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# INTERNATIONAL JOURNAL OF CURRENT RESEARCH IN BIOLOGY AND MEDICINE

ISSN: 2455-944X

<https://darshanpublishers.com/ijcrbm/ijcrbmindex.html>Volume 6, Issue 2 - 2021

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## Review Article

DOI: <http://dx.doi.org/10.22192/ijcrbm.2021.06.02.004>

## Prevalence and Public Health Importance of Bovine Hydatidosis

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### Abstract

Hydatidosis/Cystic echinococcosis (CE) is a severe cyclo-zoonotic parasitic infection caused by the closely related cestodes of the genus *Echinococcus*, namely, *E. granulosus*, *E. multilocularis*, *E. oligrathrus* and *E. vogeli* and is one of the world's most geographically widespread zoonotic diseases. Cystic *Echinococcosis* (*hydatidosis*) is a zoonotic parasitic infection of many mammalian species caused by the larval stage of *Echinococcus granulosus*. Hydatid disease in human is a very serious disease and no person should consider themselves immune from this disease. Hydatidosis in human is much more common in rural areas of Ethiopia where dogs and domestic animals live in a very close association usually sharing the same accommodation. Hydatidosis occurs throughout the world and causes considerable economical and public health problems in many countries. Its distribution is usually more prevalent in developing countries especially in the rural communities where the dog lives in close quarters with man and domestic herbivores, feeding on scraps and offal of wild herbivores hunted by his master or domestic herbivores bred for butchering. In Ethiopia, it is a common practice to feed dogs and cats with hydatid infected organs; hence human beings facilitate the maintenance of the perfect life cycle progression in an environment. The purpose of meat inspection is to protect public health and to provide risk free products to the society. Also, it provides information that can be utilized for animal diseases control. Abattoir data is an excellent option for detecting diseases of both economic and public health importance especially in ascertaining the extent to which human is exposed to certain zoonotic diseases in addition to estimating the financial implications of carcass condemnations.

**Keywords:** Economic losses, Hydatidosis, Prevalence, Zoonosis

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### Introduction

The world human population is growing at a rate much faster than food production and this increase is mainly in developing countries which are unable to assure adequate food for their people. Developing countries have nearly two third of the world's livestock population, but produce less than a third of the world meat and fifth of its milk (Kebede *et al*, 2009).

Hydatidosis/Cystic echinococcosis (CE) is a severe cyclo-zoonotic parasitic infection caused by the closely related cestodes of the genus *Echinococcus*,

namely, *E. granulosus*, *E. multilocularis*, *E. oligrathrus* and *E. vogeli*. A wide variety of animal species, both domestic and wild, that act as intermediate hosts have made *E. granulosus* to be widely distributed across the globe and at least 10 genetically distinct populations exist within the complex *E. granulosus* (Permin and Hansen, 1994).

The life cycle of hydatidosis consists of two mammalian hosts, the definitive and intermediate hosts. The definitive hosts are carnivores which harbor mature tapeworm in the intestine and excrete the

parasite eggs along with their feces and plays a major role in the epidemiology of the disease, while livestock and humans are intermediate hosts for whom the outcome of infection is the development of hydatid cysts in lung, liver or other organs. The transmission of *Echinococcus* species from intermediate to definitive host is the result of predator-prey relationship existing between hosts, however it can be modified by human behavioral factors for synanthropic cycles and man is usually a dead end intermediate host (Helina *et al.*, 2012)

The wide variety of animal species that can act as intermediate hosts and the domestication spread of some of the animals from Europe to other parts of the world have given *echinococcus granulosus* a worldwide distribution. It has been extensively studied in number of different geographical areas and is now present in Asia, Africa, south and Central America and the Mediterranean region (Mc Manus, 2006).

Hydatidosis occurs throughout the world and causes considerable economical and public health problems in many countries. Its distribution is usually more prevalent in developing countries especially in the rural communities where the dog lives in close quarters with man and domestic herbivores, feeding on scraps and offal of wild herbivores hunted by his master or domestic herbivores bred for butchering (FAO, 2004). Previous cross studies have shown that cystic echinococcosis represented a considerable economic and public health significance in different countries including Ethiopia. One of the major parasitic as well as zoonotic diseases prevailing in the area is hydatidosis occurring both in humans and in domestic animals causing huge organ losses due to condemnation (Kebede, 2010).

In Ethiopia, it is a common practice to feed dogs and cats with hydatid infected organs; hence human beings facilitate the maintenance of the perfect life cycle progression in an environment. Despite the high prevalence of the disease in domestic ruminants and dogs, it seems that the required attention is not given to it. So to protect this disease meat inspection is very necessary (Eshetu and Bogale, 1982; Getaw *et al.*, 2010). The purpose of meat inspection is to protect public health and to provide risk free products to the society. Also, it provides information that can be utilized for animal diseases control. Abattoir data is an excellent option for detecting diseases of both economic and public health importance especially in ascertaining the extent to which human is exposed to

certain zoonotic diseases in addition to estimating the financial implications of carcass condemnations. Most of the abattoir studies undertaken on prevalence of fasciolosis and hydatidosis and the extent of loss from organs condemnation in different parts of Ethiopia (Jobre *et al.*, 2006). Most of the studies not included other major problems of condemnations in different parts of the country. Hence, this review was conducted to

- ✓ -Review the prevalence of bovine hydatidosis
- ✓ -Highlight the direct and indirect financial losses associated with bovine hydatidosis
- Assessing the public health significance of bovine hydatidosis

## Literature Review

### Etiology

Echinococcosis is caused by several species of *Echinococcus*, tiny cestode parasites in the family Taeniidae. Currently recognized species include *Echinococcus granulosus*, *E. multilocularis*, *E. vogeli*, *E. oligarthrus* and possibly *E. shiquicus* (Taylor *et al.*, 2007).

*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. The G9 strain has been reported only from human cases by *E. multilocularis* that causes a type of echinococcosis known as alveolar echinococcosis, alveolar hydatid disease, multilocular echinococcosis or multivesicular hydatidosis. It has been divided into Eurasian, North American and Chinese 'strains,' which are less distinct than those of *E. granulosus*. One group of organisms has been proposed as a distinct species, *Echinococcus shiquicus*. It has been isolated only from small mammals and Tibetan foxes (*Vulpes ferrilata*) from the Tibetan Plateau region of China. Whether it should receive its own species designation is still uncertain (Perminand Hansen, 1994).

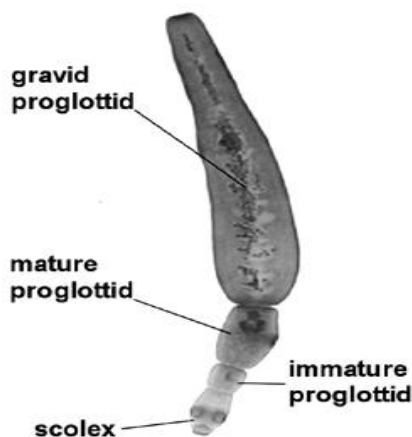
Infections with *Echinococcus vogeli* and *Echinococcus oligarthrus* are usually known as polycystic echinococcosis (or neotropical polycystic echinococcosis), from the form of the disease in intermediate hosts. Because *E. oligarthrus* has been

reported only as one or more discrete cysts in humans, this disease has also been called unicystic echinococcosis (FAO, 2004).

Some strains or species of *Echinococcus* affect people infrequently, or grow relatively slowly and are less likely to cause disease. *E. oligarthrus* seems to be extremely rare in people, and *E. equinus* (*E. granulosus* strain G4) has not been reported to be zoonotic. The G1 sheep strain of *E. granulosus*, which is particularly widespread, is the most frequent cause of disease in humans (Tolosa *et al.*, 2009).

### General morphology

*Echinococcus* exhibits certain characteristics that differentiate it from the other major genus in the family *Taenia*. The adult *Echinococcus* is only a few millimeters long (rarely more than 7mm) and usually has no more than six segments, whereas species of *Taenia* can grow to several meters in length and consist of several thousand segments. Like all tape worms, *Echinococcus* has no gut and all metabolic interchange takes place across the syncytial outer covering, the tegument (Eckert, *et al.*, 2002).



**Figure 1.** Morphology of a mature adult worm of *E. granulosus*.

(Source:

[TMCRhttp://tmcr.usuhs.mil/tmcr/chapter3/epidemiology2.htm](http://tmcr.usuhs.mil/tmcr/chapter3/epidemiology2.htm))

### Scolex and Strobila

The anterior end of the adult worm possess a specialized attachment organ, the scolex, which has four muscular suckers and two rows of hooks, one large and the other small on the rostellum (head). The body or strobila is segmented and consist of reproductive units (proglottids) which vary in number from two to six. The adult worm is hermaphrodite with reproductive ducts opening at a common lateral genital pore. The position of the genital pore varies according to species and strain. For *E. granulosus*, the genital pore is proximal to mid body of the proglottid. There is a prominent cirrus sac which may be horizontal or tilted interiorly and the vitellarium is globular. The uterus dilates after fertilization; eventually occupy most of the terminal segments when the eggs are fully developed (Ahmadi and Dalimi, 2006).

### Morphology of *Echinococcus* eggs.

*Echinococcus* eggs contain an embryo that is called an oncosphere or hexacanth. The name of this embryo stems from the fact that these embryos have six hooklets. The eggs are passed through the faeces of the definitive host and it is the ingestion of these eggs that lead to infection in the intermediate host (Endalew and Nuraddis, 2013).

### Metacestode

The metacestode (second larval stage) basically consists of a bladder with an outer acellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. The metacestode is also called Hydatid or Hydatid Cyst. Protoscoleces arise from the inner wall of the brood capsules. The structure and development of the metacestode differs between the four species of *Echinococcus* (Eckert *et al.*, 2002).

### Epidemiology

#### Disease distribution

*Echinococcus granulosus* has a worldwide distribution, but more prevalent in temperate climate than tropical areas. *E. multicularis* occurs in wide areas of the northern hemisphere. *E. oligarthrus* and *E. Vogeli* are confined to Central and Southern America. In Ethiopia studies conducted in different abattoirs indicated that cystic hydatidosis is prevalent and considerable economic losses are associated with it (Zewdu *et al.*, 2010).

### Host range

Domestic and wild canids are the usual final hosts of the parasite. The domestic intermediate hosts vary according to the local husbandry but the most important is the sheep which appears to be the natural intermediate host because of scolices from these animals being the highly infective for the dogs. In northern Europe northern Russia the reindeer is the main reservoir of hydatidosis, while in parts of the Middle East it is the camel (Tolosa *et al.*, 2009)

### Risk factors

The incidence of human hydatidosis in any country is closely related to the prevalence of disease in domestic animals and is highest in where there is a large dog population and high sheep production (Nigatu *et al.*, 2009). Certain traditional activities such as widespread backyard slaughter of animals, the corresponding absence of rigorous meat inspection procedures, the long standing habit of feeding domesticated dogs with contaminated offal, customs and occupation, particularly attitude to dogs have been described as factors associated with the spread and high prevalence of the disease in some areas of the country. Hydatidosis in human is much more common in rural areas of Ethiopia where dogs and domestic animals live in very close association, usually sharing the same accommodation (Helina *et al.*, 2011).

### Transmission and Life Cycle of *Echinococcus Granulosus*.

The parasite's life cycle is almost exclusively domestic, involving dogs as definitive and ungulates (mainly sheep and cattle) as intermediate hosts (Palmer *et al.*, 2011). However, wild canids can also be involved in the transmission cycle in some areas. This transmission is responsible for the sylvatic echinococcosis cycle. The outcome of infection in livestock is hydatid cysts developing in the lung, liver or other organs (Jenkins *et al.*, 2005).

*Echinococcus* species have an indirect life cycle and must develop in both an intermediate and the definitive host. In many cases, the parasite cycles through the specific predators and scavengers, and their prey. The dog-sheep and dog-cattle cycle are most likely to result in human infections. Other cycles include dog-camel, dog-horse, wolf-deer and coyote-deer. Under ideal conditions *E. granulosus* eggs remain viable for several months' in pastures or

gardens and on house hold items (Weldegiorgis *et al.*, 2008). *Echinococcus granulosus* eggs can survive for weeks under a variety of temperature ranges but they cannot survive for long time when exposed to direct sunlight and dry conditions. The intermediate hosts which include cattle and humans are infected by ingestion of eggs within faeces of the definitive host. The eggs may also be found on foods such as vegetables, fruits or herbs, or in contaminated water. They can also stick to hands when a person handles an infected dog, cat, wild animal or its carcass, and may then be transferred to the mouth via the hands. Hydatid cyst is the common name for the larval phase of *E. granulosus*. Parasites can develop in a variety of organs in the intermediate host but are often found in the liver and lungs. The cysts grow slowly. Most cysts are discovered in humans when they are 1 to 7mm in diameter but they eventually reach 20cm in diameter. In primary echinococcosis, hydatid cysts develop in various sites from oncospheres after ingestion of *E. granulosus* eggs. In secondary echinococcosis, larval tissue spreads from the primary site and proliferates after spontaneous or trauma-induced cyst rupture or after release of viable parasite material during invasive treatment procedures (Da Silva, 2010). Each cyst is filled with fluid and is surrounded by a fibrous laminated outer membrane and an inner membrane called the germinal layer. Brood capsules develop from the germinal membrane. Each brood capsule contains several invaginated heads (protoscolices) that can develop into an adult worm if they are ingested by the definitive host. Some protoscolices float freely and are known as hydatid sand. The hydatid sand has the potential of developing into new cysts. Some cysts are sterile and either never produces brood capsules, or they become sterile after bacterial infection or calcification. The percentages of sterile cysts vary with the intermediate host and play a vital role in transmission of the disease (Parija, 2004). Cattle and numerous ungulates (goats, swine, and sheep) are intermediate hosts of CE, harbouring the hydatid cyst (Garippa *et al.*, 2004).

The adult cestode inhabits the small intestines of a carnivore (definitive host) and produces eggs containing infective oncospheres. The eggs remain infective for a period determined by the environmental conditions. Either cestode segments (proglottids) containing eggs or free eggs are released from the intestinal tract of the carnivore into the environment. Eggs have been shown to be dispersed by factors such as wind, flies and others (Eckert *et al.*, 2001). After oral uptake of the eggs by the intermediate host, a

larval stage, the metacestode, develops in internal organs. The mature metacestode typically produces numerous protoscoleces, each having the potential to develop into an adult cestode after being ingested by a suitable final host. These protoscoleces in the organs of intermediate hosts may remain viable for up to 36 days depending on ambient temperatures and relative humidity. Accidentally, eggs are also ingested by humans and other “aberrant” hosts that do not play a role in the natural cycle (Abiyot *et al.*, 2011). Whereas the infection of carnivores with immature or mature intestinal stages does not cause morbidity, the invasion of various organs (mainly liver and lungs) of the intermediate or aberrant hosts by metacestodes can cause severe and even fatal Echinococcosis (Eckert and Deplazes, 2004). An important factor influencing the persistence and spread of *E. granulosus* infection is the contamination of dogs by ingestion of the viscera of infected sheep and cattle.

**Larval/hydatid cyst stage**

From the embryo released from an egg develops a hydatid cyst, which grows to about 5–10 cm within the first year and is able to survive within organs for years. Cysts sometimes grow to be so large that by the

end of several years or even decades, they can contain several litters of fluid. The larval stage of *Echinococcus granulosus* is a fluid filled bladder or hydatid cyst that is unilocular, although communicating chamber occurs (Melaku *et al.*, 2012). Once a cyst has reached a diameter of 1cm, its wall differentiates into a thick outer, non-cellular membrane, which covers the thin germinal epithelium. From this epithelium, cells begin to grow within the cyst. These cells then become vacuolated and are known as brood capsules, which are the parts of the parasite from which protoscoleces bud. Often, daughter cysts will also form within cysts (Walther and David, 2008).

**Adult worm**

*Echinococcus* adult worms develop from protoscoleces and are typically 6mm or less in length and have a scolex, neck and typically three proglottids, one of which is immature, another of which is mature and the third of which is gravid (or containing eggs). The adult worm only develops to maturity in the definitive host. The scolex of the adult worm contains four suckers and a rostellum that has about 25-50 hooks (Walther and David, 2008).

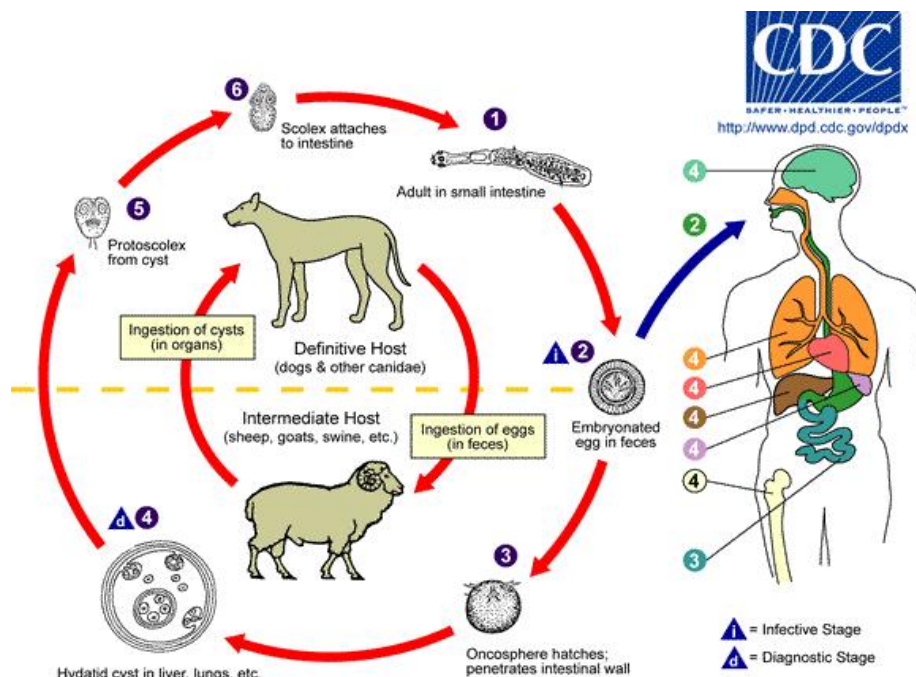


Figure.2. The Life cycle of *Echinococcus granulosus*. (Source: CDC, 2008)

### Pathogenesis

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 grow to certain sizes and continue to remain so without producing any pathological change for many years. Other cysts may rupture spontaneously or collapse and disappear completely. Pressure effects 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 shocks. In addition, the cysts can cause life threatening illness associated with liver failure, pulmonary edema, and rupture of the cyst, which may cause fatal anaphylactic shock in human (Endalew and Nuraddis, 2013).

As the cysts gradually increase in size, they may impair the health status of the host and causes dyspnea when they occur in the lung or digestive disturbance and possible ascites when the liver is affected. The adult tapeworm is not pathogenic or comparatively harmless to the dog, although in large numbers, enteritis may be seen (Yifat *et al.*, 2011)

### Clinical signs

In domestic animals the hydatid cysts are usually tolerated without any clinical signs. But, in symptomatic cases, the clinical manifestation of the disease is highly variable depending on the organ involved, size of the cyst and their site with the involved organ, interaction between the expanding cysts and adjacent organ, and complication caused by rupture of the cysts (Jobre *et al.*, 1996).

Hydatid cyst of the liver causes hepatic signs with slight icterus, digestive troubles (diarrhea and irregular appetite) due to malfunction of organs. Lung cysts produce chronic bronchopneumonia symptoms (Permin and Hansen, 1994)

In contrast, when man is involved as intermediate host, the hydatid cyst in its pulmonary or hepatic has often pathogenic significance. When a cyst ruptures there is a risk of death from anaphylaxis or if the person survives, released daughter cysts may reserve development in other regions of the body. Moreover, fever and generalized purities are systemic symptoms associated with hydatid disease (Talor *et al.*, 2007).

### The disease significance

#### Economic significance

Hydatidosis is the cause of high economic loss to the animal industry mainly due to organ condemnation that results a huge economic loss. Infected viscera usually lungs and liver are the cause of large losses since the cyst render these organ unsuitable for human consumption and thus meat is thrown away (Dawit, 2008).

A significant loss of meat and milk production and fleece value from infected animals may also occur. These losses are special significance in countries with low economic output. The loss from discarding infected viscera in abattoir in Ethiopia is estimated to be about 144,092.40 Ethiopian birr (Helina *et al.*, 2012).

#### Public health significance

Hydatidosis is a public health problem in different geographical areas of the world. It is considered as emerging and reemerging disease in Central Europe and China. Humans become infected with hydatid disease by ingesting the eggs of echinococcus spp (Dawit, 2008).

Approximately 2-3 million human cases are thought to occur worldwide. Cystic Hydatid Disease in humans can be a significant disease because of the mechanical and toxic effects of the cyst(s). The tremendous reproductive potential of the tapeworm as well as the sheer size of the hydatid cyst(s) can cause problems in the organs where they are lodged. If the cyst(s) bursts, the resultant toxic (anaphylactic) shock would probably be fatal. In Alaska and Canada most infections are benign, indicating humans are probably a less suitable host for the sylvatic form of *E. granulosus* than for the pastoral form (Endalew and Nuradis, 2013).

### Diagnosis

Diagnosis of *E. granulosus* in the definitive host is accomplished by demonstrating the presence of adult cestodes (usually less than 6 mm long and possessing 2 to 6 proglottids) in the feces or in the upper one-third of the small intestine and identifying them using morphological characteristics (position of the genital

pore, the uterus or the testes). Enzyme Linked Immunosorbent Assay (ELISA) tests for detecting coproantigens in the feces of canids can be used to test for *E. granulosus*. Coproantigens can be detected shortly after infection and prior to the release of eggs by the adult tapeworms. Serological testing can also be performed to determine the presence of oncosphere, cyst fluid, and/or protoscolex antibodies in the serum. This test; however, does not distinguish between current and previous infections and cross reactivity between *Echinococcus spp.* and *Taenia spp.* (Jobre *et al.*, 1996).

Diagnosis of *E. granulosus* in the intermediate host is accomplished through necropsy examination of the animal and identifying the larval cyst in the organs, usually the liver or the lungs. Formalin fixed tissue positive on periodic-acid-Schiff (PAS) staining demonstrates a positive acellular laminated layer with or without an internal cellular nucleated germinal membrane (a specific characteristic of the metacestodes of *Echinococcus spp.* (Dawit, 2008).

Diagnosis of *E. granulosus* in humans is accomplished through imaging methods, such as radiography, computed tomography, ultrasonography and scintigraphy, and through an ELISA test which uses an antigen preparation (hydatid fluid) which detects antibodies. The presence of hydatid cysts can also be determined on autopsy examination (Polydrous, 1981).

### Treatment

Treatment in definitive hosts can be accomplished by giving canids Praziquantel or Arecoline. Arecoline is a parasympathetic agent and increases the tonus and the mobility of smooth muscle resulting in the purgation of *E. granulosus* adults from the intestinal tract and passing them from the body in the mucus that follows the formed fecal material. The drug works by paralyzing the tapeworm, resulting in its relaxing its hold on the intestinal wall. Dosage with Arecoline is 1 tablet/10 kg. Body weight but pregnant bitches and animals with cardiac abnormalities should not be treated (Taylor *et al.*, 2007). Treatment of cervid intermediate hosts is unnecessary as this parasite causes limited pathological damage and is not a significant mortality factor (Helina *et al.*, 2012).

Treatment of human intermediate hosts consists of removal of the hydatid cyst(s). Removal of the cyst(s) is recommended for pastoral infections but cysts of sylvatic origin may allow for a more conservative treatment. If surgery is performed to remove the

cyst(s), a course of drugs (the drug of choice is Albendazole) is prescribed to kill any remaining tapeworm larvae that might still be in the body. The disease may not always be cured by surgery (Dawit, 2008).

### Prevention and control

Controlling *Echinococcus spp.* that occur in domesticated animal cycles reduces human exposure. In particular, dogs should not be fed the entrails from livestock at slaughter. Because dogs and cats can also be infected from parasites in wildlife cycles, they should not be allowed to hunt wild animals, or be fed any tissues from these species. In endemic areas, regular testing and/or treatment is advisable in animals allowed outside (Polydrous, 1981).

It is difficult to completely prevent exposure to *Echinococcus spp.* eggs from wild animals; however, food safety precautions, combined with good hygiene, can be helpful. All fruits and vegetables, particularly those picked in the wild, should be washed thoroughly to remove any eggs. Fences should be placed around vegetable gardens to keep animals, especially dogs and other canids, away. The hands should always be washed after handling pets, farming, gardening or preparing food, and before eating. Untreated water from sources such as lakes may also contain *Echinococcus* eggs, and should be avoided. Wild carnivores, especially canids and felids, should be discouraged from coming close to homes. If these animals or their carcasses must be handled, gloves should be used. In some areas, foxes have been treated with antiparasitic drugs in bait, to decrease the prevalence of *E. multilocularis*. Meat, particularly canine intestines, should be thoroughly cooked before eating (Taylor *et al.*, 2007).

Anyone who handles the definitive hosts or material that may be contaminated with eggs should use appropriate personal protective equipment. Regular surveillance with serological tests can be helpful in high-risk populations such as laboratory personnel working with eggs, or children who have been exposed to the feces of infected foxes. The purpose of testing is to detect cysts in the early stages, when they are most treatable. Vaccines are not available for people (Dawit, 2008).

## Conclusion and Recommendation

Hydatidosis is one of the most important diseases of public health importance in 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. Based on the above conclusion the following recommendations are forwarded:

- In endemic areas of hydatidosis, the subspecies and strain identification of *E. granulosus*, followed by immunological study of infected animals should be carried out to promote the production of vaccines against the adult parasite in the dogs.
- The government should initiate and involve pertinent agencies such as public health and other related agencies.
- The Ministry of Public Health has to increase the awareness of public regarding risk factors for transmission of the parasite

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How to cite this article:

Tsegaye Mitiku and Alemu Alehegn. (2021). Prevalence and Public Health Importance of Bovine Hydatidosis. *Int. J. Curr. Res. Biol. Med.* 6(2): 32-40.

DOI: <http://dx.doi.org/10.22192/ijcrbm.2021.06.02.004>