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PREVALENCE OF CYSTIC ECHINOCOCCOSIS IN LIVESTOCK SLAUGHTERED IN SELECTED ABATTOIRS OF LAIKIPIA WEST SUB-COUNTY, KENYA
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PREVALENCE OF CYSTIC ECHINOCOCCOSIS IN LIVESTOCK SLAUGHTERED IN SELECTED ABATTOIRS OF LAIKIPIA WEST SUB-COUNTY, KENYA

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ABSTRACT

Background: **Cystic echinococcosis (CE) is a neglected, emerging and reemerging zoonotic disease caused by the larval stage of the dog tapeworm of the genus Echinococcus. It causes great public health and economic concerns wherever it occurs. CE is endemic in Kenya and most studies done in the country focused on two loci; Turkana and Maasai communities. The prevalence of CE has not been documented in Laikipia County which is located between two CE hot spot areas in Kenya.**

Objectives: **To estimate the prevalence of CE in livestock slaughtered in abattoirs of Laikipia west Sub County**

Design: **A cross-sectional study**

Setting: **Three selected abattoirs in Laikipia west Sub County**

Subjects: **All cattle, sheep and goats slaughtered in the selected abattoirs between October and December, 2015.**

Main outcome measures: **Species, sex, CE status, and origin**

Results: **A total of 339 cattle, 1396 sheep and 478 goats were examined for presence of hydatid cysts in both the thoracic and abdominal cavities during postmortem meat inspection. Overall prevalence was 3.3% and individual species' prevalence was 11.8%, 1.5% and 2.3% in cattle, sheep and goats respectively. Most (99.1 %) slaughter animals originated from the study area. Forty-three percent (31/72) of the CE positive animals had fertile cysts and 87.1% of them originated from the study area.**

Conclusion: **The results show a significantly higher prevalence of CE in cattle with most slaughter animals and those with fertile cysts originating from the study area. Possible implications for public health and the livestock economy require immediate control measures.**

INTRODUCTION

Cystic echinococcosis (CE) is a zoonotic parasitic disease caused by larval stage of the dog tapeworm of the genus *Echinococcus* (1). The definitive hosts, particularly the dog and foxes get infected while feeding on raw organs containing fertile cysts. The tapeworm eggs are passed in faeces into the environment exposing humans, domestic livestock and other intermediate hosts to risk. The intermediate hosts, commonly the herbivores ingest the eggs while grazing in contaminated environments. However, humans as aberrant hosts get infected when they accidentally ingest the eggs either from contaminated environments or directly from close contact with the dog (1, 2).

Hydatid cysts (fluid- filled bags) develop in vital organs primarily the liver and lungs, although they can develop anywhere else in the body (3). CE is an emerging complexity; an emerging and a re-emerging zoonosis with a worldwide distribution (4). Approximately two to three million people are afflicted worldwide (5). It is among the oldest known zoonotic parasitic diseases as reported in WHO/OIE manual of echinococcosis (6). Despite its economic and public health importance, CE remains a neglected disease in Sub-Saharan Africa (6). There is little information and awareness about the extent of the problem which gives a false perception that the burden and impact to society is low and yet people's health and livelihoods continue to be at risk (7).

The disease causes considerable public health and economic problems due to Disability-Adjusted Life Years (DALYs) and organ condemnation (6, 5). Globally, the estimated DALYs and annual livestock production losses are US $193,529,740 and $141,605,195 respectively (5). In Kenya, the estimated average direct annual cost of treatment is US $ 22,658 while the indirect annual economic losses were estimated to be US $ 4,414 and US $1,339 for a herdsman and housewife respectively (8).

Reported losses due to hydatid cysts condemnation in Kenya were US $ 97393.2 in cattle in 1984 and US $ 5588.2 in sheep and goats in 1986 (9). CE is endemic in Kenya from where the highest global human incidence (220/100,000) has been reported (10). Most of the work done on CE in the country has been in the Rift Valley region and focused more on two loci; Turkana and Maasai communities (11, 2, and 12). The prevalence of CE has not been documented in Laikipia County which is in the Rift Valley region of Kenya and is sandwiched between the two known CE hot spot loci.

The county is an Arid and Semi-Arid Land (ASAL) bordering other pastoralist counties such as Samburu, Baringo and Isiolo. Laikipia is known for livestock production and has a number of ranches and conservancies; these factors favor the occurrence of CE. Home slaughtering occurs in many communities but meat inspection is rarely done and dogs can easily get access to infected offal thereby perpetuating the cycle (2). Studies have shown a low level of awareness even among health professionals (14, 13).

In livestock, diagnosis is often made at postmortem when nothing can be done except to condemn the affected organs. In humans, diagnosis requires radiological techniques while treatment employs radical surgery which makes the management of CE to be very expensive and out of reach for the affected persons who are usually from the marginalized poor communities (6). This study set out to estimate the prevalence of CE in cattle, sheep and goats slaughtered in abattoirs in Laikipia West Sub-County and to contribute to the body of knowledge on CE.

MATERIALS AND METHODS

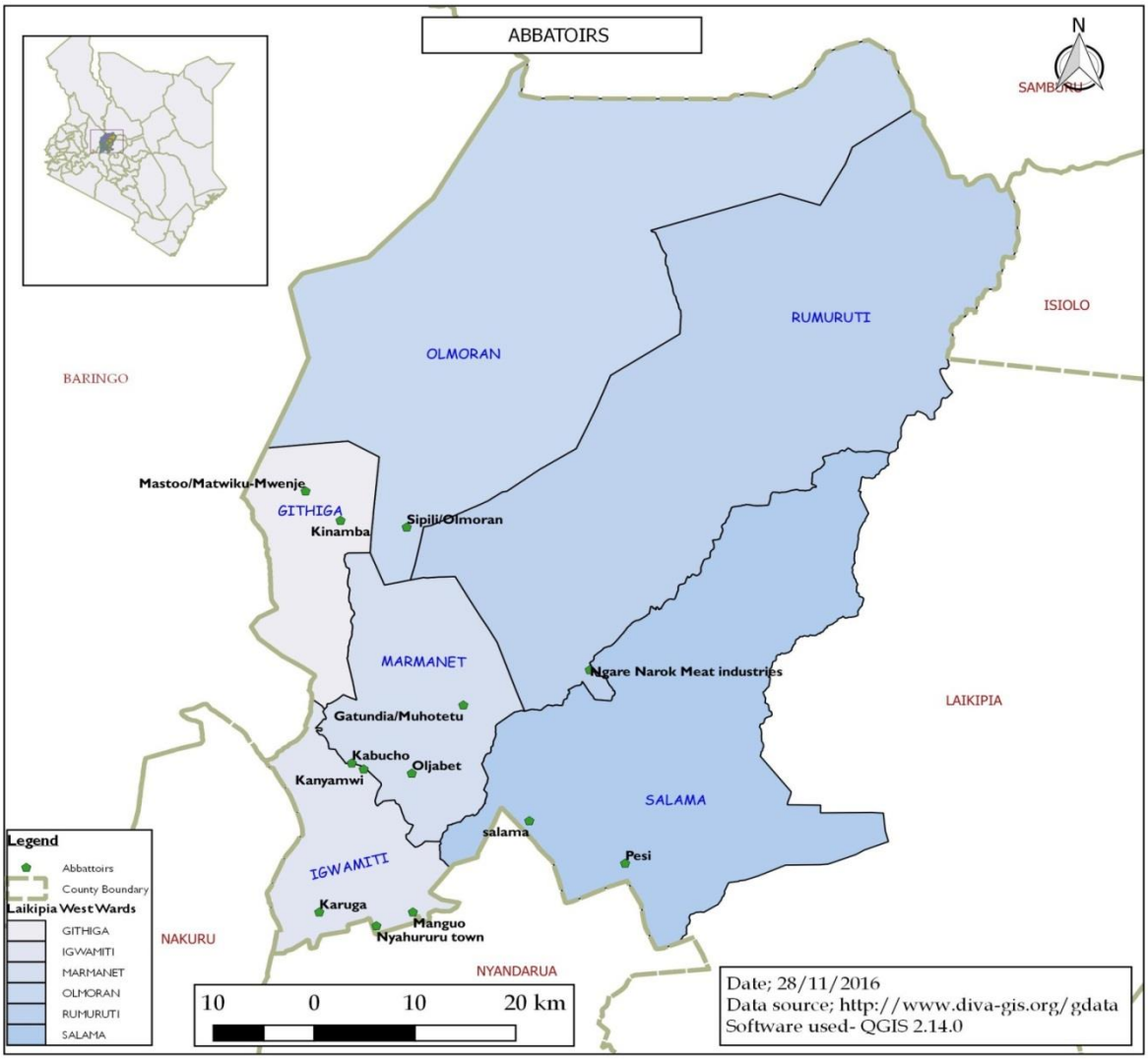
The study was conducted in Laikipia West Sub-County (Figure 1) which has a population of 224,431 (15) and covers an area of 3,891.4 km^2 comprising of six wards; Marmanet, Igwamiti, Salama, Githiga, Rumuruti Township and Ol-Moran. It shares borders with Samburu, Baringo, Isiolo, Nakuru and Nyandarua counties.

The County is an ASAL area with many ranches and conservancies. The main source of water for both domestic and animal use includes seasonal rivers, shallow wells and surface run off. Most residents practice agro-pastoralism. Although Kikuyu is the major ethnic community, other ethnicities such as Kalenjin, Turkana and Samburu who are pastoralists are present. The annual rainfall ranges from 900mm on the foot of

the Nyandarua ranges to 500mm in the Western parts of the Sub-County.

Figure 1

Map showing the location of Laikipia west Sub County and distribution of abattoirs



Approval to carry out the study was sought and obtained from the KEMRI's Scientific and Ethics Review Unit (SERU) and the Animal Care and UseCommittee (ACUC) reference: SERU/CMR/P0020/3081. Permission to carry out the study was obtained from The Director of Veterinary Services, State department of Livestock in the Ministry of Agriculture, Livestock and Fisheries as well as from the County Director of Livestock and Fisheries, Laikipia County.

A cross-sectional study design was conducted between October and December, 2015. The study population included all cattle, sheep and goats slaughtered in three selected abattoirs (Ngare Narok meat Industries, Gatundia/Muhotetu and Nyahururu) in Laikipia west Sub County (figure 1). The abattoirs are run by qualified meat inspectors who were recruited as research assistants after undergoing a brief refresher course organized by the Principal Investigator (PI) on hydatid cyst recognition.

Data was collected daily from each abattoir for six days per week for 5 weeks and details of animals recorded in data collection sheets detailing the species, sex, origin, status of disease, and the organs affected where applicable. Every cattle, sheep and goat slaughtered in the abattoirs during the period of the study was inspected visually and by palpation during postmortem examination for presence of hydatid cysts in both the thoracic and abdominal organs. Any swelling within the organs that felt firm like a tennis ball was considered to be a hydatid cyst. The organs found with cysts were removed whole, put in polythene bags and labeled appropriately. The day's collection was then transferred into an airtight bucket and transported to the laboratory at the Animal Health and Industry Training Institute (AHITI) – Nyahururu for further examination. Cysts with protoscolices and or with a healthy white germinal layer on incision were considered fertile, those calcified and showing signs of degeneration were considered sterile. Contents of individual cysts were separately put in labeled specimen bottles and preserved with ethanol. The samples were transported to Kemri's Centre for Microbiology Research (CMR) laboratory where confirmation of cysts' viability and genotyping was done by another researcher. Details of cysts' data were recorded and these included the species, sex, origin of animal, organ affected, and fertility. All data received were entered into Microsoft office (MS) Excel, 2010 and counterchecked.

Data analysis was done using SPSS version 20.0 and this commenced once all data had been verified and imported into SPSS. Daily backup and storage was done to ensure data safety. Categorical variables were analysed using frequency distribution. Statistical analysis of the species characteristics was carried out. Estimates of the parameters were considered statistically significant at $p<0.05$ and 95% confidence interval.

RESULTS

A total of two thousand, two hundred and thirteen (2,213) animals were inspected for hydatid cysts in three abattoirs (Ngare Narok meat Industries, Gatundia/Muhotetu and Nyahururu). These consisted of 63.1% (n=1396) sheep, 21.6% (n=478) goats and 15.3% (n=339) cattle. The overall proportion of males to females slaughtered was 41:59 (1:1.5) while in individual species the proportions were: 38:62(1:1.6), 42:58 (1:1.4) and 38:62 (1:1.6) in cattle, sheep and goats respectively. Most (99.1%) of the animals slaughtered originated from Laikipia west sub county (Table 1). Details of the animals slaughtered in each abattoir are shown in table 1. Nyahururu abattoir had the highest proportion (43.7%) of animals slaughtered while Ngare Narok meat industries abattoir had the least proportion (19.7%).

Table 1

Prevalence of CE and distribution of animals slaughtered by abattoir and origin

Abattoir name	All cattle, sheep and goats slaughtered (%)	Prevalence of CE in cattle (n)	Prevalence of CE in sheep (n)	Prevalence of CE in goats (n)	Origin of animals (%)	
					Within Laikipia west	Outside Laikipia west
Ngare Narok Meat Industries	435(19.7)	11.9(201)	11.6 (69)	3.0 (165)	435(100)	0(0.0)
Gatundia/Muhotetu	811(36.6)	8.3(24)	1.6 (629)	3.2 (158)	811(100)	0(0.0)
Nyahururu	967(43.7)	12.3 (114)	0.4 (698)	0.6 (155)	947(97.9)	20(2.1)
Total	2213	11.8 (339)	1.5 (1396)	2.3 (478)	2193(99.1)	20(0.9)

The overall prevalence of CE was 3.3% (72/2213). Ngare Narok meat industries abattoir contributed the highest proportion (51.4%) to the positive animals despite having just about half of the number of animals from Gatundia/Muhotetu abattoir which contributed the least proportion (table 2). Cattle contributed the highest proportion (40/72) to the overall prevalence while goats contributed the least 11/72 as shown in table 2. Ngarenarok meat industries abattoir contributed most proportionally, towards the prevalence of cattle and sheep while Gatundia/Muhotetu contributed most proportionally towards the prevalence of goats. The individual species prevalence was 11.8% in cattle, 1.5% in sheep and 2.3% in goats. Table 3 shows comparison of prevalence to those from recent studies in the country. The prevalence of CE in cattle was significantly higher than in both sheep and goats (p= 0.000). A significantly higher number of females had the disease (p=0.012). The association between CE and organs affected was significant (p=0.000). The lung was the most (62.5%) frequently parasitized organ. The prevalence of CE in Ngare narok meat industries abattoir was significantly higher than in the other abattoirs (p=0.000). Most (76.4%, n=72) of the positive animals originated from Rumuruti township ward and about 15% came from outside the sub county (table 2).

Table 2

Prevalence of CE and characteristics of animals slaughtered in three abattoirs in Laikipia west Sub County

Variable	Category	Frequency (%)	Frequency of positive (Prevalence)	χ^2 p-value
Species	Cattle	339 (15.3)	40 (11.8)	
	Sheep	1396 (63.1)	21 (1.5)	0.000
	Goats	478 (21.6)	11 (2.3)	
Sex	Male	901 (40.7)	18 (25.0)	0.012
	Female	1312 (59.3)	54 (75.0)	
Organs	None	2141(96.7	0 (0.0)	
	Lungs	45 (2.0)	45 (62.5)	0.000
	Liver	8 (0.4)	8 (11.1)	
	Lungs/liver	18 (0.8)	18 (25.0)	
	Lungs/spleen	1 (0.0)	1 (1.4)	
Origin (specific ward)	Other county	20 (0.9)	11 (15.3)	
	Igwamiti	1(0.0).	0(0.0)	
	Githiga	(0.0)	0 (0.0)	
	Olmoran	64 (2.9)	3 (4.2)	
	Marmanet	10 (0.5)	2 (2.8)	
	Rumuruti township	2117 (95.7)	55 (76.4)	
	Salama	1 (0.0)	1 (1.4)	
Abattoir name	Ngare narok meat industries	435(19.7)	37(51.4)	0.000
	Gatundia/Muhotetu	811(36.6)	17(23.6)	
	Nyahururu	967(43.7)	18(25.0)	

Table 3

Comparison of CE prevalence's in livestock in Kenya from recent studies

Livestock species	Laikipia west (this study)	Confidence Interval (this study) %	Turkana (Njoroge et al. 2002)	Maasailand (Addy et al. 2012)	Central Kenya (Mbaya et al. 2014)
Cattle	11.8 (n=339)	[10.1– 13.6]	19.4 (n=381)	25.8 (n=587)	1.9 (n=4,595)
Sheep	1.5 (n=1396)	[1.2 -1.8]	3.6 (n=588)	16.5 (n=430)	4.6 (n=65)
Goats	2.3 (n=478)	[1.6 - 3.0]	4.5 (n=5,752)	10.8 (n=194)	0.4 (n=2,955)

Thirty one (43%, n=72) of the CE positive animals had fertile cysts (Table 4). These consisted of 42.0% cattle, 51.6% sheep and 6.5% goats. Most, (87.1%) of the animals with fertile cysts originated from Laikipia west Sub County. About 33% (n=40), 76% (n=21) and 18% (n=11) of the positive cattle, sheep and goats respectively had fertile cysts.

Table 4

Origin of animals with fertile cysts

Species/ Origin	Igwamiti	Githiga	Olmoran	Marmanet	Rumuruti township	Salama	Total from Laikipia west (%)	Total from other county (%)	Overall Total (%)
Cattle	0	0	1	0	8	0	9 (69.2)	4 (30.8)	13(42.0)
Sheep	0	0	0	0	16	0	16 (100.0)	0 (0.0)	16(51.6)
Goats	0	0	0	0	2	0	2 (100.0)	0 (0.0)	2(6.5)
Total	0	0	1	0	26	0	27 (87.1)	4 (12.9)	31

DISCUSSION

Most studies on prevalence of CE have been based on data from abattoir surveys (16). Slaughter surveys are considered economical and since the lesions of CE remain for life, it is possible to tell at postmortem whether the animal was infected or not.

This study provided information on CE infection status and the origin of the animals slaughtered in abattoirs in Laikipia west Sub County during the study period. However, there was the limitation of establishing the true origin of some animals since only the immediate history on arrival at the abattoir could be ascertained. The significant difference in prevalence between the abattoirs could not be fully explained, but most probably it depends on the source of animals for slaughter.

The individual species prevalence in cattle, sheep and goats depict a familiar trend when compared to previous studies in Kenya, where cattle generally had the highest prevalence (2, 12, and 17). When compared to the most recent survey from a non hot spot area in central Kenya (17), the prevalence in this study were higher by a factor of six in cattle and goats (11.8:1.9) and about a third that of sheep (1.5:4.6).

The prevalence in cattle was just about a half (11.8:19.4&25.8) of that from the two known hot spot areas of Turkana and Maasai land (2,12) while that of sheep and goats was about a half (1.5:3.6 &2.3:4.5) of what was reported from Turkana (2). Although Laikipia west has not been documented as a CE hot spot area, these results are reasonably comparable to those from Turkana and Maasai land which are known all over the world for CE.

The differences in prevalence between the studies could be attributed to the differences in sample sizes; with the smaller sizes being more

likely to have a higher degree of bias. Except for the study from central Kenya (17) where sheep had the highest prevalence, the prevalence agrees with similar studies done elsewhere in Kenya whose results showed that cattle were leading in prevalence (2, 12, 18). Examples of other studies from outside Kenya with similar trends include North Africa (19) Sudan (20) and Ethiopia (21). The results of this study show that cattle contributed the highest proportion to the overall prevalence while goats contributed the least. Among the animals slaughtered, cattle were more likely to have CE than sheep or goats. This could be explained by the fact that cattle take longer to mature for slaughter and since CE develops slowly, lesions are more likely to be seen in cattle than in sheep or goats.

Females were three times more likely to have CE than males, in spite of the ratio of males to females sent for slaughter being 1:1.5. Although the reasons for this are not clear, in most communities males are more likely to be sent to slaughter at an earlier age than females unless they are selected for breeding. Most females are kept for offspring production and hence they are only sent to slaughter when they become unproductive; if there is any infection, cysts will have enough time to grow in females unlike in case of most males. The lung was the most (68%) frequently parasitized organ and this agrees with the results from other studies (2, 11, 16, and 18).

The consistently higher involvement of the lungs could be explained by the large capillary network and the loose connective tissue structure of the lung where Onchospheres can easily get trapped and develop into cysts (18). Even though cattle had the highest prevalence (11.8%); sheep had the highest proportion (76%) of animals with fertile cysts and the results agree with the findings from other similar studies elsewhere (2, 12). Given that sheep are more likely to be slaughtered at home during functions and ceremonies where meat inspection is rarely done and consequently improper disposal of organs found unfit for human consumption are more likely to occur; the public health importance of sheep in regards to CE cannot be ignored!

The reported low levels of knowledge of CE among even the health professionals (14, 13) only increases the public health concerns. Most (99.1%) of the animals slaughtered originated from Laikipia west sub county and these contributed 85% of the positive cases (n=72) while only 0.9% from outside the sub county contributed 15% of the positive cases. Given that 43% (31/72) of the animals with CE had fertile cysts and that most, (87.1 %) of these originated from Laikipia west Sub County; there is a high possibility of environmental contamination with Echinococcus eggs in the study site.

Even though most positive animals (76.4%, n=72) originated from Rumuruti township ward, it is important to note that there a big livestock market which receives animals from other counties. The study site is multiethnic and the presence of a large livestock market at Rumuruti encourages both livestock and human movement. This movement, coupled with home slaughter and low levels of awareness (14, 13) provides fertile ground for the spread and transmission of CE which is considered as an emerging and a re-emerging zoonosis (4); the disease is being reported in areas previously considered clean and it is also reappearing in areas where it had been controlled.

CONCLUSION

The results show a significantly higher prevalence of CE in cattle compared to sheep and goats. Although the study area is not among the known CE hot spot areas of Kenya, the prevalence in this study are just about half of what has been reported from these areas. Most slaughter animals and those with fertile cysts originate from the study area. This suggests environmental contamination and possible transmission of CE in the study area. Possible implications for public health and the livestock economy require immediate control measures.

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