by the larval stage of pork tapeworm, *Taenia solium*. The aim of the study was to investigate the knowledge, attitudes and practices among communities in two districts of Northern Uganda. A community based cross sectional study was conducted between February to March 2019 in two Sub-Countries of Amuru and Gulu districts. Multi-stage sampling and lottery methods were used to select the study sites and the respondents, respectively. Data was collected from 296 participants. Bivariate and multivariate analyses were used to detect the independent factors associated with dependent variables. Variables with $P < 0.05$ were considered as statistically significant. Fifty six percent (56%) of the participant had moderate knowledge about NCC. Respondents with satisfactory level of attitude and practices were 52.3 and 51%, respectively. Sixty percent (60%) of the respondents eat pork. Majority (94.3%) of the respondents always wash their hands after visiting toilets. Sixty seven percent (67%) of the respondents agreed that epileptic patients should marry but seventy (70%) reported that they should not go to school. Majority (80%) of the respondents reported that NCC patients should be taken to hospital for medical care. Multivariate logistic regression model revealed sex ($P=0.017$, $OR=1.27(95\%CI: 1.04-1.54)$), level of education ($P=0.006$, $OR= 4.451(95\%CI: 1.49-12.20)$) and occupation ($P=0.03$, $OR=3.843(95\%CI: 1.13-12.71)$) were more significantly associated with knowledge on NCC. Sex ($P = 0.013$, $OR= 1.88 (95\%CI: 1.14-3.10)$), level of education ($P= 0.031$, $OR= 5.43(95\%CI: 1.17-25.20)$) was significantly associated with positive attitudes towards patients with NCC. Male exhibited better practices towards patients with NCC ($P<0.05$). The findings indicate that there is a limited knowledge on NCC among the rural communities in the district of Amuru and Gulu, Northern Uganda. In addition, the findings show that the communities practice risky behaviors that promote development of NCC in the region. The intervention of health authorities in this area is required for the prevention and/or control NCC in the region.

Key words: Communities, knowledge, attitude, practices, neurocysticercosis, Northern Uganda.

INTRODUCTION

Neurocysticercosis (NCC) is the hematogenous invasion of the central nervous systems (CNS) with the cysts of *Taenia (T) solium* pork tapeworm and presents serious public health problems in endemic region (Deckers and Pierre, 2010; Goitra et al., 2011). The condition arises from a two-stage development cycle between the pigs and humans when infected with cysticerci (Kungu et al., 2017). The first cycle of development stage occurs in pigs which serve as the intermediate hosts causing porcine cysticercosis. The second cycle of development stage occurs in humans who serve as the definitive hosts leading to taeniasis (Kungu et al., 2017). Humans and pigs acquire the larval form of the worm by ingesting the eggs of the parasite or by consuming food or drinking water contaminated with the worm's eggs (Moulton et al., 2007; Dahourou et al.; 2018). It has been demonstrated that carriers of adult tapeworms can get cysticercosis by retro-peristaltism (Dahourou et al., 2018). In humans, cysticerci migrate through the intestinal mucosal wall into the blood circulation, penetrate other striated muscles and eventually form cyst in the brain leading to NCC (Lescano et al., 2007). NCC is the most common helminthic infection of the human. CNS and has been recognized as a major cause of secondary epilepsy in endemic areas (Schmidt et al., 2015; Chacha et al., 2014). Globally, 2 billion people suffer from cysticercosis and 50,000 die of cysticercosis-related diseases annually (Ar Ka Aung et al., 2016; Dorny et al., 2017). In Sub-Saharan Africa (SSA) the estimates of NCC range between 1.9 and 6.16 million people (Chacha et al., 2014; Schmidt et al., 2015). In Uganda, despite significant information about NCC, the country still lags behind in respect to this disease in the region (Alarakol et al., 2018). A previous study conducted among patients with epilepsy in Northern Uganda indicates 15% of the patients were exposed to *T. solium* infections (Alarakol et al., 2017), ostensibly contributing to late onset of epilepsy among NCC patients. The risk factors for NCC include; consumption of undercooked infected pork, free range rearing of pigs, poor sanitation, deliberate use of human feces as fertilizers or feeds for pigs, open defecation, negative attitudes and beliefs (Powloski et al., 2005; Ar Ka Aung and Spleman, 2016; Mwape, 2018). Additionally, previous studies have reported that knowledge, positive attitudes and practices have influence on the prevention and /or control of parasitic infections (Chacha et al., 2014; Dahourou et al., 2018). However, most of these studies were conducted in regions with unique characteristics geographic,

socioeconomic and cultural settings. Northern Uganda, in particular, is uniquely inhabited by majority of the communities who were formally been in Internally Displaced Camps during the Lord's Resistance Army (LRA) war and their social, cultural and community structures have been totally disrupted (Baines and Gauvin, 2014). In order to institute effective interventional programs for NCC in the region, it is important to know the current knowledge, attitudes, practices and beliefs about NCC among the rural communities. The aim of the study was to investigate the current knowledge, attitudes and practices (KAP) in relation to NCC prevention and/or control among communities in the districts of Amuru and Gulu, Northern Uganda.

MATERIALS AND METHODS

Study design

A cross sectional study to investigate the in-depth dimensions of communities knowledge, attitudes, practices and beliefs was conducted between February and March 2019 among rural communities in the two districts of Amuru and Gulu, Northern Uganda. Quantitative and qualitative methods were used to collect the research data. Qualitative data were collected and analyzed as described by Bryman (2001). Informed consents were obtained from all the respondents. The research protocol was approved by Gulu University Research Ethic Committee (GUREC) and Uganda National Council of Science and Technology (UNCST).

Study setting

This study was conducted in two sub counties in each district of Amuru and Gulu, Northern Uganda. The two districts cover a total area of over 3000 km² with an estimated population of 600,000 inhabitants (Uganda Population and Housing Census, 2014). The two districts were purposely selected because they are among the pig producing districts in Northern Uganda (Ikwap et al., 2014), and their proximity to Gulu Municipality. Lamogi Sub County (Amuru district) and Unyama Sub County (Gulu district) are the main suppliers of pigs to slaughter houses in Gulu Municipality. Unyama Sub-County has four parishes and 16 villages with approximately 4000 households (population of 15,000). Lamogi Sub- County has five parishes and fourteen villages with 5000 households (population of 16,000). The two Sub-Counties are the sources of the livelihood of many people in the area who largely depend on pig farming in the area. The communities in these areas practice largely subsistence farming where peasant farmers focus on growing food stuffs to feed themselves and their families (Alarakol et al., 2018). These areas have high level of poverty, lack sanitation infrastructure and the communities practiced free range pig farming which provide suitable environment for survival of *T. solium* in the

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study population (Alarakol et al., 2017). Most of the pigs are usually kept in pens at night and released in the morning to scavenge for foods in the environment (Alarakol et al., 2017). In addition, these areas have shortage of pit latrines as well as safe sources of water for domestic use. The pit latrines coverage is estimated at 89% of the population (Uganda Population and Housing Census, 2014). The main sources of water in these areas are: ground springs, wells, bore holes, tap-water and protected wells (Uganda Population and Housing Census, 2014). The research participants including rural communities, community leaders and local authorities were selected from the Sub-County of each district under study.

Sample size determination

The estimation of the sample size for this study was done according to a formula described by Kish (1965). Since, there are no KAP studies done in the two districts previously, a 50% estimate was considered at 95% confidence interval, with a 10% margin of error. Therefore, a total of 96 samples were required. In order to minimize the sampling error, this value was doubled and multiplied by the design effect at 1.5 to 288. This was adjusted by 2.5% to 296 to cater for non-responses. Thus, the overall sampled size was 296.

Sampling procedures

A multi-stage cluster sampling technique was used to select eligible study participants. The districts of Amuru and Gulu were purposively selected for the study. A two-stage cluster sampling method was used to select the participants. In the first stage, two Sub counties clusters were randomly selected using simple random sampling technique. This includes Unyama and Lamogi Sub-counties in Gulu and Amuru districts respectively. In the second stage, two parishes and 8 villages were randomly selected. The identified study participants in the households were selected by simple random sampling. The individuals selected were consented prior to being included in the study.

Data collection

Self-administered semi-structured questionnaires were used to collect the data. The questionnaires were first pretested with a limited number of samples (20%) in Patiko Sub County outside the study area to check for the quality and validity of the questions. Data on demographic characteristics, knowledge, attitudes and perceptions were collected. The study protocol was fully explained to the participants prior to the administration of the questionnaires. Additionally, key informant interviews were conducted by the researchers using interview guides. Participants provided informed consent to participate in the interviews. The interview lasted approximately an hour and respondents were compensated in cash. The key issues discussed related to knowledge, attitudes, practices, beliefs and norms.

Statistical analysis

Both descriptive and analytical statistics were used. The data are presented as mean, standard deviation, frequency and variance. Pearson's chi-square was used to test for levels of significance between means of proportions. Bivariate logistic regression was used to test for the strength of association between dependent and independent variables. Variables with P value less than 0.2 were

included into multivariate logistic regression to detect for possible predictors of knowledge, attitudes and practices towards NCC in the region. All values greater than statistical P value 0.05 was considered significant. Data from the key informant interviews were analyzed manually using thematic analysis. Themes were developed for key words noted from the interview and further analyzed for commonalities, variations and disagreements.

Knowledge, attitudes and practices performance scores

Performance scores were calculated for each of the variables used to assess knowledge on Neurocysticercosis as described by Kungu et al., (2017). Briefly, 0 to 10 points were assigned as overall scores to the responses on questions assessing each knowledge variable. A respondent was considered to have knowledge on a variable when his/her responses scored 8 to 10 points and these were then recoded into dichotomous variables (Yes versus No). Similarly, good and bad practices and/or attitudes were recorded and their mean scores calculated. The scores were ranked from 1 to 10. The highest score was given to the respondents with the best practices. Any score greater than their mean scores or higher was considered good. The knowledge, attitudes and practices scores for each study participants were used to calculate percentage scores out of possible maximum assumed points of 73, 53 and 64 for knowledge, attitude and practice respectively.

RESULTS

Demographic information of the study population

A total of 296 respondents were interviewed between February and April, 2019 (Table 1). The mean age of the study participants was 37 ± 14.1 years and ranges from 17 to 87 years old. Majority of the participants were in the age groups 20-29 and 30-39, respectively. There was an almost equal gender enrolment for this study with females, 150 (50.7%). Religion distributions were; Catholic 205 (69.3%), Protestants 66(22.3%) and Pentecostal based organization, 15 (5.1%). More than half 164 (55.4%) of the participants had no formal educations and basically derived their livelihood through farming 183 (61.8%). Most 223 (75.3%) were married persons who have lived in the study area for more than thirty years (Table 1).

Knowledge on neurocysticercosis among communities

Table 2 shows communities' knowledge on NCC. Of the 296 respondents, 204 (69%) practiced pig farming with more than half (51%) of the respondents' pigs were farmed by free range system. Eighty percent (80%) of the pig farmers largely rear pigs for sale and more than sixty percent (62.2%) of them knew pork tapeworms. However, majority (45%) had no knowledge of having ever passed out tape worms in their feces. Most (80%) respondents could not recognize tape worms when shown to them in

Table 1. Demographic characteristics of study population (n=296).

Independent variable	Frequency	Percentage
Sex		
Male	146	49.3
Female	150	50.7
Age		
10-19	27	9.1
20-29	89	30.1
30-39	81	27.4
40-49	44	14.9
50-59	34	11.5
60+	21	7.1
Marital status		
Married	223	75.7
Single	49	16.6
Widowed	24	8.1
Religion		
Catholic	205	69.3
Protestant	66	22.3
Moslem	5	1.7
Jehovah	5	1.7
Pentecostal	15	5.0
Education level		
None	164	55.4
Primary	69	23.3
Secondary	33	11.1
Tertiary	30	10.1
Occupation		
Farmers	183	61.8
Business	49	16.6
Teachers	44	14.9
Others	20	6.8
Residency (year)		
< 1	71	24.0
>1	22	7.4
>4	46	15.5
>10	44	14.9
>30	113	38.2

study pictures. 80% of the respondents had heard about NCC but only 46% knew how humans get infected with NCC. Majority (74%) did not know how pigs get infected with tapeworm but most (65%) heard about the white nodules (rice) in the pigs.

Attitudes among communities about neurocysticercosis

Of the 296 respondents, 45 (15.2%) reported that they were diagnosed positive for tapeworm infections (Table

Table 2. Knowledge on neurocysticercosis among communities (n=296).

Variable	Frequency	Percentage
Knowledge on tape worm		
Yes	184	62.2
No	112	37.8
Recognition of tapeworm		
Yes	36	19.6
No	148	80.4
Whether expelled tapeworm in their feces		
Yes	39	13.2
No	121	40.9
Don't know	136	46.0
Keeping pigs in this homestead		
Yes	204	68.9
No	92	31.1
Whether the pigs are free ranged		
Yes	47	51.1
No	45	48.9
Purpose for keeping pigs		
Consumption	10	10.9
Sale	74	80.4
Reproduction	6	6.5
Others	2	2.2
Knowledge on how pigs get infected		
Yes	77	26.0
No	219	74.0
Whether seen or heard of white nodules in pig		
Yes	195	65.9
No	101	34.1
What happens to pig founded infected?		
Sell them	53	18.0
Slaughter and eat them	64	21.7
Slaughter and bury	57	19.3
Others	121	41.0
Knowledge to identify pigs infected nodules		
Yes	137	46.3
No	159	53.7

3). 33(11.0%) reported felt extremely sad when diagnosed positive for tapeworm and up to (46%) reported they knew the danger associated with NCC. 55% routinely deworm their pigs and 45% sought

veterinary assistance. Majority (74%) of the participants did not have patients with NCC at their homes. However, most (95%) respondents agreed that NCC patients should be taken to the hospital for medical services.

Table 3. Attitudes among communities on neurocysticercosis (n=296).

Variable	Frequency	Percentage
Being diagnosed to have tape worm		
Yes	45	15.0
No	255	84.8
Feeling when you were told you had tape worm		
Extremely sad	33	11.0
Very sad	45	15.0
Sad	12	4.0
Having person with epilepsy at home		
Yes	74	25.0
No	222	75.0
Treatment of patients with epilepsy at home		
Very well	30	10.0
Well	210	70.0
Fairly well	46	15.1
Not well treated	10	3.3
Whether patients with epilepsy should go to school		
Yes	67	76.7
No	10	23.3
Whether patients with epilepsy should be taken for medical care		
Yes	281	94.9
No	15	5.1
Where are patients with epilepsy can get medical care		
Health centers 111	6	2.0
Health center IV	26	8.7
Clinics	30	10.0
Village health team	4	1.3
Hospital	230	76.7
Whether people with epilepsy should marry		
Yes	216	73.0
No	80	27.03

73% of respondents reported NCC patients should also enjoy the right to marry. Most (76.7%) of the respondents agreed the NCC patients should be sent to school to study.

Community's practices and beliefs on neurocysticercosis

Of the 296 respondents, 66.9% had toilets and reported always washing their hands (94.3%) after using the facility (Table 4). Majority (74.7%) reported eating pork but 5.1% did not throw away pork meat infested with

cysticerci (condemned pork meat). When asked about eating infested pork, one respondent confessed, "meat is not thrown away but it is smoked, dried on fire, cooked and eaten". He added, "Meat's soup is better than vegetable's soup my dear". Furthermore, a respondent confessed that meat is never buried in soil as it is a taboo in their culture". He added. The most interesting finding in this study was when one of the respondents told the researchers that; "here in the village, no parts of the pigs are thrown away including their hoofs". Most respondents (75.8%) send their pigs for vaccination and routinely conduct deworming exercises. Respondents with epileptic patients in their homes send them (94.3%) for

Table 4. Community practices on neurocysticercosis (n=296).

Variable	Frequency	Percentage
Pork consumption		
Yes	221	74.7
No	75	25.3
Whether persons eat cyst from pork meat		
Yes	15	5.1
No	281	94.9
Sending pigs for vaccination		
Yes	150	75.8
No	48	24.4
Sending patients with epilepsy for medical care		
Yes	279	94.3
No	17	5.7
Have pit latrines at home		
Yes	198	66.9
No	98	33.1
Use of pit latrines at home		
Always	249	89.3
Sometimes	30	10.8
Never	17	5.7
Hands washings after using toilet		
Yes	204	73.1
No	75	26.9
Eating roasted or cooked pork		
Both	156	52.7
Roasted only	46	15.5
Cooked only	94	31.7
Routine deworming of your pigs		
Yes	164	73.1
No	132	26.9
Seeking help from veterinary assistants		
Yes	135	55.4
No	161	44.6

medical care and those with pigs routinely (55.4%) seek veterinary assistance.

Factors associated with knowledge towards neurocysticercosis

The bivariate analysis of the variables sex, age group, marital status, religion, occupation, and residency and education level was conducted to ascertain their association with knowledge on NCC. The data with

p-value less than 0.2 in the bivariate analyses were included into multivariable logistic regression model. Multivariate logistic regression analysis indicated no statistically significant difference between age groups, marital status, religion and duration of residency in respect to factors associated with knowledge on NCC. However, sex ($P=0.017$, $OR=1.27(95\%CI: 1.04-1.54)$), level of education ($P=0.006$, $OR=4.451(95\%CI: 1.49-12.20)$) and occupation ($P=0.03$, $OR=3.843(95\%CI:1.13-12.71)$) were significantly associated with better knowledge on NCC (Table 5).

Table 5. Factors associated with knowledge towards neurocysticercosis.

Variable	Category	Knowledge on NCC		χ^2	P- value (95%CI)
		Yes	No		
Sex	Male	95(65.0)	51(35.0)	3.50	0.017(1.57-102.5)*
	Female	89(59.3)	61(40.7)		
Age group	10-19	20(74.1)	7(26.0)	2.95	0.052(0.98-69.6)
	20-29	58(65.2)	31(34.8)		
	30-39	49(60.5)	32(39.5)		
	40-49	27(61.3)	17(38.6)		
	50-59	19(55.9)	15(44.1)		
	60+	11(52.4)	10(47.6)		
Marital status	Married	136(60.9)	87(39.01)		
	Single	35(71.4)	14(28.6)		
	Divorced	13(54.2)	11(45.8)		
Education level	None	97(59.2)	67(40.9)	2.481	0.007(1.41-8.76)*
	Primary	45(65.2)	24(34.8)		
	Secondary	23(69.7)	10(30.3)		
Occupation	Tertiary	19(63.3)	11(36.7)	2.743	0.03(1.69-12.19)*
	Business	32(65.3)	17(34.7)		
	Teacher	26(59.1)	18(40.9)		
	Farmers	109(59.6)	74(40.4)		
Residency (year)	Others	17(85.0)	3(15.0)		
	<1	46(64.7)	25(35.2)		
	>1	13(59.1)	9(40.9)		
	>4	28(60.9)	18(39.1)		
	>10	29(65.9)	15(34.1)		
	>30	68(60.2)	45(37.8)		

*Significant values, $P < 0.05$.

Factors associated with positive attitudes and practices towards neurocysticercosis

Furthermore, the study conducted a bivariate analysis on the independent variables sex, age group, marital status, religion, occupation, and residency and education levels as already described. Multivariate logistic regression analysis revealed no statistically significant difference between age groups, marital status, and religion, duration of residency in respect to factors associated with knowledge on NCC. However, being male ($P = 0.013$, $OR = 1.88(95\%CI: 1.14-3.10)$), level of education up to secondary level ($P = 0.031$, $OR = 5.43(95\%CI: 1.17-25.20)$) was significantly associated with positive attitudes towards patients with NCC (Table 6).

Factors associated with practices towards neurocysticercosis

Furthermore, the study conducted a bivariate analysis on the independent variables sex, age group, marital status,

religion, occupation, and residency and education levels and practices/ beliefs as described. Multivariate logistic regression analysis revealed no statistically significant difference between age groups, marital status, and religion, duration of residency and level of education in respect to factors associated with knowledge on NCC. However, being male was significantly associated with better practices towards NCC than the female counterparts ($P = 0.00$) (Table 7).

Qualitative data

Key Informants (KI) agreed that large numbers of people are rearing pigs in the area. This has been attributed to the increase demand for pork meat in Gulu Municipality. They also agreed that pork consumption have increased among the rural communities and no parts of the pigs are thrown away due to their delicacies. They also agreed that pig farming has become a source of livelihood since it provides the quickest means of income to the rural communities. Additionally, they agreed that in their

Table 6. Factors associated with attitudes towards neurocysticercosis.

Variable	Category	Attitudes on NCC		X ²	P- value (95%CI)
		Positive	Negative		
Sex	Male	128(87.7)	18(12.3)	3.394	0.041 (0.23-22.4)*
	Female	123(82.0)	27(18.0)		
Age group	10-19	24(88.9)	3(11.1)	2.53	0.011(1.24-5.63)*
	20-29	73(82.0)	16(7.98)		
	30-39	69(85.2)	12(14.8)		
	40-49	37(84.1)	7(15.9)		
	50-59	30(88.2)	4(11.8)		
	60+	18(85.7)	3(14.3)		
Marital status	Married	189(84.8)	34(15.3)	6.751	0.009(1.37-10.22)*
	Single	43(87.8)	6(12.2)		
	Divorced	19(79.2)	5(20.8)		
	Widowed	3(14.3)	1(4.6)		
Education level	None	140(85.4)	24(14.6)	2.53	0.011(1.24-5.63)*
	Primary	58(84.1)	11(15.94)		
	Secondary	27(81.8)	6(18.2)		
	Tertiary	26(86.7)	4(13.3)		
Occupation	Farmers	159(86.9)	24(13.1)	6.751	0.009(1.37-10.22)*
	Teacher	39(88.6)	5(11.4)		
	Business	35(71.4)	14(28.6)		
Residence	<1 year	61(85.9)	10(14.1)	6.751	0.009(1.37-10.22)*
	>1 year	21(95.4)	1(4.6)		
	>4 years	38(82.6)	8(17.4)		
	>10 years	32(72.7)	12(27.3)		
	>30 years	99(87.6)	14(12.4)		
Attitudes	Good	115(69.7)	50(30.3)		
	Bad	88(67.2)	43(32.8)		

*Significant values, P<0.05.

tradition, it is a taboo to bury meat in the ground.

DISCUSSION

Community knowledge on NCC

The findings indicate the majority of the respondents (54%) do not have adequate knowledge about NCC and only (46%) knew how humans get infected with NCC. This shows a clear knowledge gap that exists among the communities in the region about NCC. While pig farming is on the increase in the region, there is evidence that the

communities are already exposed to tapeworm parasites and many could be carrying the infections (Alarakol et al., 2017). However, with fairly good knowledge of tapeworm (62%) amongst the community, the health authorities could use this information to reinforce public health campaigns for the prevention and control of *T. solium* infections in the region. It should be noted that up to 45% of respondents in the rural communities reported they do not know and have never seen tapeworms. These are the rural populace who particularly need to be enlightened about NCC through health education programs. They are deficient of knowledge on NCC and yet continue to interface with *T. solium* infected victims in their

Table 7. Factors associated with practices neurocysticercosis.

Variable	Category	Practices on NCC		X ²	P- value (95%CI)
		Good	Bad		
Sex	Male	136(93.2)	10(6.8)	2.0	0.00 (1.23-10.79)*
	Female	145(96.7)	5(3.3)	0.42	0.53 (0.21-1.64)
Age group	10-19	26(96.3)	1(3.7)		
	20-29	85(95.5)	4(4.5)		
	30-39	76(93.8)	5(6.2)		
	40-49	43(97.7)	1(2.3)		
	50-59	32(94.1)	2(5.9)		
	60+	11(90.5)	2(9.5)		
Marital status	Married	212(95.1)	11(4.9)		
	Single	45(91.8)	4(8.2)		
	widowed	24(100)	0(45.8)		
Education level	None	97(59.2)	67(40.9)		
	Primary	45(65.2)	24(34.8)		
	Secondary	23(69.7)	10(30.3)		
	Tertiary	19(63.3)	11(36.7)		
Occupation	Business	46(93.9)	17(6.1)		
	Teacher	40(90.9)	18(9.1)		
	Farmers	178(97.3)	5(2.7)	3.72	4.21(1.8-12.69)
	Others	17(85.0)	3(15.0)		
Residency (year)	<1	68(95.8)	4(4.2)	0.33(0.18-0.60)	0.42(0.18-0.96)
	>1	22(100.0)	0(40.9)		
	>4	42(95.5)	2(4.5)		
	>10	44(95.7)	2(4.3)	1	1
	>30	105(92.19)	8(7.1)		

*Significant values, P<0.05.

neighborhoods. Furthermore, most (74%) of the respondents interviewed were illiterate and/or had only lower primary education. The findings indicate that 67% of the respondents had primary education and most (58%) are able to read and write. Further analysis revealed that male farmers and those who had at least a secondary education level were significantly more associated with better knowledge on NCC. While this is significant in terms of their formal education, translating this limited education into actual practices of behavioral change remains a challenge in most rural communities. Therefore, more robust behavioral efforts are necessary to enhance community's knowledge on tapeworms' infections. Health education to cause behavioral changes in these practices can therefore be an effective intervention strategy (Mishra et al., 2007). These findings are similar with other studies done previously elsewhere. Decker and Pierre (2010) conducted studies in Northwest

India and reported that most rural respondents had knowledge of NCC, but some were unable to describe which drugs were used in the treatment of the NCC. Ngowi et al. (2015) in a related study conducted in a rural village in Burkina Faso, reported that most people confessed they had seen worms in their feces or those of others, however, they were unable distinguish between worm species. Similarly, Kungu et al. (2017) reported that male farmers were significantly associated with better knowledge about PCC than their female counterpart. On the other hand, Gutra et al. (2017) reported that low level of education among rural communities increased risk of infections and prevalence of NCC.

In the present study, the knowledge of the populace on NCC may be attributed to the mass treatment of helminthes introduced from 2007 to 2010 in Northern Uganda. Through this effort, significant numbers of people in the rural communities received public health

educations on neurocysticercosis in the region. Therefore, it is necessary that knowledge on NCC is provided to communities for the elimination of the negative perceptions and attitudes for the betterment of the welfare of epileptic people (Chacha et al., 2014).

Community attitudes, practices and beliefs

The findings show that the community in the region provides basic healthcare support to patients with NCC and the majority sends them to school. This is an important contribution to the people with epilepsy since leaving them at home would disadvantage them from benefiting from the community social transformation programs. The study revealed that males' play significant role in ensuring that people with epilepsy are taken care of. Males are 4 times more likely to send people with epilepsy to school than their female counterparts. Similarly males are more likely to send people with epilepsy to medical facility than their female counterparts. This may be attributed to male traditional roles of providing services to their families. Previous studies reported that; males' were significantly associated with better practices towards neurocysticercosis (Dahourou et al., 2018). In the current study majority (78%) of the respondents care about patients with NCC and many send them to health facilities for medical care, schools and they are also allowed to marry. Up to 90% of the respondents reported that, in case of sickness, the NCC patients are routinely sent to Hospital or health facility. While at least 10% of the respondents reported they send NCC patients to herbalist. Although, traditional healers enjoy support from a number of people in the rural community, limited data on their operations invalidate and prevent efforts to know the extent of their roles in the prevention of NCC in the region.

Additionally, the findings indicate that majority of respondents confessed consumption of pork and most eat both the roasted and cooked pork. While both pork forms are grossly eaten, there was no statistical difference between those who eat roasted pork and the cooked ones ($P=0.02$). The main reason for this may be due to both males and female's preference to either of the two forms of pork. Chi square analysis indicates that males' preference on pork consumption significantly deferred between eating roasted and cooked pork ($P=0.23$). In contrast, the females appear to enjoy cooked pork more than the male counterparts.

There is a misconception within the rural communities that NCC patients suffer from witchcrafts, and that these people are unable to get cure. Such beliefs are embedded within the populace since time immemorial, the practices have been in place, and eradicating it will require extensive health education. This study findings indicate that some NCC patients were taken to the

traditional healers before they actually seek for help at the health facilities. Gutra et al. (2017) reported that, persons beliefs are centered on tradition attachment and those beliefs are increasingly promoted among rural communities. Parija and Raman et al. (2011) reported that in India, misconception is a reality since; many people believe epilepsy is a form of super natural punishment. In addition, previous studies have reported connection between beliefs and the community's practices (Feury et al., 2013). In the current study, 30% of the respondents' believed that meat are not thrown away but can be roasted or cooked and eaten. Interestingly, one of the respondents confessed meat's soup is better than vegetable's soup". Relatedly, Ngowi et al. (2015) in a study conducted in a rural village of Burkina Faso reported that most participants were aware of the health-related risks of eating pork meat, but they could not afford to throw it away. Similarly, in South India, Parija and Raman et al. (2011) reported that *T. solium* cyst mixed with milk, called "Malal" was known to provide a "delicious" source of "meal". However, in the current study most respondents do not eat cyst of *T. solium* but more than 70% eat pork meat. This shows that pork meat is a very delicious and popular source of proteins among the rural communities. Therefore, proactive intervention strategies for prevention and control of NCC need to be put in place to minimize the proliferation of transmissions of *T. solium*. Future research should focus on examining the influence of pig husbandry and management practices on pig production among pig farmers in the rural communities. Additionally, further study should establish the sero-epidemiology of *T. solium* cysticercosis among the rural communities for better understanding level of the exposure or current infection among the population.

Conclusion

The findings indicate there is a limited knowledge gap on NCC among the rural communities in the district of Amuru and Gulu, Northern Uganda. In addition, the findings show that the communities practice risky behaviors that are potential drivers for NCC in the region. Therefore, health authorities need to improve communities' knowledge, attitudes and practices in the prevention/control NCC in the region.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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