# Epidemiology of Cystic Echinococcosis in Pastoral Communities of Kenya

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## Abstract:

**Introduction:** Cystic Echinococcosis (CE), a chronic debilitating parasitic disease in humans caused by larval stage of dog tapeworm, *Echinococcus granulosus* has a worldwide distribution. Over time, Turkana in Kenya was the only known endemic region. This study reports status of CE in pastoral communities of Kenya.

**Methods:** Individuals were screened to identify presence of hydatid cysts. This exercise was done at a health facility, local homestead or school while either lying down or standing up. The study team used a portable ultrasound-imaging machine (Titan Ultrasound system, SonoSite with a 5.2 MHz transducer). Prior to examination, comprehensive information about the disease and its causative agents and ultrasound procedure was provided using pictorial diagrams that showed pictures with different stages of the disease.

**Results:** 14,088 individuals had full body examination. The prevalence of CE ranged from 23/2577 (0.9 %) in Samburu and 'Maasai Mara' to 188/6512 (2.9%) in Turkana North. Most of the hydatid cysts (65.5%) were found in the liver followed by 18.6% in the kidneys, 11.3% spleen, 2.7% lungs 1.7% and heart 0.2% cysts.

**Conclusion:** Low prevalence recorded in Samburu (0.9 %) and Maasai Mara communities is surprising compared with Turkana North (2.9 %). This is despite higher infection rates in livestock (>25%) and having more dogs per household. Tharaka and Isiolo had comparatively high numbers of human CE cases. Tharaka North is located at the periphery of Meru National park and often-wild animals' frequent homesteads. People in this area keep large numbers of domestic dogs to keep away wild animals at night, which could contribute to the reported numbers in the area. A possible reason for the numbers in Isiolo (an ethnically mixed community) could be due to cultural and behavioral practices amongst the three major communities (Borana, Samburu and Turkana).

*Keywords: Cystic Echnococcus, epidemiology, Pastoral, Kenya*

## Introduction

Cystic Echinococcosis (CE) is a chronic, debilitating zoonotic disease, and a major public health problem in endemic countries. It is caused by larval stage of dog tapeworm, *Echinococcus granulosus*. The lifecycle implicates carnivores (domestic dogs, lion, hyena etc) as definitive hosts and herbivores (all livestock, wild herbivores and human) as intermediate hosts (McManus *et al*., 2003).

Man acts as accidental intermediate hosts and usually form an end in the transmission cycle (Macpherson CN, 1984). Infection occurs after ingestion of eggs from adulterated locations during grazing (herbivores) or by accident (human). In transitional hosts, the larvae (oncospheres) hatch from ingested Taeniid eggs in the small intestine, penetrate actively through the intestinal wall; into the blood then are transported to various internal organs or tissues. Once in organs and tissues, they develop into fluid filled cysts (Karim *et al.,* 2015).

Dogs and other definitive hosts play an important role in transmission of the parasite after consumption of hydatid cysts from infected herbivores (domestic or wild) during home slaughter or careless and unsafe deposal of infected commercial organs in slaughter facilities or when fed by wild carnivores (Kagendo *et al.*,2014; Mbaya *et al.,* 2014).

CE has been recorded in most African countries including Kenya and other surrounding countries. In Kenya, the Turkana community has been reported as harbouring one of the highest prevalence of CE worldwide (Macpherson *et al.,* 1989; Magambo *et al.,* 2006; Mutwiri *et al.*, 2014). However, the burden of human infection in the country remain unclear despite previous data showing that the disease has been documented in the Turkana community, and suspected in a number of areas which share climatic, socio-cultural conditions and pastoral undertakings. Previous studies done in the Turkana community showed that the prevalence of the disease was high ranging from 3-6% (Macpherson *et al.,* 1989; Magambo *et al.,* 2006).

In other pastoral communities, who live in close relationship with their livestock, pets i.e. dogs, and interact with wild animals such as the Samburu, Maasai Mara, Isiolo and Tharaka, Human CE has not been well documented. As such, theirs' is only existence of preliminary data on the status of CE in Kenya (Addy *et al.,* 2012; Kagendo *et al.,* 2014; Mbaya *et al.,* 2014). Therefore, the aim of this study was to document the burden of CE in Kenya with a focus on the pastoral communities.

**Methods**

This study was carried out in five pastoral communities of Turkana (Turkana North), Narok South (Maasai Mara), Samburu (Uaso division), Tharaka North and Isiolo and Counties. Turkana was included for comparisons, since previous studies reported prevalence that were relatively high. We used a portable ultrasound imaging machine (Titan Ultrasound system, SonoSite with a 5.2 MHz transducer) to assess for presence of hydatid cysts among individuals in these communities.

From 2013-2016, we examined 14,088 individuals to identify for presence of hydatid cysts. Voluntary participation was encouraged and only for those who gave informed consent prior to examination were enrolled into the study. Those found with cysts were given referral letters and Ultrasound pictures. They were advised to seek further treatment. Those who were in a position to travel were referred to Kakuma Mission Hospital where CE surgical operations and treatments were being done for free under an AMREF outreach program.

The study was Ethically reviewed and granted approval by the KEMRI/Scientific and Ethical Review Unit (SERU) SSC protocol number 1684. The protocol was further reviewed and granted Ethical approval by the Institutional Ethical Review Committee (Meru University of Science and Technology Institutional Ethics Review Committee (MIRERC-035-2017).

Information about the disease, its causative agents and ultrasound procedure was provided using a pictographic diagram that

showed pictures with different stages of the disease. Individual participants were screening while lying down or standing up and all examination took place in a privately secured cubicle at either a health facility, local homestead or school**.**

Standardized Ultrasound WHO-IGWE classification was used to identify ultrasound images of hydatid cysts during the survey. Referring to this standard classification, our study identified CE2 and CE3 types as either CE2A, CE2B and CE3A, CE3B respectively.

CL Unspecified fluid filled lesion
CE1 Fluid filled cyst with distinct parasitic membrane
CE2A Cyst with only two or 5 daughter cysts
CE2B Cyst filled with daughter cysts (honey comb)
CE3A Detachment of parasitic membrane (endocyst) from ectocyst)
CE3B Degeneration/disintegration of daughter cysts
CE4 Total collapse and degeneration of endocyst or of daughter cysts
CE5 Calcified ectocyst and total destruction of endocyst

## Results

*Hepatic CE prevalence in different study areas*

The crude prevalence of hepatic CE cysts was about 2%. (272/14088) The Turkana community had the highest prevalence of CE 2.9%) (188/6512) (with Maasai Mara carrying the lowest burden 0.9 %) (23/2577). A wide variation of the differences in prevalence varied by region in different pastoral communities as shown in table 1.

***Table 1. Frequency distribution of the prevalence of Hepatic CE cysts in different study areas.***

| Geographical Location | Total Screened (N) | Female screened (n) | Male screened (n) | CE Cases (n) | Prevalence of CE (%) |
|---|---|---|---|---|---|
| Turkana North | 6,512 | 3,787 | 2,725 | 188 | **2.9%** |
| Tharaka North | 1,078 | 580 | 498 | 16 | **1.5%** |
| Isiolo | 2,420 | 1469 | 986 | 30 | **1.2%** |
| Samburu East | 1,501 | 859 | 642 | 15 | **1.0%** |
| Masai Mara | 2,577 | 1717 | 860 | 23 | **0.9%** |
| Total | **14,088** | **8,412** | **5,711** | **272** | **1.9%** |

Generally, prevalence of hepatic CE among all women screened was about 2%. Highest prevalence of liver CE in females was recorded in Turkana (3.1%), followed by Tharaka (1.6%) and least numbers of females with this CE was in Maasai Mara (0.8%) as detailed in Table 2.

Generally, prevalence was higher in women of childbearing age (25-45) with a prevalence of 47.1% and older women (45-59) with a prevalence of (24.0%)

***Table 2: Prevalence of Hepatic CE cysts among female in different study areas.***

| Geographical Location | Total No. screened (N) | people with liver cysts (n) | % with Hepato-CE (n/N*100) |
|---|---|---|---|
| **Turkana** | 3787 | 116 | 3.1% |
| **Tharaka North** | 580 | 9 | 1.6% |
| **Isiolo** | 1469 | 18 | 1.2% |
| **Samburu East** | 859 | 9 | 1.0% |
| **Maasai Mara** | 1717 | 14 | 0.8% |
| Total | 8412 | 166 | 2.0 % |

compared to ages (16-25) and (06-16) who had 8.7% and 8.0% respectively. Hepato-Prevalence in women in these two age groups compared with prevalence recorded in women above 60 years (8.7%). Lowest prevalence (3.5%) was recorded in girls aged 5 years and below.

*Prevalence of liver CE in men*

In males, the prevalence of liver CE was 1.9%. Prevalence varied based the study area ranging from 2.6% in Turkana to 0.9% in Samburu. Generally, prevalence was highest in males aged 45-59 who recorded a prevalence of 40.2% of the 106 males found to have liver cysts across all study areas.

Individuals in age group 60 years and above recorded a relatively high prevalence (14%) compared to same age group in females where we had 8.7%.

***Table 3: Prevalence of Hepatic CE cysts among male in different study areas.***

| Geographical Location | No. of males screened (N) | Number of males with liver CE (n) | % prevalence in males (n/N) |
|---|---|---|---|
| **Turkana** | 2725 | 72 | 2.6 |
| **Tharaka North** | 498 | 7 | 1.4 |
| **Isiolo** | 986 | 12 | 1.2 |
| **Samburu East** | 642 | 6 | 0.9 |
| **Maasai Mara** | 860 | 9 | 1.0 |
| Total | 5711 | 106 | 1.9 |

Similarly, numbers recorded in children below 5 years was higher in males (5.9%) than in females (3.5%). Equal numbers of liver CE cases were recorded among males of age 25-45 and those in age 6-16 both of which had 15.2% as shown in table 3.

*Table 4: Hepatic CE cases in different communities by cyst type*

| Type/Site | Turkana | Tharaka | Isiolo | Samburu | Maasai Mara | Total | % |
|---|---|---|---|---|---|---|---|
| CE1 | 65 | 8 | 14 | 7 | 9 | **103** | 37.9 |
| CE2A | 2 | 0 | 0 | 0 | 0 | **3** | 1.1 |
| CE2B | 20 | 0 | 0 | 1 | 2 | **23** | 8.5 |
| CE3A | 8 | 0 | 0 | 0 | 1 | **9** | 3.3 |
| CE3B | 41 | 3 | 6 | 5 | 7 | **60** | 22.1 |
| CE4 | 52 | 5 | 10 | 2 | 4 | **74** | 27.2 |
| Total | **188** | **16** | **30** | **15** | **23** | **272** | |

The proportion of hydatid cysts infection was higher in Turkana than Samburu and Maasai Mara despite the fact that these areas are closely linked in terms of cultural activities. Classification of hepatic cysts based on the WHO standard showed that majority of the cysts were CE1 (37.9%), followed by CE4 (27.2%), CE3B (22.1%) with the least recorded being CE2A (1.1%) as shown in table 4.

A good proportion 15.2% (75/493) of cysts were observed sequestered in other internal body organs. Based on WHO-IGWE classification, the most common non- hepatic CE types recorded was CE1, followed by CE4, CE3B etc., as shown in table 5. Mixed infestations with more than one type of cyst was common and the majority of the non-hepatic cysts however were found sequestered in the abdomen (Mesenteries and Omentum). Unlike previous and past studies in the country, a CE cyst was observed in the heart, and this was from a 11-year-old boy in the Maasai Mara national reserve environments.

**Table 5. Distribution of Non-hepatic CE cysts by type and location**

| Type / Site | Abdominal | Lung | Kidney | Spleen | Heart | Total |
|---|---|---|---|---|---|---|
| **CE1** | 14 | 4 | 8 | 3 | 1 | **30** |
| **CE2A** | 1 | 0 | 0 | 0 | 0 | **1** |
| **CE2B** | 5 | 0 | 1 | 0 | 0 | **6** |
| **CE3A** | 2 | 0 | 1 | 1 | 0 | **4** |
| **CE3B** | 17 | 0 | 4 | 0 | 0 | **21** |
| **CE4** | 9 | 3 | 8 | 3 | 0 | **23** |
| Total | **48** | **7** | **22** | **7** | **1** | **75** |

*The CL and CE5*

Using the WHO classification of Ultrasound images, significant numbers of cysts were identified which fall under the CL and CE5. However, using ultra sonographic visualisation, it was difficult to tell whether these cysts were actually CE cysts or just simple cysts.

These cysts needed further analysis and together with other non-hepatic cysts were excluded from the numerator when computing CE prevalence in this study as shown in table 6.

***Table 6: Distribution of CL and CE5 by site***

| CE site/Type | CL | CE5 | Total |
|---|---|---|---|
| **Liver** | 68 | 42 | **110** |
| **Kidneys** | 19 | 6 | **25** |
| **Abdominal** | 0 | 7 | **7** |
| **Spleen** | 3 | 1 | **4** |
| **Lungs** | 0 | 0 | **0** |
| **Heart** | 0 | 0 | **0** |
| **Total** | **90** | **56** | **146** |

## Discussion

The prevalence of liver CE in this study varied based on study area and ranged from 3.1% in Turkana to 0.9% in Maasai-Mara. These results reaffirm that cystic echinococcosis is endemic and common among livestock rearing communities of Kenya. Previous reports showed prevalence of 3%-5.6% in Turkana (Mutwiri *et al.*, 2014). People with more livestock are known to have more dogs and thus have higher risk of infection (Magambo *et al*, 2006: Ikhlass EL Berbri *et al.*, 2015).

The level of infection in Turkana has remained persistently high despite various interventions to control the infection. In 1983, the prevalence of infection was 5.6% (Macpherson CNL, 1989) and has slightly dropped to 3.1%, which is still higher compared with other communities of Maasai Mara and Samburu. It remains unclear as to this difference as these communities share many similar cultural dynamics and hence expected to harbour relatively same level of CE infection. A common practice among all these communities is livestock rearing but also have dogs per household.

The findings of this study correspond with that of a retrospective hospital-based survey in Tanzania (Ernest E *et al.*, 2010) that showed that the prevalence of CE in women

was higher than in men, but did not show gender differences in younger age groups (0 to 15 years) and those aged 60 years and above. However, the study reported a relatively higher proportion of CE cases among the youths. In our study, the majority of CE cases were within the age of 16 to 45 and predominantly in in Turkana community. Our study did not find higher proportion of infected people in those below the age of 15 years. The observed difference in prevalence of CE between women and men and might be due to differences in contacts with dogs between with women being more frequently close to dogs than men hence exposing them to increased risk of CE infection. It is common that domestic dogs often accompany women during their house chores, handling of puppets, fetching water, slaughter of animals etc. as these are normally routine activities carried out by women on day to day.

In most pastoral communities, slaughtering animals by men is only done during special ceremonies. In a study done in Morocco, women were reported to handle dogs two times (52.9%) more than men (21.9%) and children (25.2%) (Ikhlass EL Berbri *et al*., 2015). In males, the higher prevalence of CE observed in the 16-25 years age group could be as a result of young men who graduate from home chores such as herding (an indication of increased man-dog frequency of contact). This is due to shifting responsibilities as these young men mature into Morans (which is a security group of men among the pastoral nomadic communities). In comparison to this age group, higher numbers were reported among aged 25-45 years who often are accompanied by domestic dogs as they pasture their animals.

From previous investigation, the lowest prevalence of CE was reported in Maasai Mara and Samburu communities, despite cultural and environmental similarities with Turkana community and a known higher infection among the livestock species (sheep, goat, cattle) in the areas (Addy *et al.*, 2012). It was discovered during the study that the Maasai and the Samburu herdsmen use special herbs and traditional treatments supplied. This could be a possible reason for the lower prevalence of CE in these communities. However, there is need for further studies to fully explore this to obtain a clear explanation.

Previous reports have clearly shown that majority of cysts are harbored in the liver (Cooney *et al.*, 2004). The liver is a preferred organ for CE based on its role in the purification process of blood and probable route of hatched oncospheres (Symeonidis N., 2013). In some cases, infestation of hepato cysts with cysts sequestered in other organs was found, which corresponds with a study findings of Dasbaksi *et al.*, 2015, where hepatic cysts in combination with a pericardial hydatid cysts were reported. Other studies that have reported finding hydatid of the liver including hepato cyst that raptured into the peritoneal cavity of the patient following abdominal trauma. (Meneza S, 2011; Mermet. Y. I., 2012). In addition to hepato cyst, there are existing reports that exposes existence of hydatid in other organs (Xiaoyan. Z., 2015).

Our study showed presence of hydatid cysts in other organs, including the abdomen, the kidneys, the spleen, and the heart. Globally, cardiac cysts account for only 0.5-2% of CE deposits in internal organs (Yaman ND *et al.*, 2017). We found a case of cardiac –hyadatid cyst in a young boy aged 11 in a village at the periphery of the Mara national reserve. A similar report was authored by Sinan et al, who reported hydatid cysts of the heart in a young male patient who had an habit of feeding pets at home (Sinan D *et al.*, 2012).

Up to 17 abdominal cases were reported in different study areas, majority of these were CE3b and found in women. A previously documented report showed that CE cyst was found in a 60 old woman, and this report emphasised the fact that CE cysts may be found in any anatomical locations of a human body (Abhishek.V., 2012). This reaffirms our study findings where cysts were found in uncommon organs like the spleen and kidney. Other reports have also documented non-hepato cysts in organs including heart, bone and body muscles (Shyamapada M., *et al.*, 2011). It is however possible that the non-hepato cysts may actually have originated from raptured liver cysts (Mermet.Y. L., 2012).

Few cysts were reported in the lungs. These needed to be verified using radiography. Patients suspected to have hydatid cysts of the lungs were thus referred to a hospital for radiological examination. Such cysts have been reported before, most of which have initially the patient presents with persistent chest pains before radiological examinations, a confirmatory examination for hydatid cysts of the lungs (Ghedira B *et al.,* 2010). The study by Ghedira reported hydatid cysts in a fourteen-year-old boy who had two giant hydatid cysts sequestered on the upper and lower lobes of his right lung, and in a seven-year-old girl with a giant hydatid cyst in the right upper lobe of the lungs. A CE4 was reported in the lung of a 56-year-old male. The cyst was said to have originated from a raptured liver cyst (Nilufer B *et al.,* 2017). Raptured cysts may be largely attributed to recent reports of hydatid cysts in organs other than the liver.

CE of the urinary tract is rare, and accounts for only 2-3% of all reported cases worldwide (Nasr R., 2014). Our study reports 22 cases of viable kidney cysts, most of which were CE1 and CE4. Other cysts found in the Kidney included CE5 and the CL type. A study by (Shah N *et al.,* 2016) which reported a cyst in the left kidney of a 40 year old female patient emphaised the need for improved identification and early detection of hydatid cysts in organs that are said to be rarely infected. Other reported kidney cysts include a case where a labortory technician was found to have hydatid cysts in the kidney (Seetharam V *et al.,* 2012).

Other cyst reported here were spleen cysts and these included 3 CE1 AND CE4, 1 CE3A , 4 CL'S and A CE 5. Data on existence of splenic cysts are rare and hence our study provides some additional information regarding occurrence of non hepato CE cysts. Such studies indicate that splenic cysts depend largely on organs adjascent to it such as the liver, with only very few cases of primary liver hydatid cysts (Belli S *et al.,* 2014).

## Conclusion & Recommendations

CE is endemic in several nomadic and pastoral communities in Kenya. However, the prevalence of this disease varies from community to community and is unusually higher in women than men. The liver is one of the most common infected organs that harbors CE cysts with CL type being the most common type of CE in these communities.

Turkana community has highest burden of CE in human however, there is no clear explanation to the existing differences in prevalence of CE observed among communities that share similar cultural dynamics, hence further studies need to be conducted to obtain a clear understanding of the underlying factors behind the observed difference in prevalence of CE among between communities. In addition, it is crucial to assess proximity of these communities to the national parks and national reserves as these might possibly contribute to spillover phenomenon of the wild life cycle of CE into the domestic cycle.

Based on known value of albendazole in treatment of CE (WHO, 2010), communities in endemic areas might need to be dewormed regularly to reduce the risk of infection. Lastly, there is need to establish the role of community slaughterhouses in the transmission process to CE. Prevention of infections by the dog tapeworm require frequent supervision of animal slaughtering practices by experienced veterinary officers, reinforcement of appropriate slaughter practices by local authorities, regular deworming of dogs and elimination of stray dogs.

Advancing need for a health education programmes in schools and at the community on dangers of frequency of man-dog, contacts would be vital to control of CE. The study showed presence of Echinococcus cysts in communities other than the Turkana where the disease has for many decades been known to be most prevalent. Most people had more than one cyst per location, and most cysts were found in the liver. Clinically, as the cysts grow, they tend to replace the liver and the fluid filled cysts cause deleterious and mechanical damage to the liver. Because of this the liver is not in a position to function properly. Reliable cure for cystic Echinococcosis has remained to be total removal of the cysts or treatment with albendazole over a long period of time for individuals with small cysts and CE1.

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