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Review Article

Echinococcosis: The Status of Cystic Hydatidosis in Ethiopia

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Abstract

Hydatidosis is a globally distributed zoonotic parasitic disease, caused by larval stages of *Echinococcus granulosus*, which primarily maintained through domestic and sylvatic life cycle that perpetuates the disease and creates obstacles for control and eradication programs. In this review, we discuss about etiology, life cycle, distribution, and transmission of Echinococcus organisms, and the pathogenesis, clinical features, diagnosis, treatment, prevention and control strategies of the diseases they cause, in both animal and humans. Research findings from abattoir surveys conducted in Ethiopia have been also reviewed, which revealed the prevalence of cystic bovine hydatidosis, ranging from 6.51% (Debre-brhan) to 62.38% (Assela) and annual economic loss ranging from 8,798.50 (Arsi) to 19,847,704.00 (Addis Ababa Abattoir Enterprise) Ethiopian Birr. However, still the real public health and economic burden of the disease have been under-estimated due to poor reporting, and that is why, the disease lacks to bring the attention that it deserves. Nevertheless, these research findings have indicated the present damage and warning alarm of the future economic and public health consequences. Therefore, these findings warrant the need of an urgent multi-sectorial collaborative intervention to control the disease, and further studies should focus on the national magnitude of public health and economic impacts, transmission dynamics, prevention and control measures. Moreover, attention should have given towards regular deworming of dogs and appropriate disposal of infected organs.

Keywords: Animal; Cystic Hydatidosis; Economic Impact; Ethiopia; Human; Prevalence

Introduction

Hydatidosis is a parasitic zoonotic disease caused by larval stages of *Echinococcus granulosus*, associated with severe economic losses and great public health significance worldwide [1,2]. The disease constrains the animal production systems through decreased live weight gain and economic loss due to organ contamination [3]. Besides, the livestock infections, it has also estimated to affect approximately two to three million people worldwide, with Africa amongst the primarily endemic regions [4].

The genus Echinococcosis has four species having zoonotic importance, namely, *Echinococcus granulosus, Echinococcus multilocularis, Echinococcus vogeli* and *Echinococcus oligarthrus*, which are morphologically distinct both in their adult and larval stage [5]. The adult parasite is a small (2-8mm) cestode of carnivores especially dogs, is found in the small intestine of carnivores while metacestode (Hydatid cyst) is found in different organs of a wide variety of ungulate animals and man. Cysts usually grow 50-100mm, but up to 500mm have been reported [6].

Echinococcus granulosus, primarily maintained through domestic and sylvatic life cycle perpetuates the disease and creates obstacles for control and eradication programs. The infection source of the disease is during the pastoral cyclic, dogs are always involved and infested by feeding on ruminant's offal containing hydatid cyst. Sylvatic cycle occurs in wild canines and ruminant, based on predation or carrion feeding [7]. Transmission dynamics of the parasite determines by interaction of the factors associated with hosts and the external environment [8].

Ethiopia, findings from abattoir survey in different part of the country have indicated the present damage and warning alarm of the future economic and public health consequences. However, ac-

cording to the Mitiku and Amenu's [9] report, there is no preparedness to implement integrated control measures, and weak veterinary extension system and lack of integration of concerned bodies to fight against zoonotic diseases in general and bovine hydatidosis in particular may worsen the problems. However, the fattening farms and abattoir industry were dramatically increasing recently in the country. Therefore, the objective of this paper is to review about the disease cystic hydatidosis, its prevalence situation and economic significance in Ethiopian.

Etiology

Echinococcosis is a term used to describe infection of animal and Humans with Adult Echinococcus tapeworm or larva/metacestode stage of Echinococcosis species, hydatid cyst [10,11]. At present, four Echinococcus species were been recognized as having zoonotic importance, namely, *Echinococcus granulosus, Echinococcus multilocularis, Echinococcus oligarthrus* and *Echinococcus Vogeli.* These species belongs to the Kingdom: Animalia, Phylum: Platy helminthes, Class: Cestode, Order: Cyclophilide, Family: taneidae & Genus: Echinococcus [12].

Echinococcous Species	Intermediate host	Final host
Echinococcous granulsus	Ruminant	Dog
	Human	Wild canids
	Donkey	-
	Horse	-
Echinococcous multilocluaris	Small rodents	Dog
	Human	Cat
	Large mammals	Wild canids
Echinococcous oligurthrus	Large rodent	Wild fields
Echinococcous Vogeli	Large rodent	Domestic & Bush dog

Table 1: Describing the intermediate and final hosts of *Echinococcous species* [5].

Adult parasite

An adult Echinococcus is only a few millimeter long (rarely more than7mm) and usually has no more than six segments. Like all tapeworms, Echinococcus has no gut and metabolic interchange takes place across the syncytial outer covering of the segment [8]. Anteriorly an adult Echinococcus possesses a specialized attachment organ. The scolex has four muscular suckers and two rows of hooks, one large and one small on the rostellum. The body or strobili has segments and consists of reproductive units (proglottds), which may vary in number from two to six [13].

Eggs

The Echinococcus eggs, excrete with feces of the infected dog, and are infective to man, sheep, cattle and other intermediate hosts. Echinococcus eggs have a sticky coat that adheres to an animal's fur and other objects; they are spherical in shape, brown in color, measure 31-43 µm in diameter and consist of two layers, an outer thin wall and inner embryophore. Each egg consists of a hexacanthe embryo with three pairs of hooks [7]. Survival of the infective egg has influenced by environmental factors like humidity and temperature. While eggs may survive for several months under moist condition and moderate temperatures, desiccations is detrimental and they will only survive a short time when exposed to direct sun light and dry condition [1].

Larva Stage (Hydatid cyst)

It is fluid filled bladder usually uniloculor, but communicating chambers also occur. The Cyst consists of inner germinal (nucleated) layer supported externally by tough elastic a cellular laminated layer of variable thickness, Surrounded by host produce fibrous advential layer [10]. Endogenous daughter cyst can be produce; individual cyst bladder may reach up to 30 cm in diameter and occur most frequently in liver and lungs, and may develop in other organs [6]. The inner layer is the vital layer of the hydatid cyst, which gives rise to broad capsule and scolices, and secretes clear fluid known as hydatid fluid. The fluid is nutritive and Provide nourishment for growing broad capsule and scoliecs. It is slightly acidic (PH 6.7), rich in electrolyte (Nacl, Naso4) and has a low specific gravity (1+01.010). The Hydatid fluid is antigenic and highly toxic [11].

Geographical distribution

Echinococcus granulosus has a worldwide geographical distribution; high prevalence have been reported from parts of Mediterranean region, Russian federation and adjacent independent states, the people republic of China, Africa (northern and eastern region), Australia and South America. High incidence rates or prevalence have also been recorded from countries, in northern and eastern Africa (prevalence up to >3%) and South America (Uruguay annual incidence of 6.5% per 100,000 population in 1997). A few islands are now free of *Echinococcus granulosis* (Iceland, Green land) or provisionally free of (New Zealand, Southern Cyprus). The occurrence of *Echinococcus granulosis* is sporadic or not reported from other region, including counters in northern and central Europe, in the pacific region and in the Caribbean [14].

Echinococus Species	Geographical distribution
Echinococosis granulosus	Mediterranean Cost, Middle East, South American, South Russia, North Africa and Australia
Echinococosis oligarthrus	Central and South America
Echinococosis multiloculari	North America, Middle East, India and Japan
Echinococosis vogeli	Central and South America

Table 2: Geographical distribution of *Echinococus species* [7,15].

Figure 1: Life cycle of *Echinococcus granulosus* [19].

Mode of transmission and life cycle

The source of infection for *Echinococosis granlosis i*s of two cycles that is pastoral and sylvatic in the pastoral cycle the dog is always involved, and then infected by feeding ruminant's offal (mainly sheep) containing hydatid cyst. The sylavatic cycle is in wild canids and ruminant, and is on predation or carrion feeding [7]. The parasite perpetuated in life cycle with carnivores us definitive hosts, which harbor the adult with egg producing stage in the intestine of intermediate host animal, in which the infective metacestode stage develops after perforal infection with eggs. Metacestodes may incidentally develop in human, causing various forms of Echinococcus [12].

The intermediate hosts include a large number of domestic and wild animals, particularly herbivores, and humans can infected too. If an intermediate host ingests the eggs, onchospheres released and penetrate the gut wall, carried with blood or lymph to the large organs, then grow into cysts in many [16]. It has also been shown that flies and possible other insects may mechanically transport eggs over considerable distance, having been contaminated during feeding or egg laying activities [17].

Life cycle of Echinococcus species involve two hosts, and a free living eggs are passed in the feces of the carnivore, which are immediately infective, and on ingestion by cattle the onchosphere penetrate an intestinal venules or lymphatic lacteal to reach the liver or the lung although, other organs can be infected [18]. The hydatid cysts composed of broad capsules, each containing protoscolices develop about five month after infection. At this stage, the cyst is infective for the definitive host and life cycle completes when dog ingested the protoscolices [8].

Pathogenesis

Depending on the mode of development of cystic Echinococcus is of two types, primary cystic and secondary cystic Echinococcus. Primary cystic Echinococcus after oral infection with *Echinococcus granulosus* egg, which gives rise to hydatid cyst in different parts of the body while secondary cyst Echinococcus occur by rupturing primary cyst Echinococcus due to trauma. Therefore, the protoscolecse will be carried by blood to different body parts, and then develop into the secondary hydatid cyst [11].

The effect on the host depends up on the organ parasitized and the size attained by the hydatid cyst, which may measure up to several inches. The hydatids are usually surrounded by mononuclear cell, eosinophil, multinucleated giant cell and fibrous connective tissue. The inflammatory reaction becomes sever when the cyst ruptures. In human, rupture of the cyst can lead to an anaphylactic shock or other severe allergic reactions, and adjacent tissues undergo compression atrophy. Hydatid cyst may degenerate spontaneously, in which case they undergo calcification [20].

Clinical symptoms

There are few available data on the clinical effect of cystic hydatidosis in the intermediate host, since the cyst is growing slowly and animal are often slaughtered before it manage to create sufficient pressure on the tissue and organ [21].

- **Animal:** Two types of clinical forms of Echinococcus have known to occur in animals. **1,** Intestinal infection with adult or immature stage of Echinococcus species and **2,** Infection of internal organ of intermediate of aberrant host animal with the metacestode stage [14]. Clinical signs associated with the presence of cysts in animals are few; despite quiet sever level of infection. However, if a large cyst is present in the liver, ascites may result due to rarely cause problem except some enteritis in heavy infestation [22].

- **Human:** Symptoms in human related to the severity of the infection, the sites and size of the cyst. Usually both liver (especially the right lobe) and lungs are affected, but cysts may

found in almost any organ in the body, even in the pulmonary artery and the inferior vena cava. Many cases, however, are a symptomatic and in some case, cyst growth may arrest with calcification. Some picked up at post mortem and others during chest x-ray, CT Scanning and Sonography for unrelated condition [22]. In pulmonary cases there is often coughing, with or without haemopoities (splitting of blood) with coughing up of membrane from ruptured cyst. Liver lesions are sometimes painful and cranial cysts rupture to become secondarily and/or cause fatal anaphylaxis [11].

Diagnosis

- **Animal:** In the definitive host, a post mortem examination is the most reliable method of diagnosis. Examination of the faces after using arecoline as a purgative is less reliable; although, proglottides in the feces are concussive, egg counts are not specific because of the similarity of eggs from other tapeworms of the Taenia family [23]. Serological screening has recently proved to be a powerful tool in detecting infected dogs and is superior to the arecoline testing [24]. In the intermediate host, diagnosing Hydatidosis is possible through scanning radiology, serology and post mortem examination [25].

- **Human:** A non-invasive confirmation of the diagnosis can usually accomplished with the combined use of radiologic imaging and immunodiagnostic techniques [26]. In many case, diagnosis can be made by detecting the characteristic structure and size of Echinococcus cyst visualized by various imaging techniques, including ultrasonography (US), which improves the diagnostics, computed tomography (CT), standard radiology (x-ray) and magnetic resonance imaging (MRI) in specialized centers [14]. The direct diagnosis, made by macroscopic identification of the structure and size of the cysts obtained by surgery and/or by histological examination of parasite tissues available after surgery or biopsy. Sophisticated techniques in direct diagnosis include finding specific *E. granulosus* antigens in the fluid from sterile cysts or DNA markers in the cysts fluid or parasite tissue, by Polymerase Chain Reaction (PCR) [27].

Echinococcus-specific PCR are useful in the diagnosis of the disease from patients biological specimen or biopsy [28]. Reverse transcription PCR is used to assess the viability of parasite following chemotherapy. Diagnosis of hydatid cysts can be confirmed in seronegative individuals by demonstrating protoscolices/hydatid membranes or specific antigen also. Patients with ruptured pulmonary cysts may have protoscolices detected in the sputum or bronchial washings [29]. New testing modalities that could be used in small laboratories to facilitate epidemiologic studies in countries where the disease is endemic are being developed. A loop-mediated isothermal amplification (LAMP) assay is such an example. The assay is able to accurately detect 5 different species of Echinococcus (*E. granulosus sensu stricto, E. equinus, E. ortleppi, E. canadensis,* and *E. felidis*) [30].

Disease Management

The management of cystic echinococcosis is complex, and great variations exist in the management of the disease worldwide [31]. In general, there are four different management modalities: percutaneous therapy, surgery, chemotherapy, and observation without intervention (watch and wait). The expertise of the personnel and the availability of resources, the stage, size, and location of the cyst,

- **Surgery:** was the only option for treatment until the 1980s [26] has been considered the gold standard, but alternatives exist for selected patients and are now considered the first management options [32]. The indications for surgery include large cysts that are superficial and likely to rupture, infected cysts, cysts in vital anatomical locations, and cysts exerting substantial mass effect [33]. Various surgical techniques available include enucleation, pericystectomy, cystostomy with capitonnage, open aspiration, and lung resection [34]. Surgery is the treatment of choice at present, surgical removal of intact hydatid cysts, when possible, remains the treatment with the best potential to remove cysts and lead immediately to complete cure [35].

- **Chemotherapy:** Several of the benzimidazole compounds have shown efficiency against hydatid cyst in the intermediate host [14,36]. A number of anthelmintic drug have proved to be effective against adult stages of *Echinococcus granulosus* in the final host. Long-term treatment with albendazole has a particularly marked effect on the cysts. The best drug currently available is praziquantel, which exterminates all Juvenile and adult Echinococcus from dogs [37]. Moreover, the combination of praziquantel and albendazolehas been used successfully in the treatment of hydatid disease [38].

Prevention and control strategies

Preventing infection in humans depends on education to improve hygiene and sanitation. Strict control and prohibition on farm slaughter and aggressive stray dog elimination plus strict

control of working dogs and those kept as pets were, key features [39]. In endemic areas, wild animals contact with dog and foxes should be avoided, although, it is impractical to eliminate the parasite from these wild animal hosts. Infection in dogs and cats prone to eat infected rodents can prevent by monthly treatment with praziquantel [40].

According to the WHO [41], control program should include the following four phases, namely 1, Planning (appropriate control strategies identified) 2, Attack (involves the dosing of dog and public education programs) 3, consolidation (quarantine of the infected/at risk farms) and 4. Maintaining eradication (continuous surveillance and monitoring the human, canine and livestock population). A promising advance has been the development of a recombinant vaccine (EG95), which seems to confer 96-98% protection against challenge infection. Mathematical modeling has revealed that the most effective intervention against echinococcosis is a combination of sheep vaccination and dog anthelmintic treatment [42].

The Status of Cystic Hydatidosis in Ethiopia: overview

- **Bovine hydatidosis:** Ethiopia, according to the abattoir based studies conducted by various authors on bovine hydatidosis at different parts of the country; findings have come up with different range of cystic hydatidosis infection rate mainly from that of cattle [43]. From Nekemt Municipality Abattoir has reported a relatively higher (62.38%) prevalence of bovine hydatidosis, while, Tsegaye [44] have recorded the lower (7.2%) infection rate of cystic bovine hydatidosis from Debrebrhan Region (Table 3).
- **Economic importance:** According to some abattoir studies reported from Ethiopian, economic losses due to hydatidosis was commonly calculated from the annual money lost due to condemned organs like lung, liver, heart, and kidney and carcass weight loss. A relatively highest economic loss (19,847,704.00 ETB) has reported from Addis Ababa Abattoirs Enterprise [45]. However, the lowest annual economic loss has reported from Arsi administrative region with about 8,798.50 Ethiopian Birr (ETB) [46]. All the research findings reported from Ethiopia have indicated that, Economic losses of visceral organ condemnation and carcass weight loss of cattle due to cystic hydatidosis has been dramatically increasing in the recent years (Table 3).
- **Human incidence:** Currently information on the prevalence of human cystic echinococosis in Ethiopia is scanty as the disease is not considered a critical medical condition, and is not even a notifiable disease. According to Assefa., *et al*. [63], a five-year (2008-2012) retrospective data survey from ultrasound examinations results in Addis Ababa hospitals revealed, a mean annual incidence rate of 0.1851 per 100 000 population. Females were much more likely to be infected than males, and the highest prevalence was observed in patients above 40 years of age. Hydatid cysts were most commonly encountered in the liver (81.5%; 22/27) and less frequently in the spleen (11.1%; 3/27) and kidneys (7.4%; 2/27). Moreover, other studies from different parts of Ethiopia have also reported an estimated incidence rate of the disease, Kebede., *et al.* [64] from Bahir-Dar city (2.3%) and Eckert., *et al*. [65] (0.5% – 1.6%) in southern Ethiopia.

Author(s)	Study Area	Prevalence in Cattle	Annual Economic loss
Terefe., *et al*. [45]	Addis Ababa Abattoir	40.50%	19,847,704.00
Demissie and Kemal [47]	Kara-Aloab-attoir PLC	25.70%	22,010
Hussen., *et al*. [43]	Assela	62.38%	-
Brhane and Abeba [48]	Jimma	30.70%	94,485.00
Tadesse., *et al*. [49]	Nekemte	17.10%	4,000,000.00
Zewdu *et al*, [50]	Ambo	29.69%	160,032.23
Lema., *et al*. [51]	Harar	11.30%	96,315.00
Haftu and Kebede, [52]	Bako	11.88%	180,792.00
Guadu., *et al*. [53]	Shire	25.92%	54,679.00
Gebreyohannes and Wondie [54]	Dire-dawa	32.18%	362,617.39
Alemayehu [46]	Arsi region	54.80%	8,798.50
Asrat [55]	South Wollo	28.30%	64,442.60
Feseha and Yilam [56]	Debre-zeit	46.50%	831,526.46
Mohammed, [57]	Gamo-gofa	25.88%	21,054.84
Nibiyou [58]	Bahirdar	54.90%	7,331.94
Debas and Inrahim [59]	Gonder,Alfora	28.00%	674,093.04
Akeberegn., *et al*. [19]	Debre-brhan	06.51%	-
Yemane [60]	Nazareth	37.70%	10,879.64
Yilkal [61]	Around Dessie	38.40%	5,892.00
Hagos [62]	Mekelle	32.12%	129,934.00

Table 3: Prevalence of Bovine hydatidosis and estimated annual economic loss in Ethiopia.

Conclusion

Hydatidosis is a globally distributed, parasitic zoonotic disease caused by larval stages of *Echinococcus granulosus*. This parasite primarily maintained through domestic and sylvatic life cycle (mainly dogs), which perpetuates the disease and creates obstacles for control and eradication programs. The disease constrains the livestock production systems through decreased live weight gain and economic loss due to organ contamination. Besides, the livestock infections, is estimated to affect approximately two to three million people worldwide. The effect on the host depends up on the organ parasitized and the size attained by the hydatid cyst, though, cyst rapture may worsen the condition. Cyst visualization using imaging techniques for human and Post mortem examination for animals are the most reliable methods of diagnosis. Ethiopia, this disease is imposing huge economic loss to the country, through affecting the production efficiency of livestock and resulting condemnation of organ and carcasses in abattoirs, above19 million Ethiopian birr loss has recorded from Addis Ababa Abattoirs Enterprise per Annam. However, this is not the real estimate, because animals slaughtered at backyard areas are not considered. Nevertheless, it indicates the present damage and warning alarm of the future economic and public health consequences. However, weak veterinary extension system and lack of integration of concerned bodies to fight against zoonotic diseases in general, and bovine hydatidosis in particular may worsen the problems. Therefore, these findings warrant for the need of urgent multi-sectorial collaborative interventions to control the disease, and further studies should focus on the national magnitude of public health and economic impacts, transmission dynamics, prevention and control measures. Moreover, attention should have to give towards regular deworming of dogs and appropriate disposal of infected organs.

Conflicts of Interest

Authors declare no conflict of interest.

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