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Hydatidosis, its Epidemiology and Economic Importance in Ethiopia

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Abstract: *Echinococcosis/* hydatid disease is one of the most important of the helminth zoonoses and remains a significant problem worldwide. 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. This review highlights on the epidemiology, pathogenesis, diagnosis, control and prevention of hydatidosis and its public health and economic impact. The life cycle is complex, involving two hosts and a free-living egg stage. Hydatidosis causes considerable economic loss due to condemnation of edible organs, decreased meat and milk productions, reduced hide and fleece value and decrease in fecundity. 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. In the intermediate host, diagnosing hydatidosis is possible through scanning, radiology, serology and postmortem examination. Unfortunately, surgery is the treatment of choice at present, but several of the benzimidazole compounds have been shown to have efficacy against the hydatid cyst in the intermediate host. Therefore, *Echinococcosis* can be controlled through dosing dogs, inspecting meat and educating the public on the risk to humans and on avoiding feeding offal to dogs, as well as introducing legislation.

Key words: Animal · Echinococcosis · Economic Impact · Ethiopia · Hydatidosis · Human · Prevalence

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 man 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 Echinococcus 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. *E. 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] and leads to huge economic losses. Human cases of hydatidosis are frequently reported from different corner of the country [14-17] and 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 about the disease cystic hydatidosis, its epidemiology and economic importance of hydatidosis in domestic animal and human.

Etiology of Hydatidosis: Echinococcosis is a zoonotic infection caused by adult or larval (metacestode) stages of cestodes belonging to the genus *Echinococcus* and the family Taeniidae. At present, four species of *Echinococcus* are recognised, namely *Echinococcus granulosus, E. multilocularis, E. oligarthrus* and *E. vogeli*. Hydatid disease in people is mainly caused by infection with the larval stage of the dog tapeworm, *Echinococcus granulosus* [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 Poland and a tenth strain (G10) in reindeer in Eurasia [20]. The sheep strain (G1) is the most cosmopolitan form and is that most commonly associated with human infections [20].

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 with 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 with the means of eating infected cyst-containing organs condemned at the slaughter houses/abattoirs. Humans are accidental intermediate hosts that become infected with 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: *Echinococcus* species have an indirect life cycle and must develop in both an intermediate and a definitive host. Adult worms live in the small intestine of the definitive host and they reproduce releasing eggs into the environment in the faeces of the host animal. In many cases, the parasite cycles through specific predators or scavengers and their prey [19]. Segments containing eggs (gravid proglottids) or free eggs are passed in the faeces of the definitive host, a carnivore. The eggs are ingested by an intermediate host, in which the metacestode stage and protoscoleces develop. The cycle is completed if such an intermediate host is eaten by a suitable carnivore [18, 19]. The intermediate host ingests the eggs incidentally while grazing, foraging or drinking. The eggs hatch in the small intestine, become larvae which penetrate the gut wall and are carried in the circulatory system to various organs. Liver and lungs are the two commonest sites for larval development; but occasionally oncospheres escape into the general systemic circulation and develop in other organs and tissues there the cysts, called hydatid cysts or metacestodes, are formed. The cysts, which contain larvae, either comprise fluid filled bladders, which contain larval pre-tapeworms

(protoscoleces) and cause the disease cystic echinococcos due to *E. granulosus* or alternatively, for *E. multilocularis* a multivesiculated lesion or mass containing protoscoleces that grows rapidly by exogenous budding and causes alveolar echinococcosis in rodents and other small mammals. Though slow growing in humans and long-lived animals (e.g. camels or horses) cysts of *E. granulosus* can reach a size of 10-20 centimeters, but in sheep are usually 2-6 cm [19, 26-29].

Pathogenesis: Hydatid cyst is typed according to their stage of development, namely primary and secondary cystic echinococcosis. The first occurs after the ingestion of eggs of *E. granulosus* and gives rise to the formation of hydatid cysts in different organs of the body, while the second occurs by the rupture of the primary CE due to trauma. In this condition, the protoscolices are carried out by the blood to different organs and develops to secondary hydatid cyst [30]. Calcification can occur in pericyst, mother cyst and daughter cyst. The endocysts calcification indicates the cyst is none viable. The calcification of the pericyst can occur in half of the cyst at all stage of development [31].

The cyst of *E. granulosus* vary greatly in size and shape (typically unilocular, but sometimes multilobed or multilocularis) and may be present in large numbers in one or several organs. The location of cysts and cyst morphology is controlled not only by the host factors, but also by parasite factors such as the strain of *E. granulosus* involved. Usually the host and the metacestode of Echinococcus coexist well. Initially, following infection, there is a cellular response from the host). This resolve and causes to develop a fibrous capsule (adventitial layer) around the parasite, which enlarges to accommodate the cyst as it grows. Under certain circumstances, the cellular response from intermediate host is protracted resulting in the death of the parasite [32]. Displacement of the lung or liver tissue and fibrous of the area surrounding the cyst, as well as pressure placed on the organs as a result of the hydatid cyst increasing in size during the life of intermediate host, results in pathological tissue changes. Occasionally, larvae localize in the kidney, spleen or brain tissue where their effect are more severe and often fatal [33].

Clinical Signs: Infection with *E. granulosus* cyst in the intermediate hosts are typically asymptomatic, except for a small number of cases with chronic and heavy infection. The effect of hydatid cyst on the intermediate host depends on the size and location of the cyst. If large cyst is located in an area of the body, with rigid bounders, such as the brain or lungs, the consequences can be very serious [34]. Since the cyst is slow in growing and animals are often slithered before it manages to create sufficient pressure on the tissue or organs. Fever and generalized pruritis are systemic symptoms often associated with hydatid disease. Rupture of cysts, particularly into serosal cavities, may cause acute and sometimes fatal anaphylactic reaction [35]. The adult *Echinococcus* is considered to be rather harmless to the definitive host, except when it occurs in large numbers, which may cause severe enteritis. The effect of hydrated cyst on the intermediate host depends on the size and location and location of the cyst. There are few available data on the clinical effects of the cystic hydatid disease in animals since the cyst is slow in growing and animals are often slithered before it manages to create sufficient pressure on the organs [36].

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 offal's 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].

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 [48]. Echinococcus infections are estimated to affect approximately two to three million people worldwide, with Africa amongst the primarily endemic regions [49]. Humans are infected by ingesting eggs of *E. granulosus* through contaminated food, water and soil, or through direct contact with dogs [50]. The role of dogs in the spread of the disease has also been reported by other researchers in Ethiopia [51]. CE in humans has frequently been reported from different regions of the country [52]. The disease is more common in rural areas, where dogs and domestic animals live in very close association [17]. Most CE cases in humans are caused by the sheep strain (GI) and camel strain (G6) of *E. granulosus* [53]. 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 [54]. 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 [51]. The disease also has a wider public health importance. Humans are accidental intermediate hosts [11]. 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 [40].

Economic Significance: Hydatidosis is a disease of major economic importance in both humans and animals [55]. The direct economic losses due to hydatid cyst infection in livestock are due to condemnation of carcass and visceral organs including the liver lungs, spleen, heart and kidneys [56]. Moreover it causes retarded growth, reduced performance, reduced milk and meat yield as well as reduced to poor quality of wool, decreased hide and skin value and reduced birth rate [55, 57, 58]. In humans, the economic loss is associated with the direct monetary loss due to diagnosis, hospitalization and surgical interference or percutaneous treatments. Therapies, post-treatment care and travel for both patient and family members and other indirect costs, which may be mortality and suffering. In addition to economic and social consequences of disability associated with undiagnosed and, therefore, untreated cases, there is also loss of working days or " production " and abandonment of farming or agricultural activities by affected or at-risk persons need to be considered. Furthermore, in most reports, between 1% and 2% of CE cases are fatal [59]. Even without correcting for the underreporting of human CE, the disease has substantial global impact in terms of disability adjusted life years (DALYs) and monetary losses. For example, in the North African countries, the cost to human health treatment and animal losses was estimated at US$ 60 million per year [56].

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 from diverse countries in different intermediate hosts (Table 1).

Table 1: Varying prevalence rates of hydatidosis in Bovine

Study area	Animal	Prevalence (%)	Reference
Addis Ababa Abattoir	Cattle	40.50	[60]
Kara-Aloabattoir PLC	Cattle	25.70	[61]
Assela	Cattle	62.38	[62]
Jimma	Cattle	30.70	[63]
Nekemte	Cattle	17.10	[64]
Ambo	Cattle	29.69	[65]
Harar	Cattle	11.30	[66]
Bako	Cattle	11.88	[67]
Shire	Cattle	25.92	[68]
Dire-dawa	Cattle	32.18	[69]
Arsi region	Cattle	54.80	[70]
South Wollo	Cattle	28.30	[71]
Debre-zeit	Cattle	46.50	[72]
Gamo-gofa	Cattle	25.88	[73]
Bahirdar	Cattle	54.90	[74]
Gonder,Alfora	Cattle	28.00	[75]
Debre-brhan	Cattle	6.51	[76]
Nazareth	Cattle	37.70	[77]
Around Dessie	Cattle	38.40	[78]
Mekelle	Cattle	32.12	[79]
Hararge	Cattle	27.98	[80]

Table 2: Prevalence rates of hydatidosis in shoats and man

Study area	Animal	Prevalence (%)	Reference
Nazareth	Sheep	29.3	[54]
Wollega	Sheep	22.20	[81]
Gamo Goffa	Sheep	18.8	[82]
Bahir Dar	Sheep	34.05	[83]
Wollo	Sheep	4.4	[84]
Hararge	Goat	6.51	[80]
Nazareth	Goat	6.7	[54]
Tigray	Human	31.85	[85]

Table 3: Estimated losses due to hydatidosis in organ/carcass condemnation at different abattoirs.

Abattoir	Year	Type of animals	Loss due to condemnation	Reference
HELMEX	2006	Shoats	2.7 million	[87]
DireDawa	2011	Cattle	165876	[88]
Shire	2010	Cattle	54679	[68]
Harar	2014	Cattle	96315	[66]
HELMEX	2008	Shoats	3.2 million	[89]
Nekemte	2014	Cattle	4.00 million	[64]
Jimma	2014	Cattle	94485	[90]
Addis Ababa Abattoir Enterprise	2012	Cattle	19847704	[91]

A retrospective survey of bovine hydatidosis conducted in Gondar, Injibara and Finote Selam municipal abattoirs during 2002 to 2007 revealed an increasing trend from year to year in prevalence of bovine hydatidosis that caused the condemnation of 79.5% organs [86]. This might be attributed to backyard slaughter practice, an increase in the population of stray dogs and the absence of control program [25].

In Ethiopia *E. granulosus* is frequently reported in domestic animals and there are also few report of human cases [14. 40-55]. The disease is highly distributed with prevalence ranges from 5.51% to 62.38%, 4.4% to 34.05% and 6.51 to 6.7% in cattle, sheep and goats respectively and is cause of economic loss due to condemnation of organs (Table 1 & 2).

Economic Importance: Annual losses in the abattoirs due to carcass/ organ condemnation, ranges from minimum of 54,679 birr at Shire abattoir to maximum of 19,847,704 birr in Addis Ababa Abattoirs Enterprise. This is summation of the carcass weight loss and loss due to organ condemnation. But these losses and infection prevalence do not show the real estimates because these estimates are made by meat inspection in abattoirs only and many animals slaughtered at backyard are not been included [64, 68]. 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 hydatidosis infection was reported from different part of the country such as Nekemte and Bahir Dar hospitals [66, 92]. Study conducted in 2006 at Bahir Dar indicated that human infection with hydatidosis is estimated to be 2.3 cases per 100000 [92]. But after four years (2011) similar study at the same town showed that incidence rate increased by 10 cases per 100000 [93] and this is due to high population of dogs, poor community awareness on risk of cystic echinococcosis and backyard slaughter practice [92].

Even though there is no well done study showing the rate of slaughter in abattoir (slaughter house) and backyard; it is expected to be very high in backyard system and contributing a big role in continuation of hydatidosis life cycle. In Addis Ababa nearly 76% of sheep and 82% of goats are slaughtered in the backyard and there are a number of factors that discourage slaughtering in slaughter houses in favor of backyard slaughter. There are very few slaughtering facilities available in the country compared to the populations. In rural area there is only backyard and there are a number of factors that discourage slaughtering in slaughter houses in favor of backyard slaughter. There are very few slaughtering facilities available in the country compared to the populations. In rural area there is only one slaughter facility for about 1 million in population [94].

Even though, zoonotic disease control and prevention strategies necessitate integration and collaboration of both veterinary and human health professionals, in Ethiopia there is no satisfactory progress in this aspect. There is no participation of veterinarians in public health departments to create awareness and to train community in zoonotic diseases [95].

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
- Backyard, open air and road side slaughtering practice should be prevented by implementing the law and regulation of meat inspection.
- Good personal hygienic practice with environmental hygiene protection through active community participation should be introduced and must be encouraged in all level.
- 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.
- Detailed study should have to be done on the epidemiology and economic impact in Ethiopian condition.

REFERENCES

1. Thompson, R.C. and D.P. Memanus, 2001. Aetiology : Parasites and Lifecycles: In: WHO/OIE Manual on Echinocosis in humans and animals a public health problems of global concern edited by Eckert J, Gemmen MA, Meslin FX, Pawlowski, ZS, Japan, 9-15.
2. Martinma, E.A., 2007. Oxford Concise Medical Dictionary. 7th (Edn.). Oxford University Press, India, Bungar, pp: 342-343.
3. Urquhart, G.M., J. Armour, J.I. Duncan, A.M. Dunn and F.W. Jennings, 1995. Veterinary Parasitology. 2nd (Edn.). Blackwell Publishing, USA, pp: 122129.
4. Abdel-Rahman, N., N. Daragmeh, M. Adwan, D. Al-Qaoud and SK. Abdel Hafez, 2001. Human Cystic Echinococcosis in the west bank of Palestine: Surgical incidence and Sero-epidemiological Study, pp: 19.
5. Eckert, J. and P. Deplazes, 2004. Biological, epidemiological and clinical aspects of Echinococcus, a zoonosis of increasing concern. Clinical. Microbiology Review, 17: 107-135.
6. Soulsby, EJ., 1986. Helminth, Arthropods and Protozoa of Domesticated Animals (7th edn), Baillere Tindal London, UK, pp: 119-124.
7. Jenkins, D., J. Lallen and M. Goullet, 2008. An encroachment of Echinococcus granulosus into urban areas in eastern Queensland, Australia. and Australian Veterinary Journal, 86: 294-300.
8. CSA (Central Statistics Authority), 2004. Ethiopian Agricultural Sample Survey Report on live-stock, Poultry and Beehives Populations, CSA, Addis Ababa, Ethiopia.
9. Eckert, J., R.L. Rausch, M.A.G. Gemmell, P. Raudoux and M. Kamiya, 2001. Epidemiology of Echinococonccus multilocularis, Echinococcus vogeli and Echinococcus oligarthus. In WHO/OIE manual on echinococcosis in humans and animals: a public health problem of global concern; edited by Eckert J, Gemmel MA, Meslin FX, Pawlowsk, ZS, 167.7.
10. Ogunrinade, A. and G.O. Adegoke, 1982. Bovine Fasciolosis in Nigeria, Intercurrent Parasitic and Bacterial Infection. Tropical Animal Health Production, 14(2): 121-125.

11. Tor, M., A. Atasaliki, N. Altuntas, T. Sllue Senol, A. Kir and R. Baran, 2000. Review of Cases with cystic hydatid lung disease in a territory referral hospital located in an endemic region: a 10 years experience. Department of Pulmonary Medicine, Istanbul, Turkey, 67: 539-542.
12. Hubbert, W.T., W.F. Culloch, S. Scnurren and A.A. Beger, 1995. Diseases Transmitted from Animals to man. Sixth (Edn.). Choreler C, Thomas Publisher, Spring Field Illinosis, USA, pp: 682-692.
13. Annon, A., 1990. FAO WHO guide line for servilance, prevention and control of echinococcus/Hudatidiosis servilance World Organization, pp: 146-153.
14. Kebede, M., A. Hagos and Z. Girma, 2009. Echinococcus/ hydatidosis prevalence, economic and public health significance in Tigray region. North Ethiopia, Trop. Anm. Health Prod., 41: 865-871.
15. Tolosa, T., W. Tigre, G. Teka and P. Dorny, 2009. Prevalence of bovine cysticercosis and hydatidosis in Jimma municipal abattoir, SouthWest Ethiopia. Onderstepoort J. Vet. Res. Health Prod., 76: 323-326.
16. Getaw, A., D. Beyene, D. Ayana, B. Megersa and F. Abunna, 2010. Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at price of organs and mean annual slaughter rate in Adama municipal abattoir, Central Oromia, Ethiopia. Acta. Trop., 113: 221-225. doi:10.1016/j. actatropica, 10.019
17. Fromsa, A. and Y. Jobre, 2011. Infection prevalence of hydatidosis (Echinococcus granulosus, Batsch, 1786) in domestic animals in Ethiopia: A synthesis report of previous surveys. Ethiopian Vet. J., 15(2): 11-33.
18. World Health Organization (WHO), 2022. Neglected tropical diseases; GSK reaffirms longstanding commitment and expands its donation programme to three diseases.
19. The Center for Food Security and Public Health (CFSPH), 2012. Echinococcosis: Echinococciasis, Hydatidosis, Hydatid Disease. College of Veterinary Medicine.Lowa State University, Ames Lowa, 50011; 4-14.
20. Pedro, M. and M. Schantz, 2009. Echinococcosis: a review. International Journal of Infectious Diseases, 13: 125-133.
21. Better Health Fact (BHF), 2014. Hydatid Disease, retrieved 12 May 2014.
22. Ahmed, M.E., M.I. Abdelrahim and M. Ahmed, 2011. Hydatid disease, a morbid drop needs awareness. Ann. Saudi Med. J., 122: 56-64.
23. Center For Disease Control (CDC), 2013. Hydatid Disease, retrieved 20 March 2014.
24. Toulah, F.H., A.A. El-Shafaeis and M.N. Alsolami, 2012. Prevalence of Hydatidosis among slaughtered animals in Jeddah, Kingdom of Saudi Arabia. J. Egypt Soc. Parasitology, 42(3): 563-572.
25. Abebe. F. and Y. Yilma, 2013. Estimated annual economic loss from organs condemnation, decreased carcass weight and milk yield due to bovine hydatidosis. Ethiopian Veterinary Journal, 16(2): 1-14.22. Schantz PM (1990) Parasite zoonosis
26. Jahannes, E. and D. Peter, 2007. Biological, Epidemiological and Clinical Aspects of Echinococcosis, azoonosis of increasing concern. Clin. Microbiol. Rev., 2004; 1: 107-135.
27. Tylor, M.A., R.L. Coop and R.L. Wall, 2007. Veterinary Parasitology, 3rd edition. Blackwell, London, pp: 376-377.
28. Jorge, A., 2014. Guisantes. Control and Prevention of Hydatidosis. 2014; 3393-25.
29. Oku, Y., R. Malgor, U. Banavideze, C. Carmona and H. Kamiya, 2004. International Congress Series, 1267: 98-104.
30. Parija, S.C., 2004. Text book of Medicine and Parasitology, Protozoology and Helminthology. (2nd edn), India publishers and Distributors, India, New Delhi, India, pp: 5-39.
31. Khuroo, M.S., 2002. Hydatid disease, current status and recent advances. Ann Saudi Medicine 122: 56-64.
32. Thompson, R.C.A. and C.E. Allsopp, 1988. Hydatidosis Veterinary perspectives and annotated bibliography. C.A.B. International, Wallingford, Oxon, UK, pp: 246.
33. Department of National Resource (DNR), 2009. Echinococcosis (Cystic hydatidosis) pp: 2-4.
34. Daryani, A., R. Alaei Arab, M. Sharif, M.H. Dehghan and H. Ziaei, 2007. The prevalence intensity and viability of hydatid cyst in slouthered animals in the Arab provinces of North West Iran. Journal of Helminthology, 18: 13-17.
35. Parry, E., D. Godfrey and M. Gill, 2004. Principles of Medicine in Africa. (3rd edn), Cambridge, USA, pp: 406-408.
36. Dunn, A., 1987. Veterinary Medicine, Addis Ababa University, Ethiopia. Handbook for Ethiopia, pp: 2.
37. Zhang, W., J. Li and D.P. Mc Manus, 2003. Concepts in immunology and diagnosis of hydatid disease. Clinical. Microbiology. Review, pp: 18-36.

38. Abbasi, I., A. Branzburg, P.M. Campos, S.K. Abdel Hafez and F. Roul, 2003. Copro-diagnosisis of Echinococcus granulosus infection in dogs by amplification of newly identified repeated DNA sequence. American Journal of Tropical Medical. Hygiene, 69: 3254-3360.
39. Brunetti, E., 2010. Expert consensus for the diagnosis and treatment of cystic and alveolar echinococcosis in humans. Acta Tropica, 114(1): 1-16.
40. Craig, P.S., D.P. Mc Manus, M.W. Lightowlers, JA. Chabalgoity and H.H. Garcia, 2007. Prevention and control of Cystic echinococcosis. Lancet Infectious Disease, 7: 385-394.
41. Pedro, M. and M.S. Peter, 2009. Division of Parasitic Diseases, Coordinating Center for Infectious Diseases, Atlanta, Georgia and USA. Center of Disease Control and Prevention, 13: 125-133.
42. Vuitton, D.A., P. Economides and WHO-IWGE. EurEchinoReg Network, 2011. Echinococcosis in Europe Web site, Echinococcosis in Western Europe, a risk assessment/riskmanagement approach.
43. Lightowlers, M.W., 2006. Cestode vaccines: origins, current status and future prospects. Parasitology, 133: 27-42.
44. Philip, S., P.S. Craig, D.P. McManus, W. Marshall and W.M. Lightowlers, 2007. Review on prevention and control of cystic echinococcosis. Lancet Infectious Disease, 7: 385-394.
45. Petavy, A., 2008. An oral recombinant vaccine in dog against Echinococcus granulosus, the causative agent of human hydatid disease: a pilot study. PLoS Neglected Tropical Diseases, 2(1): e125.
46. Kachani, M., 2003. Public health education: importance and experience from the field. Educational impact of ultrasound screening surveys. Acta Tropica, 85: 263-269.
47. Daryani, A., M. Sharif, A. Amouei and M. Nasrolahei, 2009. Fertility and viability rates of hydatid Disease in Wales. Br Medical Journal, 312: 674-675.
48. Romig, T., R.A. Omer, E. Zeyhle, M. Hüttner and A. Dinkel, 2011. Echinococcosis in sub-Saharan Africa: Emerging complexity. Veterinary Parasitology, 181: 43-47.
49. Cummings, H., M. Rodriguez-Sosa and A.R. Sat Oskar, 2009. Hydatid disease. In Sat Oskar AR, Simon GL, Hotez PJ, Tsuji M (Eds.), Medical Parasitology, pp: 146-152.
50. Pednekar, R.P., M.L. Gatne, R.C.A. Thompson and R.J. Traub, 2009. Molecular and morphological characterization of Echinococcus from food producing animals in India. Veterinary Parasitology, 165: 58-65.
51. Jones, O., N. Kebede, T. Kassa, G. Tilahun and C. Macias, 2011. Prevalence of dog gastrointestinal parasites and risk perception of zoonotic infection by dog owners in Wondo Genet, Southern Ethiopia. Journal of Public Health and Epidemiology, 3: 550-555.
52. Erbeto, K., G. Zewde and B. Kumsa, 2010. Hydatidosis of sheep and goats slaughtered at Addis Ababa Abattoir: Prevalence and risk factors. Tropical Animal Health and Production, 42: 803-805.
53. Japheth, M., N. Ernest and Z. Eberhard, 2006. Epidemiology and control of echinococcosis in sub-Saharan Africa. Parasitology International, 55: S193-S195.
54. Getaw, A., D. Beyena, D. Ayana, B. Megersa and F. Abunna, 2010. Hydatidosis: Prevalence and its economic importance in ruminants slaughtered at Adama municipal abattoir, Central Oromia, Ethiopia. Acta Tropica, 113: 221-225.
55. Torgerson, P. and C. Budke, 2003. Echinococcosis-an international public health challenge. Research in Veterinary Science, 74(3): 191-202.
56. Budke, C.M., P. Deplzes and P.R. Torgerson, 2006. Global socio-economic impact of Cystic Echinococcosis. Emerging Infectious Disease, 12(2): 296-303.
57. Moro, P.S., 2006. Cystic echinococcosis in the Americas. Parasitology International, 55: 181186.
58. Torgerson, P.R. and C.N. Macpherson, 2011. The socioeconomic burden of parasitic zoonoses: global trends. Veterinary Parasitology, 182(1): 79-95.
59. Torgerson, P., R. Karaeva, N. Corkeri, T. Abdyjaparov, O. Kuttubaev and B. Shaikenov, 2003. Human cystic echinococcosis in Kyrgystan: an epidemiological study. Acta Tropica, 85(1): 51-61.
60. Terefe, D., 2012. Prevalence and financial loss estimation of hydatidosis of cattle slaughtered at Addis Ababa Abattoirs Enterprise. Journal of Veterinary Medicine and Animal Health, 4.3: 42-47.
61. Demissie, G. and J. Kemal, 2014. Bovine Hydatidosis and its Economic Importance at Kara-Alo Abattoir PLC, Addis Ababa, Ethiopia. Journal of Veterinary Science & Technology, 5: 206.

62. Hussen, W., 2013. Prevalence and characterization of hydatid cysts in cattle slaughtered at Nekemte Municipal Abattoir, Western Ethiopia. J. Vet. Med. Anim. Health, 6: 280-288.
63. Brehane, A. and B. Abeba, 2015. Epidemiological Investigation of Hepato-Pulmonary Bovine Hydatidosis and its economic and zoonotic Importance at Jimma Municipal abattoir, Ethiopia. Journal of Biology Agriculture and Health Care, 5: 11.
64. Tadesse, B., 2014. Prevalence, public significance and financial loss of Hydatid cyst on cattle slaughtered at Nekemte Municipal abattoir, West Ethiopia. Acta Parasitologica Globalis, 5.3: 151-159.
65. Zewdu, E., 2010. Bovine Hydatidosis in Ambo Municipality Abattoir, West Shoa, Ethiopia. Ethiopian Veterinary Journal, 14.1: 1-14.
66. Lema, B., 2014. Prevalence of Bovine Hydatidosis and its Economic significance in Harar Municipality Abattoir, Eastern Ethiopia. American-Eurasian Journal of Scientific Research, 9(5):143-149.
67. Haftu, B. and T. Kebede, 2014. Study on Prevalence and Economic Significance of Bovine Hydatidosis in Bako Muncipal Abattoir, West Shoa Zone, Oromiya Regional State. Journal of Veterinary Science & Technology, 5: 197.
68. Guadu, G., 2013. Economic and zoonotic importance of bovine hydatidosis in Shire Municipal Abattoir, North West Zone, Tigray Region, Ethiopia. Acta Parasitologica Globalis, 4(3): 92-98.
69. Gebreyohannes, M. and M. Wondie, 2014. Hydatidosis: Prevalence and Economic Significance in Cattle Slaughtered at Diredawa Municipal Abattoir, Ethiopia. IJAVMS, 8(3): 64-80.
70. Alemayehu, L., 1990. The prevalence of hydatidosis in cattle, sheep and goats and Echinococcus granulosus in Dogs in Arsi administration region. Dvm thesis faculty of veterinary medicine, Addis Ababa University, Debrezeit, Ethiopia, pp: 85.
71. Asrat, G., 1996. Prevalence and economic significance of hydatidosis (Echinocosis) in slaughtered cattle, sheep and goats in south Wollo. Dvm thesis. Faculty of veterinary medicine Debrezeit Ethiopia.
72. Feseha, G. and J. Yilma, 1984. Preliminary study of economic and public health Significance of echinococcosis in Ethiopia. 3rd scientific journal.
73. Mohammed, A., 1988. Study on prevalence and economic significance of bovine hydatidosis in Gamogoffa region. Dvm thesis Addis Ababa University faculty of veterinary medicine, Debrezeit, Ethiopia.
74. Nebiou, G., 1990. Study of hydatidosis in cattle slaughter at Bahirdar Municipatal abattoir.Dvm thesis, faculty of veterinary medicine, Addis Ababa University, Debrezit, Ethiopia, pp: 91.
75. Debas, E. and N. Ibrahim, 2013. Prevalence and Economic Importance of Hydatidosis in Cattle Slaughtered at North Gonder Elfora Abattoir, European. Journal of Applied Sciences, 5(1): 2935.
76. Akeberegn, D., 2017. The Prevalence of Bovine Hydatidosis among Slaughtered Cattle at Debre Berhan Municipal Abattoir, North Shewa Zone, Ethiopia. Journal of Veterinary Science and Medicine, 5(1): 5.
77. Yemane, G., 1990. Preliminary study on Echinococcosis, in ruminant slaughters at Nazareth abattoir. Dvm thesis, Addis Ababa University faculty of veterinary medicine Debrezeit Ethiopia.
78. Yilkal, A., 1989. Hydatidosis in cattle, sheep and pigs; cysticercus tenuicollis in sheep around dessie and the efficacy of Hygenia abyssinya (Kossa) on Taenia Hydatigenia. Dvm thesis, Addis Ababa University faculty of veterinary medicine, Debrezeit Ethiopia.
79. Hagos, Y., 1997. Hyadatidosis (Echinococcosis; prevalence and economic impact in bovine at Mekelle municipal abattoir zoon sis and infection in dogs Mekelle-Tigray. Dvm thesis, Addis Ababa University faculty of veterinary medicine, Debre-zeit, Ethiopia.
80. Woubet, M., 1988. A Preminary study on Echinococcusis in Harage region and the efficacy of Glinus lotidus seeds against Echinococcosisgranulosus in pups infected experimentally with hydatid material.AAU, FVM, DVM Thesis Debre Zeit, Ethiopia.
81. Bersissa, K., 1994. Hydatidosis in Nekemte: Prevalence in slaughtered cattle and sheep, estimated economic loss and incidence in stray dogs. AAU, FVM, DVM Thesis. Debre Zeit, Ethiopia.
82. Fikre, L., 1994. An assessment trail of its prevalence, economic and public health importance. Echinococcosis/Hydatidosis in Konso (Southern Ethiopia), AAU, FVM, DVM Thesis. Debre Zeit, Ethiopia.
83. Nigatu, K., M. Abebe and T. Getachew, 2009. Hydatidosis of slaughtered animals in Bahir Dar abattoir, North Western Ethiopia. Trop Anim Health Prod., 41: 42-50.
84. Yilkal, A., 1989. Hydatidosis in cattle, sheep and pigs; Cysticercus Tenuicollis in sheep around Dessie and the efficacy of Hgenia abyssinyca (Kosso) on Taenia hydatigenia. AAU, FVM, DVM Thesis. Debre Zeit, Ethiopia.

85. Kebede, W., 2008. Echinococcusis/hydatidosis:its prevalence, economic and public health significance in Tigray region, North Ethiopia. Tigray Regional State Bureau of agriculture and rural development, Mekelle,Ethiopia. Faculity of veterinary medicine, Addis Ababa University, Ethiopia.
86. Kebede, N., 2010. A retrospective survey of bovine hydatidosis in three abattoirs of Amhara National Regional State, northwestern Ethiopia. Trop Anim Health Prod., 42: 323-325.
87. Jibat, T., G. Ejeta, Y. Asfaw and A. Wudie, 2008. Causes of abattoir condemination in apparently healthy slaughtered sheep and goats at Helmex abattoir, Debre Ziet, Ethiopia. Revue Med., 5: 305-311.
88. Mulatu, M., M. Biruk, T. Habtamu and A. Kumar, 2013. Bovine Hydatidosis in eastern part of Ethiopia. Momona Ethiopian Journal of science (MEJS). 2013; 5: 107-114.
89. Ezana, G., 2008. Major diseases of export oriented livestock in export abattoirs In/Around Ada Liben Woreda, Debre zeit. DVM Theses, Faculty of veterinary medicine, Haramaya University, pp: 21-41.
90. Atsede, B. and A. Belay, 2015. Epidemiological Investigation of Hepato-Pulmonary Bovine Hydatidosis and its economic and zoonotic Importance at Jimma Municipal abattoir, Ethiopia. Journal of Biology Agriculture and Health Care, 5: 11.
91. Dechassa, T., K. Kibrusfaw, B. Desta and W. Anteneh, 2012. Prevalence and financial loss estimation of hydatidosis of cattle slaughtered at Addis Ababa Abattoirs Enterprise. J. Veter. Med. and Anim. Health, 4: 42-47.
92. Kebede, N., A. Mitiku and G. Tilahun, 2010. Retrospective survey of human hydatidosis in Bahir Dar, north west Ethiopia. EMHJ, 16: 9.
93. Belina, T., A. Alula, M. Nenyou, Y. Azena and G. Sisay, 2012. Prevalence and Public health significance of bovine hydatidosis in Bahir Dar Town, Ethiopia. J. Veter. Med. and Anim . Health, 6: 48-53.
94. Agricultural Growth Project (AGP), 2013. Value Chain Analysis for Ethiopia: Livestock Market Development, pp: 21-87.
95. Girma,S., Z. Girma, T. Ketema and J. Tariku, 2012. Assessment of awareness on food borne zoonosis and its relation with veterinary public health services in and around Addis Ababa, Ethiopia. Ethiop, 16: 15-22.