



The monetary burden of cystic echinococcosis and its distribution based on gender and age in Turkana North District, Kenya

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ABSTRACT

Cystic Echinococcosis (CE) is caused by the larval stage of the tapeworm *Echinococcus granulosus*. The disease occurs worldwide, and is endemic in Turkana and Maasai areas, Kenya. The objective of the study was to assess the direct and indirect monetary burden of CE in Turkana North District of Kenya. This study involved a retrospective review of CE patients' medical records obtained from AMREF-Kenya (1991-2011), with patients originating from Turkana North district of Kenya. Data obtained were used to calculate CE-associated direct costs. A total of 586 surgical cases treated at Kakuma Mission Hospital, Turkana, Kenya were evaluated. The ratio of infection in male to female was 1:2, with individuals in the 31-40 age groups being most prevalent. The average direct cost of CE surgical treatment was US\$ 703. Direct cost for 586 surgical patients, over the 20 year study period was US\$ 453,154 with an average of US\$ 22,658 per year. Annual indirect CE-associated monetary losses associated with lost economic opportunities amounted to US\$ 4,414 for a herdsman and US\$ 1,339 for a house wife. Turkana community is a nomadic pastoralist and the rural Turkana women lack formal education, their economic contribution to the family and community was evaluated on the basis of economic potential of a herdsman and a housewife. The results show that CE has a significant economic burden on individuals in this region. This requires immediate sustainable control measures at the definitive and intermediate hosts' level to reduce the burden of the infection.

INTRODUCTION

Cystic Echinococcosis (CE) is a zoonotic disease caused by the larval stage of *Echinococcus granulosus*. Dogs and other canids are the definitive hosts while livestock/humans are intermediate hosts [1]. The outcome of infection in livestock and human is cyst development in the body organs. Intermediate hosts are infected after ingesting *E. granulosus* eggs passed in dog feces [2]

The parasite occurs worldwide and affects rural pastoral societies [1]. It is widespread in Africa especially in countries with extensive livestock economy [3-5]. Cystic Echinococcosis is highly endemic in sub-Saharan Africa [6] In Kenya, there is a very

high prevalence of CE in two pastoral communities, the Turkana and Masaai regions [7]. Transmission is most intense in livestock raising regions where veterinary services are unsatisfactory and offal from slaughtered animals is accessible to dogs [1] The adult tapeworm is harmless to the dog, although in large numbers, enteritis may occur [8].

Humans are infected with hydatid cysts after consuming eggs of *E. granulosus* through contaminated food, water and soil, or direct contact with dogs [9]. After an incubation period of 515 years, the cysts can cause life threatening illness [10]. Fatal complications may arise secondary to rupture of the cyst leading to anaphylactic reactions [11]. Morbidity depends on the number,

size, and developmental status of the cysts, the involved organ and the location of the cysts within the organ, and the defense mechanisms of the infected individual [12]. Recurrence may arise following surgery on primary cysts [13]

In clinical cases, a predominance of women has been noted, with women of childbearing age having the highest prevalence [14-15]. Hydatid cysts can occur in all parts of the body; however, hydatid cysts of the liver were most common, followed by abdominal cysts, kidney, spleen, lung, and soft tissue [16].

Human CE-associated direct economic losses arise from diagnosis procedures including ultrasound and various laboratory tests, surgical or chemotherapeutic treatment, hospitalization and convalescence, life impairment and fatalities. Livestock associated indirect economic losses arise from decrease in carcass weight, milk production and fertility rates and from increased condemnation of viscera [17]. Monetary losses due to CE have been estimated for Uruguay [18], Wales [19] and for a highly endemic area of the Tibetan plateau [20-21]. Costs associated with CE have a great impact on affected individuals, their families, and the community [17].

Non-monetary burden of CE has been assessed for a highly endemic region of China (Tibetan plateau) and globally using the disability adjusted life year (DALY) [22]. An initial valuation of the global burden of CE is estimated at >1 million DALYs lost, which gives CE a greater impact than Onchocerciasis, Dengue fever and Chagas disease. [17]. Recently, the World Health Organization (WHO) included CE in a subgroup of selected Neglected Tropical Diseases (NTDs) to be addressed within its 2008-2015 strategic plan for control of NTDs [23]. The WHO recommends that the economic impact of zoonotic infections be assessed before implementation of any control measure [24]

In Kenya there is no information on the economic significance of CE in humans and livestock. Estimation of the economic burden of CE in human and livestock is important and should be part of any cost-benefit program for the control of this parasitic zoonosis [17]. The main aim of this study was to estimate the monetary burden of CE and its distribution by age and gender in humans in Turkana North district, Kenya. This estimate will provide public health policy makers with important information to aid in the implementation of control measures at the region and country levels. The study also evaluated the economic value of a Turkana herdsman and housewife with a view of evaluating the indirect CE associated economic loss in the study area.

Turkana County lies within Kenya's ecological zone V, VI and VII, classified as arid and semi arid lands, about 65% are very arid. The economy of the county relies on indigenous livestock breeds reared on free range production systems [25]. Turkana are nomadic traditionalists, therefore the male gender at the age of ten years and above herd livestock and the rural Turkana woman is mainly a housewife, married off at 13-15 years. Literacy level is very low in Turkana County [26] The main economic contribution to the family and community of a male and female Turkana is being a herdsman and housewife respectively. Due to CE morbidity/mortality, the economic production of the affected individuals will be reduced constituting the indirect CE associated monetary loss.

MATERIALS AND METHODS

STUDY SITE

The study was conducted using 20 years (1991-2011) of

retrospective data from CE patients' records from Kakuma Mission Hospital, Turkana North District, Kenya. The CE patients' records are kept by AMREF-Kenya which conducts annual CE community ultrasound screening and treatment in the area. Turkana North District is situated in North Western Kenya. The county is hot and dry most of the year with an average rainfall of approximately 300-400 mm. The mean temperature ranges between 26°C -38°C (25).

STUDY DESIGN

A twenty year (1991-2011) retrospective medical records review was conducted using data obtained from AMREF-Kenya. Data were collected on a total of 586 CE patients surgically treated in the Kakuma Mission Hospital. Ethical clearance to use the medical data for research was granted by the Director AMREF-Kenya.

The data collected included the year and date of diagnosis, the type of surgical treatment and the patient's name, age and gender. The location of cyst in the various body organs and the cost of each type of surgical intervention were also recorded. The above data were entered into an excel spread sheet for analysis.

METHODOLOGY

Human CE-associated monetary loss was evaluated based on direct and indirect costs. The direct costs included diagnosis, laboratory charges and surgical treatment, hospitalization (bed charges and food for an average of 10 days), personnel charges (surgeon and anesthetist), logistical costs (flight, fuel) and follow-up costs. The direct CE-associated economic loss per year was estimated by computing the product of the number of CE patients treated per year and the estimated cost/procedure for CE patients treated at Kakuma Mission Hospital, Turkana. Unreported and non healthcare seeking CE cases were given an additional factor of 10% of the total economic loss per year to capture the overall direct CE-associated cost. This group comprised of asymptomatic CE cases that are not aware about the infection and terminal cases that remain at home. The additional factor of 10% was based on the percentage of the total number of positive CE cases scheduled for surgical operation at Kakuma Mission Hospital, Turkana, Kenya.

Two parameters were used to estimate the indirect CE associated economic loss in Turkana North district, Kenya. Economic contribution in monetary value of a healthy herdsman or a housewife in Turkana community of Kenya was used to estimate the CE associated indirect loss in human.

RESULTS

DISTRIBUTION OF CYSTIC ECHINOCOCCOSIS BY AGE IN TURKANA NORTH DISTRICT, KENYA

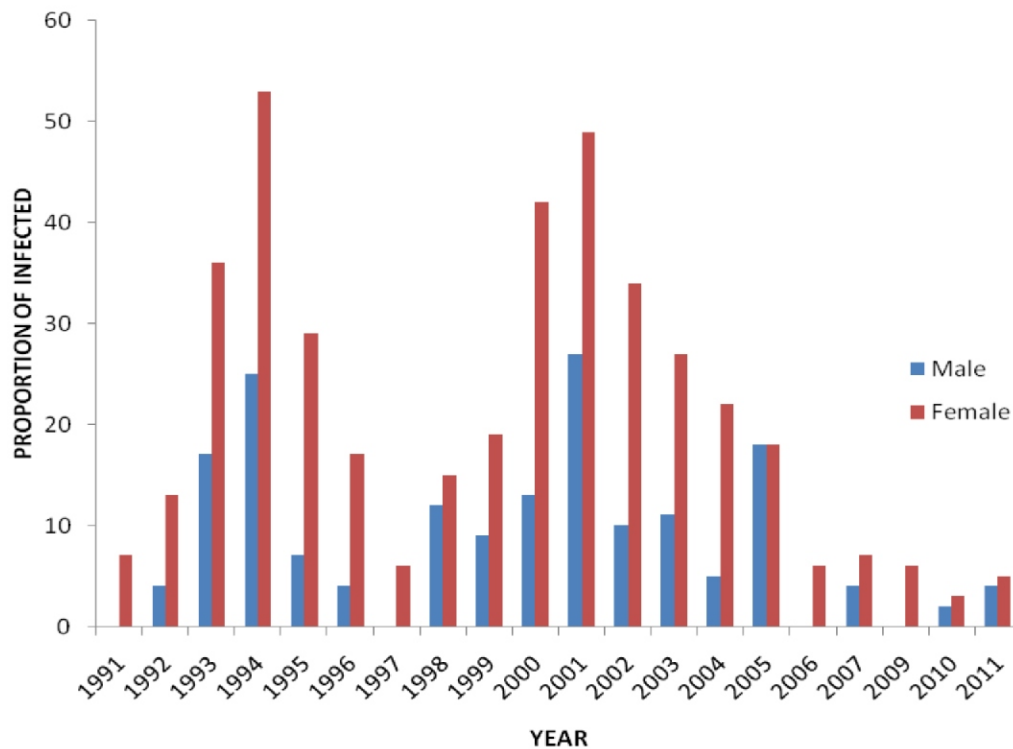
A total of 586 patients were operated during the period reviewed (1991-2011). Patients' ages ranges from □1-70 years. The middle age groups, 21-30 years, 31-40 years and 41-50 years were the most highly infected, making up 19%, 20% and 18% of the cases respectively. The older age groups, 51-60 years and 61-70 years made up 8% and 1% of the cases respectively. The youngest age group, □1-10 years made up 16% of the cases.

ESTIMATED COST FOR CYSTIC ECHINOCOCCOSIS TREATMENT PROCEDURE PER PATIENT AT KAKUMA MISSION HOSPITAL, TURKANA BY AMREF-KENYA

Table 1 shows the cost of diagnosis and surgical treatment of

Table 1. Estimated cost for Cystic Echinococcosis treatment procedure per patient

S/N	Item	Cost (US\$)
1	Laboratory costs (chemicals, equipments and personnel)	24
2	Bed charges (US\$ 2.4/day) for 10 days	24
3	Food (US\$ 3.5/day) for 10 days	35
4	Diesel (US\$ 118/5days,12 patients)	10
5	Logistical costs	29
6	Laparotomy or PAIR (drugs and equipments)	235
7	Ultra Sound screening/patient	2
8	Follow up visits after operation/patient	24
9	Surgeon's salary (US\$ 7,000/22 days, 5 days operation,12 patients)	133
10	Anesthetist salary (2) (US\$ 1529.4/22 days, 5 days operation,12 patients)	60
11	Nurses salary (3) (US\$ 353/22 days, 5 days operation,12 patients)	20
12	Surgeon's flight- Nairobi to Lokichogio and back (US\$ 9,000/ trip, 7 health centres, 12 patients)-AMREF-Kenya flying doctor aircraft.	107
TOTAL		703

**Fig. 1.** Distribution of Cystic Echinococcosis by gender

an individual CE patient in Kakuma Mission Hospital, Turkana, Kenya. The parameters were used to evaluate the direct CE associated economic loss. A total of 12 CE patients were operated during a 5 day visit by AMREF-Kenya personnel. The patients were admitted for an average of 10 days. However those with post operative complications were considered for hospitalization for more days. Diesel was used for transportation of CE patients in remote locations to the hospital. The overall cost of diagnosis and surgery for a CE patient at Kakuma Mission Hospital was estimated at an average of US\$ 703.

DISTRIBUTION OF CYSTIC ECHINOCOCCOSIS BY GENDER IN TURKANA NORTH DISTRICT

Figure 1 shows the distribution of CE by gender in the study area. The female gender had the highest CE infection proportion with a male: female infection ratio of 1:2. This phenomenon is significant considering the prevailing epidemiological factors, the female gender have a close contact with the definitive host (dog).

INDIRECT LOSS

The indirect monetary losses due to CE infection in Turkana community were based on the lost economic opportunities by an infected herdsman or a house wife who cannot perform his/her daily activities due to CE morbidity, mortality or reduced quality of life after a surgical operation.

ECONOMIC VALUE OF A HERDSMAN IN TURKANA COMMUNITY, KENYA

The figures used in Table 2 were assumptions based on the existing environmental conditions prevailing in Turkana, indigenous livestock breeds reared and the average market prices of the various livestock species sold in good body condition. The average individual herd or flock size represent the total number of various livestock species owned by a single household in Turkana community of Kenya. The total monetary loss by an individual herdsman per year due to CE in Turkana community was estimated as the equivalent of the total monetary values of the calves, lambs, kids and number of adult animals sold per year.

ECONOMIC VALUE OF A HOUSEWIFE IN TURKANA COMMUNITY, KENYA

Turkana women are generally housewives without any form of formal employment due to low education levels [27]. Their main contribution to the family and community include giving birth and caring of children, drawing water from the river for domestic use, fetching firewood and building of traditional huts. The provisions of these services/activities to the family are negatively affected due to CE morbidity and/or mortality. In the current study the economic value of a housewife in Turkana community was estimated by converting these services performed by a healthy housewife in Turkana community into monetary values by making assumptions based on existing cost of

Table 2. Estimated herd/flock size, and livestock values in monetary terms in Turkana, Kenya

Serial No.	Type of animals	Average herd or flock size/ household	Average No. of calving, lambing kidding per year	Value of a calf, lamb and kid (US \$)	Total value of the young (US \$)	No. of animals sold/ year	Value of animals sold (US \$)	Total value (US \$)
1.	Cattle	50	15	9.4	141	10	176.5	1,765
2.	Camels	20	7	23.5	165	4	352.9	1,412
3.	Sheep	80	20	2.4	48	15	35.3	530
4.	Goats	80	25	2.9	73	15	47.1	707
	Total							4,414

Table 3. Daily activities performed by a healthy Turkana woman and estimated monetary value per year

S/No	Daily activity	Monetary value/year (US\$)
1	Caring of children	756
2	Drawing water from the river	360
3	Fetching firewood	216
4	Building of homesteads	7
Total		1,339

these services/activities in an urban settlement within Turkana County of Kenya. Currently there are no uniformly acceptable costs of such services in the rural parts of Kenya. Giving birth and caring of children was equated with the cost of hiring a house help in Lodwar town in Turkana County. The cost of hiring a house help in Kenya is US\$ 63/month translating to US\$ 756/year. This is based on the Minimum Consolidated Wages by Region and Occupation in Kenya [28] Drawing of water from rivers for domestic use was equated with the value of a 20 litre container of water in Lodwar town in Turkana County. Assuming that one woman can manage 4, 20 litre containers daily using a donkey as means of transport from a river. The cost of a 20 litre container of water was assumed to cost US\$ 0.24. The county is usually dry most of the year and the women normally walk long distances to fetch water. Fetching firewood was equated with the

value of a bundle of firewood in Lodwar town in Turkana County. Firewood is the source of energy used by low income residents living in low class estates within Lodwar town. One bundle was assumed to cost US\$ 0.6 and each household consumes a bundle to prepare meals daily. Building of traditional homesteads was equated with the cost of building materials of traditional huts and labor within one homestead. The total cost was divided by the approximate number of married women in one homestead in Turkana community of Kenya to estimate the economic contribution in monetary value by a single married woman. Assuming each homestead has an average of 15 huts built of locally available materials with approximately 9 healthy married women per single homestead building the huts. The average cost of building one hut is approximately US\$ 59, cost of local materials and labour.

Table 4. Direct economic loss due to Cystic Echinococcosis in human in Turkana North district, 1991-2011

YEAR	NO. OF PATIENTS OPERATED/YEAR	ECONOMIC LOSS/YR (US\$)	TOTAL ECONOMIC LOSS PER YEAR (US\$)
1991	7	4,921	5,413
1992	17	11,951	13,146
1993	53	37,259	40,985
1994	78	54,834	60,317
1995	36	25,308	27,839
1996	21	14,763	16,239
1997	6	4,218	4,640
1998	27	18,981	20,879
1999	28	19,684	21,652
2000	55	38,665	42,532
2001	76	53,428	58,771
2002	44	30,932	34,025
2003	38	26,714	29,385
2004	27	18,981	20,879
2005	36	25,308	27,839
2006	6	4,218	4,640
2007	11	7,733	8,506
2009	6	4,218	4,640
2010	5	3,515	3,867
2011	9	6,327	6,960
TOTAL	586	411,958	453,154

The overall monetary value of the activities performed by healthy Turkana women constituted the economic opportunity lost by CE infected women due to its morbidity and/or mortality.

DIRECT ECONOMIC LOSS DUE TO CYSTIC ECHINOCOCCOSIS IN HUMAN IN TURKANA NORTH DISTRICT, 1991-2011

Table 4 shows the total direct economic loss due CE per year during the period under review, the number of CE patients operated/year multiplied by the total cost of surgically treating one CE patient in Kakuma Mission Hospital, Kenya (Table 1). An additional factor of 10% of the direct economic loss/year was included to represent the unreported and non healthcare seeking CE cases. The total CE associated direct economic loss for the 20 years (1991-2011) under review was US\$ 453,154 with an average of US\$ 22,658/year.

DISCUSSION

This is the first study on the assessment of the monetary burden of CE in humans in Kenya. The analyses were done using CE patients' data from Turkana North district, which is a CE endemic region in Kenya. Studies that estimate the burden of a disease at a regional level provide data that enable decision makers to prioritize allocation of limited resources in developing countries like Kenya [29]. Similar studies have been done in several countries such as Uruguay [18], Wales [19]. The results of this study from a single CE endemic region, Turkana, Kenya is significant and can be used to direct CE control programs in the entire country. However, direct comparison of data is difficult due to lack of standard methods for estimating the costs of the infection and the differences among countries in terms of human and animal population sizes, disease prevalence, inherent socio economic patterns, and period of evaluation [30].

The findings of this study show that the overall monetary burden of CE in the Turkana North district of Kenya is high. The average annual direct economic cost of US\$ 22,658 per year for patients treated in a single health facility in Turkana County clearly confirms that CE is a zoonotic parasitic infection with a high economic burden in the study site. The cost of CE diagnosis, surgical treatment and hospitalization of the patients at Kakuma Mission Hospital is catered for by AMREF- Kenya. The government of Kenya through the ministry of health does not have a specific budget for the diagnosis, treatment and control of CE and patients have to shoulder the whole burden in the absence of volunteer financiers such as AMREF- Kenya.

Indirect costs for this study included all the opportunities that were lost as a result of CE-associated morbidity and/or mortality. Morbidity leads to disability [31] and most likely a reduction in quality of life in CE patients [32]. Indirect CE-associated monetary loss were estimated based on the lost economic opportunities of an infected herdsman and a housewife in the Turkana community, with lost-opportunity costs corresponding to the productive time lost due to an infected person working less efficiently than someone who is uninfected [30].

The monetary value of the young animals born and the culled animals sold per year constitute the economic contribution of a herdsman to his family and community in general. In the Turkana community, women are less educated and are usually married at an early age. Their daily activities include caring for children, drawing water from the rivers for domestic use, fetching firewood, and building traditional homesteads [27]. These activities when converted into monetary values constitute the

economic contribution of a local Turkana woman to her family and community. The assumptions were made based on the cost of goods and services in the main town of Lodwar in Turkana County. Findings from this study show a significant annual indirect CE associated monetary loss by an individual herdsman (US\$ 4,414) and a housewife (US\$ 1,339) in Turkana due to CE. Kenya's Gross Domestic Product (GDP) is estimated at US\$ 40.7 billion with a per capita GDP of US\$ 943 [33]. The CE associated monetary loss by an individual herdsman and housewife in Turkana community compared to the country's per capita GDP confirms the economic burden of this zoonotic disease within the study site. From the results of this study, both males and females are at risk of contracting and developing CE with a male to female infection ratio of 1:2. French [34] studied the age-sex distribution of 355 Turkana hydatid patients and obtained similar results. He related the trend to the close contact between women and dogs during child rearing when the dogs are used as nurse maids to clean babies' faeces or vomit. The higher number of female cases can also be due to the fact that the female members of the community are normally within the homesteads during CE mass screening and if they test positive will subsequently be booked for treatment at the Kakuma Mission Hospital. The men are often out of the homesteads grazing livestock and are not fully captured during CE screening. The middle age groups, 21-30 and 31-40 made up the highest proportion of cases, which could be associated with close contact with the definitive host (dogs) in the study site. Turkana, men are known to herd their livestock with dogs and the women get close contact with dogs while child rearing.

Cystic Echinococcosis not only causes monetary losses, but also can cause social problems including stigmatization, divorce and creating a burden on the family members caring for a terminally ill CE patient. The family of a terminally ill CE patient suffer psychological stress due to the care required at this moment, this increase the overall indirect CE burden. The poverty level of Turkana County stands at 94.3% according to Kenya integrated household survey [35], CE therefore is a contributing factor to the high poverty index in the study area.

CONCLUSION

This study confirms a significant direct and indirect CE associated monetary burden and social problems within the study area and hence a parasitic zoonotic disease of public health importance in the region. The study therefore recommends comprehensive public health education on the CE risk factors and effective control measures to reduce its associated monetary burden considering the existing epidemiological information within the study site.

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