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Hydatidosis: Its Epidemiology and Public Health Significance

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Abstract: Hydatidosis/Cystic Echinococcosis (CE) is one of the most important neglected tropical parasitic diseases of livestock that has both financial and public health significance caused by larval (metacestode) stage of Cestodes belonging to the genus *Echinococcus*, family Taenidae. CE caused by the larval stage of *Echinococcus*, *granulosus* is recognized as being one of the major zoonosis and associated with severe economic losses and great public health significance worldwide. The distribution of hydatidosis is normally associated with underdeveloped countries, especially in rural communities where humans maintain close contact with dogs and various domestic animals. Carnivores are definite hosts for the parasite with livestock acting as intermediate hosts and human as accidental intermediate or aberrant host. 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). In human prevalence of 1.6% and 0.5% have been reported from southern part of Ethiopia. Breaking the life cycle is one of the main control measures. Strengthening of veterinary facilities and extension systems, expansion of abattoir facilities to avoid backyard slaughter practices, creation of community awareness, regular deworming of dogs and appropriate disposal of infected organs are recommendations forwarded in order to help zoonosis control.

Key words: Epidemiology · Hydatidosis and Public Health Significance

INTRODUCTION

Hydatidosis is a zoonotic parasitic disease caused by larval stages (hydatid cysts) of cestodes belonging to the genus *Echinococcus* and the family Taeniidae [1]. Hydatid cyst, which is the larval stage of *Echinococcus*, is a bladder like cyst formed in various organs and tissues following the growth of the oncospheres of an Echninoccus tape worm in that specific organ or tissue Martinma [2]. The larval stage develops in a very wide range of intermediate host including human and the adult stage is found in carnivores [3]. Echinococcosis /Hydatidosis/ is endemic in sheep and cattle raising areas worldwide. Especially *E. grnulosus* has a worldwide geographical distribution and occurs in all countries.

Domestic animals such as camels, cattle, goats and sheep which live in close contact with dogs are implicated as one of the important contributors of zoonotic diseases to humans [4]. It is characterized by the formation of variably sized cysts in the visceral organs of the intermediate hosts and adult tapeworm in the intestine of dogs [5]. The disease is chronic and affects all kinds of food animals, including herbivorous and omnivorous mammals. Humans can accidentally become hosts by ingesting the eggs of *E. granulosus*. In humans, the cysts develop in the liver and lung but other organs and tissues may also become affected [6].

The disease has a worldwide distribution and its prevalence varies among regions due to climate difference and agro ecology, level of education and development condition [5]. High prevalence is found in parts of Eurasia, Africa, Australia and South America. *Echinococcus multilocularis* is also distributed in the Northern hemisphere, including endemic regions in Central Europe, most of Northern and Central Eurasia, parts of North America and in Northern Africa (Tunisia) [7-10]. The life cycle of hydatidosis involves two mammalian hosts. The adult cestode inhibits the small intestine of carnivores (definitive host) and produces eggs containing infective oncosphers. Cestodes segments, proglotids containing eggs (free eggs) released from intestinal tract of final host in to the environment.

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Ethiopia has the largest livestock population and the largest number of indigenous cattle breeds in Africa, with an estimated number of large and small ruminant populations of 40.3 million cattle, 20.7 million sheep and 16.3 million goats [11]. However, this great potential was not properly exploited mainly due to prevailing traditional management and rampant diseases distribution. Both endoparasite and ectoparasite infestation represents a major drawback on livestock production in the tropics [12]. Hydatidosis (cystic echnococcusis) was one of the most important parasitic diseases of ruminants responsible for huge economic losses due to reduction in carcass, weight gain and condemnation of organs [13].

It is one of the major causes of organ condemnation in most Ethiopian abattoirs and slaughter houses [14-17]. The disease is much more common in the rural areas of Ethiopia where dogs and domestic animals live in a very close association [17]. Therefore, the objective of this paper is to review the epidemiology and public health significance of hydatidosis

Etiology of Hydatidosis: Echinococcus granulosus is a small tapeworm of carnivorous and the etiological agent of the disease known as Hydatidosis/CE. It is a parasitic zoonotic disease which is caused by the larval stage (metacestode) belonging the Phylum: Platyhelminthes; Class: Cestoda; Order: Cyclophyllidea; Family: Taeniidae and Genus: Echinococcus [18]. *Echinococcus granulosus* causes a type of echinococcosis known as cystic echinococcosis, unilocular echinococcosis or cystic hydatid disease. This species has traditionally been divided into strains, named G1 to G10, which have a degree of host adaptation and may be maintained in distinct cycles. These strains have generally been named after the intermediate host thought to be most important in perpetuating the life cycle. In some cases, other species may also maintain the strain. Strains may differ in their morphology, rate of development, virulence, geographic range and other factors [19]. The strains include two sheep strains (G1 and G2), two bovid strains (G3 and G5), a horse strain (G4), a camelid strain (G6), a pig strain (G7) and a cervid strain (G8). A ninth genotype (G9) has been described in swine in Poland2 and a tenth strain (G10) in reindeer in Eurasia. The sheep strain (G1) is the most cosmopolitan form and is that most commonly associated with human infections [20]

Epidemiology of Hydatidosis: Cystic Echinococcosis has a world-wide geographic distribution and represents a major economic and public health problem in some regions [21, 22]. CE is not found in Antarctica and has been eliminated through comprehensive control programs in Iceland, New Zealand, Tasmania, Falkland Islands and Cyprus. Hydatidosis due to *E. granulosus* is commonly prevalent in sheep-raising areas of the Mediterranean, Australia, New Zealand, Eastern Africa, South America and the Middle East including Saudi Arabia [23, 24]. It is considered endemic with high parasite prevalence in parts of Mediterranean region, central Asia, western China, Russian Federation and adjacent independent states, the Peoples Republic of China, Australia, South America (Peru, Chile, Argentina, Uruguay, southern Brazil) and Africa (northern including Algeria, Egypt, Libya, Morocco and Tunisia and eastern regions including parts of Sudan, Ethiopia, Kenya and Uganda) [25, 26]. In Africa, the disease is reported more commonly in cattle and sheep raised in a free range associated intimately with dogs [27, 28]. Cystic echinococcos is typically occurs in poor pastoral regions in which sheep or other livestock are raised and in which dogs kept, for herding or property guarding, in close proximity to households. Dogs in such regions are frequently fed offal and, for religious and other reasons, their populations might not be curtailed [29, 30]. Maintenance and spread of the disease in endemic areas are known to be influenced by the diversity of livestock production systems, poor and unsupervised slaughter-houses, illegal and family slaughtering, low public awareness of the disease and a large stray dog population [25, 31]. The G1 genotype of *E. granulosus* sensu stricto is responsible for the vast majority (88%) of human cases worldwide [32]. It has a cosmopolitan distribution and is associated with transmission from sheep as an intermediate host [25]. Camel genotype *E. canadensis* (G6) of *E. granulosus* is the most prevalent strain endemic in camels, goats and cattle as well as humans, while cattle strain (G5) is confined to cattle in the Sudan. *Echinococcuscanadensis* G6 and G7 are responsible for 7.3% and 3.7% of infections worldwide, respectively [24]. The human incidence can exceed 50 per 100, 000 person-years in areas of endemicity and prevalence rates as high as 5% to 10% can be found in parts of Peru, Argentina, east Africa and China [26, 29].

Mode of Transmission: Infection of cattle, sheep and goats with tapeworm eggs causes hydatid cysts in vital organs including the liver and lungs [21]. However, human can be infected by ingesting tape worm eggs passed from infected carnivores. It occurs most frequently when individuals handle or contact infected dogs or other carnivores inadvertently ingest food or drink water

contaminated with fecal materials containing tape worm eggs [22]. Transmission of hydatidosis to intermediate hosts takes place through the ingestion of eggs with contaminated food or water. The definitive hosts are infected by the means of eating infected cyst containing organs condemned at the slaughter houses/abattoirs. Humans are accidental intermediate hosts that become infected by handling soil, dirt or animals' hair that contains eggs. No biological or mechanical vectors for the adults or larval forms of any *Echinococcus* species found. However, carrion birds, coprophagic flies and other arthropods can act as mechanical vectors for the eggs [23].

Geographical Distribution: Hydatidosis due to *E. granulosus* commonly prevalent in sheep-raising areas of the Mediterranean, Australia, New Zealand, South Africa, South America and the Middle East including Saudi Arabia [24]. In Africa, the disease is reported more commonly in cattle raised in a free range associated intimately with dogs [25]

Life Cycle: *Echinococcos granulosus* is a Cestode whose life cycle involves dogs and other canids as definitive hosts for the intestinal tapeworm, as well as domestic and wild ungulates as intermediate hosts for the tissue-invading metacestode (larval) stage. The adult *E. granulosus* is a very short about 7 mm long and has no more than six segments that reside in the small intestine of the definitive hosts, dogs or other canids. Gravid proglottids contains as many as 500 eggs they are spherical in shape, brown in color, measures (30µm-40µm) which are discharged into the faeces from the ruptured segment that eggs are passed in the feces [33-35]. After the eggs are ingested by a suitable intermediate host (under natural conditions: sheep, goat, swine, cattle, horses, camel), the egg hatches in the intestine and releases an oncosphere that penetrates the intestinal wall and migrates through the circulatory system into various organs [36, 37]. Hydatid cysts developed in the internal organs of the intermediate host as large fluid-filled sacs, mainly in the liver and/or lungs and more rarely in other sites such as the brain and bone marrow [34, 35, 38]. The definitive host becomes infected by ingesting the cyst-containing organs of the infected intermediate host. After ingestion, the protoscolices evaginated, attach to the intestinal mucosa and develop into adult stages in 32 to 80 days [39, 40].

Pathogenesis and Clinical Signs: Pathogenesis and clinical features the pathogenesis of hydatid cyst depends on the severity of infection and the organ in which it is situated. During natural course of infection, some cysts may growth to certain size and continue to remain so without producing any pathological change for many years [41, 42]. Other cyst may rupture spontaneously or collapse and disappear completely [43, 44]. Pressure effect by cyst may develop insensitive areas. Hydatid may cause blocking effects and mechanical compressions to leading to collapse of infective bones; blinding and rupture of cyst induce sudden anaphylactic shock [45, 46]. The adult tapeworm is not pathogenic or comparatively harmless to the dog, although in large numbers, enteritis may be seen. In domestic animals the hydatid in the liver or lungs is usually tolerated without any clinical signs, but the majority of hydatid cysts cause little apparent disease as they are in the liver or lung, their presence only becoming disclosed at abattoirs [47, 48]. However, in symptomatic cases, the clinical manifestation of the disease is highly variable depends on the organ involved, size of the cyst and their sites with the involved organ, interaction between the expanding cysts and adjacent organ and complication caused by rupture of cyst [41, 49, 50]. In humans, clinical signs may occur after a highly variable incubation period of several months or years. The liver cysts may remain asymptomatic for periods of 10-12 years.

Diagnosis and Treatment: In the definitive host, a post-mortem examination is the most reliable method of diagnosis. There is usually no early parasitological evidence for the presence of cysts in organs or tissues and in most cases the early stage of infections are asymptomatic. Over the last decade diagnosis of hydatid disease was improved due to the use of imaging techniques including ultrasonography, computed tomography (CT scanning) and magnetic resonance imaging (MRI) supported by immunological assays for confirmation of clinical diagnosis [37]. Recently, a PCR for specific detection of DNA from *E. granulosus* egg has been developed [38]. Immuno diagnosis involves the detection of parasite antigens in feces (coproantigens) and serum antibody detection. ELISA has been described for several groups for the detection of coproantigens released by cestodes, including *Taenia* species of dogs and humans [11]. Treatment comprises mainly surgical intervention or percutaneous treatment and/ or high dose, long-term therapy with albendazole alone or in combination with praziquantel [39].

Control and Prevention: Echinococcosis can be controlled through preventive measures that break the life cycle of between the definitive and intermediate hosts. These measures include a complete deprivation of dogs from the access of infected raw offal's by proper disposal of hydatid cysts possessing condemned offals at abattoirs, local slaughterhouses, back yards and on farms. Further control methods include introduction of appropriate meat inspection, establishment of local slaughterhouses, education of the people, effective implementation of legislative measures, burning or burial of condemned offal's and sterilization of offal's, if it is going to be used as dog food [40]. Specific control measures including stray dogs' control, registration of all owned dogs, spaying of bitches and treatment of all (or most) dogs with praziquantel at predetermined intervals for example every 6-8 weeks [41]. Prevention can be achieved by strict hygiene measures like hand washing after animals handling, in particular dogs [11]. Control of movements of food animals and dogs from the infected areas to the "clean" ones marking and control of movements of animals from infected flocks or herds [42]. Application of an effective vaccine to reduce hydatid infection in livestock would be likely to have a substantial impact on the rate of transmission of the disease to humans [43].

Echinococcus vaccines would ideally prevent oncosphere development to hydatid cysts in sheep and thus stop the development of adult gravid tapeworms in dogs [44]. Large controlled studies with sheep have shown that vaccination with a recombinant oncospheral EG95 induces high degree of protection, reducing the cyst numbers in vaccinated animals by approximately 90 to 100%. A high degree of immunity (about 80%) persists for 6 months (in the absence of reinfection) and pregnant ewes vaccinated before lambing transfer high levels of. There is no vaccine for dogs, although research is under way [45]. An effective vaccine for ovine echinococcosis has been developed [43] and may become available soon. Community ultrasound surveys have been used to raise awareness in communities considered to be at risk [46]. Currently there are no human vaccines against any form of Echinococcosis. However, there are studies being conducted that are looking at possible vaccine candidates for an effective human vaccine against Echinococcosis [47].

Status of Hydatidosis in Ethiopia: Distribution in Ethiopia as different authors reported, hydatidosis is wide spread zoonotic disease in Ethiopia. Varying prevalence rates were also reported by different authors in Ethiopia (Table 1).

Public Health Significance: Cystic echinococcosis (CE) caused by larval stages of *E. granulosus* is one of the most common zoonotic diseases associated with severe economic losses and great public health significance worldwide [73]. *Echinococcus* infections are estimated to affect approximately two to three million people worldwide, with Africa amongst the primarily endemic regions [74]. Humans are infected by ingesting eggs of *E. granulosus* through contaminated food, water and soil, or through direct contact with dogs [75]. The role of dogs in the spread of the disease has also been reported by other researchers in Ethiopia [76]. CE in humans has frequently been reported from different regions of the country [77]. The disease is more common in rural areas, where dogs and domestic animals live in very close association [78]. Most CE cases in humans are caused by the sheep strain (GI) and camel strain (G6) of *E. granulosus* [79]. In humans the cyst may reside and grow in liver, lung and other visceral organs. Occasional rupture of the cysts often leads to sudden death because of anaphylaxis, hemorrhage and metastasis [80]. Infections in humans occur by ingesting eggs through hand to mouth transfer of eggs after contact with the faces or contaminated fur of infected dogs [76]. The disease also has a wider public health importance. Humans are accidental intermediate hosts [81]. The highest burden of human CE occurs over a large more or less contiguous transmission Zone from North Africa, Near East, Middle East, Central Asia, eastern Russia and western China [82].

Table 1: Prevalence of Hydatidosis in bovine in different parts of Ethiopia

Study area	Animal	Prevalence	Author
Addis Ababa Abattoir	Cattle	40.50%	[51]
Kara-Aloabattoir PLC	Cattle	25.70%	[52]
Assela	Cattle	62.38%	[53]
Jimma	Cattle	30.70%	[54]
Nekemte	Cattle	17.10%	[55]
Ambo	Cattle	29.69%	[56]
Harar	Cattle	11.30%	[57]
Bako	Cattle	11.88%	[58]
Shire	Cattle	25.92%	[59]
Dire-dawa	Cattle	32.18%	[60]
Arsi region	Cattle	54.80%	[61]
South Wollo	Cattle	28.30%	[62]
Debre-zeit	Cattle	46.50%	[63]
Gamo-gofa	Cattle	25.88%	[64]
Bahirdar	Cattle	54.90%	[65]
Gonder, Alfora	Cattle	28.00%	[66]

Table 2: Prevalence of Hydatidosis/CE in Small Ruminants in different parts of Ethiopia

Study area	Prevalence in Sheep	Prevalence in goat	Author
Jimma	29.5%	24.8%	[67]
Addis Ababa	8.52%	8.91%	[68]
Addis Ababa	8.02%	6.8%	[69]
Bushoftu	14.3%	3.6%	[70]
Dessie	9.02%	1.90%	[71]
Mojo	7.7%	6.13%	[72]

CONCLUSION AND RECOMMENDATIONS

Hydatidosis is a globally distributed parasitic zoonotic disease caused by larval stages of *E. 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. It is an important zoonosis and is a serious public health and economic problem throughout the world. In domestic ruminants it inflicts enormous economic damage due to the condemnation of affected organs and lowering of meat, milk and wool production. The disease is chronic and affects all kinds of food animals, including herbivorous and omnivorous mammals. The public health importance of echinococcosis includes cost of hospitalization, medical and surgical fees, losses of income and productivity due to temporal incapacity to work, social consequences, due to disability and mortality. The distribution of *E. granulosus* is higher in developing countries, especially in rural communities where there is close contact between the dog, the definitive host and various domestic animals, which may act as intermediate hosts. Improper disposal of carcass (organ), increased population of stray dogs, lack of proper meat inspection and lack of appropriate

Legislations for the control of the disease are the most important factors that increase the transmission of the disease. Based on the above conclusion, the following recommendations are forwarded:

- Regular deworming of pet dogs and control of stray dogs
- Meat should be properly inspected by sufficient number inspectors at the abattoir
- Collaboration between veterinarians and public health workers in the prevention and control of the disease is mandatory
- All affected visceral offal's should be buried in a deep pit or destroyed by burning in order to prevent infection of farm animals and dogs.
- Backyard, open air and road side slaughtering practice should be prevented by implementing the law and regulation of meat inspection.
- Detailed study should have to be done on the epidemiology and economic impact in Ethiopian condition.
- Good personal hygienic practice with environmental hygiene protection through active community participation should be introduced and must be encouraged in all level.

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