ADDIS ABABA UNIVERSITY
FACULTY OF VETERINARY MEDICINE

STUDIES ON PREVALENCE, ECONOMIC AND PUBLIC HEALTH IMPORTANCE OF HYDATIDOSIS IN SLAUGHTERED ANIMALS AT ADDIS ABABA ABATTOIR, ETHIOPIA

BY

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JUNE, 2008
DEBRE ZEIT, ETHIOPIA

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DEDICATION

This paper is dedicated to the memory of my mother w/o Askale Hassen and to my brother Berhanu Erbeto.

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First and for most praise and gratitude is to my God that I am a sinner, and believing that the Lord Jesus Christ died for my sins on the cross and was raised for my justification. I do now receive and confess Him as my personal savior in all walks of my life.

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LIST OF ABBREVATIONS

AAU	Addis Ababa University
AE	Alveolar Echinococcosis
CE	Cystic Echinococcosis
CDC	Center for Disease Control and Prevention
cm	Centimeter
CNS	Central Nervous System
CSA	Central Statistics Authority
DVM	Doctor of Veterinary Medicine
ELISA	Enzyme-Linked Immunosorbent Assay
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
FVM	Faculty of Veterinary Medicine
IFAT	Indirect Fluorescent Antibody Test
IHA	Indirect Haemagglutination Assay
LAT	Latex Agglutination Test
MD	Medical Doctor
μm	Micro meter
OIE	Office International des Epizooties
PAHO	Pan American Health Organization
%	Percentile
PAIR	Puncture Aspiration Injection Respiration
PCR	Polymerase Chain Reaction
sp., spp.	Species (singular and plural)
SPSS	Statistical Package for Social Science
TAH	Tikur Anbassa Hospital
UNEP	United Nations English Publication
USD	United States of American Dollar
WHO	World Health Organization
X-ray	Radiography

ABSTRACT

A cross sectional survey was conducted from November 2007 to April 2008 with the objective to determine the prevalence of hydatidosis in food animals slaughtered at Addis Ababa Abattoir, study the effect of risk factors on the prevalence of hydatidosis, evaluate the size, fertility and viability of the cysts, assess the economic losses and the public health significance of the disease. Routine meat inspection procedures was conducted whereby livers, lungs, hearts, kidneys and spleens were visualized, palpated and incised to detect the presence of the cysts. The sizes of the cysts was determined by measuring the diameter in cm. Fertility was evaluated by observing the presence of protoscoleces under the microscope and viability was determined by staining the protoscoleces with 0.1 % aqueous solution of eosin. Protoscoleces which took up the stain were considered as non viable. The annual economic loss was calculated by multiplying the number of annually condemned organs with the current market value of organs. The public health significance was assessed by employing structured questionnaire.

Out of the total of 3430 cattle, sheep, goats and pigs slaughtered and inspected at Addis Ababa Abattoir during the study period, 639 (18.6 %) of them were found to be infected with hydatidosis. Prevalence of 254 (21 %), 206 (19.9 %), 102 (16 %) and 77 (14 %) were recorded in cattle, sheep, goats and pigs, respectively. Prevalence of 132 (20.9 %), 85 (22.4 %) and 37 (18.7 %) was registered in cattle of Borana, Arsi and Abyssinian Zebu breeds, respectively. There was no significant variation in cattle of different breeds. Even though higher prevalence was detected in cattle from midland areas 124 (21.3 %) than in cattle originated from lowland areas 130 (20.5 %), there was no significant difference in prevalence in cattle from the two origins. The prevalence in cattle above 6 years old 117 was higher (95.9 %) than in cattle less than 2- 4 years old 11 (2.6 %). Prevalence of 88 (8.5 %), 53 (5.1 %) and 65 (6.3 %) was recorded in Black Head – Ogaden, Adal and Abyssinian sheep breeds, respectively. Sheep under less than 1 year 77 (7.4 %) was more infected than sheep above 3 years of age 11 (1.1 %) and the difference in prevalence was significant. The prevalence of hydatidosis in Arsi-Bale and Keffa goat breeds was 53 (8.3 %) and 49 (7.6 %), respectively. The frequency of infection rate was higher in pigs kept at backyard 55 (10 %) than those managed under intensive husbandry system 22 (4 %). Out of the total 2071 cysts isolated from the different organs of cattle, 1007 (48.6 %) were small, 711 (34.3 %) medium and 353 (17 %) were large.

More cysts were counted in the lungs of cattle, sheep and goats, but more cysts were found in swine's liver than in lung. Out of the total of 396 cysts isolated from organs of cattle, 217 (54.8 %) were fertile, 133 (33.6 %) sterile and 46 (11.6 %) were calcified. Out of the 217 fertile cysts, 185 (85.3 %) were viable and 32 (17.3 %) were none viable. The annual economic loss was estimated to be 10,923,601.00 Ethiopian Birr, which is equivalent to 1,139,061.63 USD. 234 cases of human hydatidosis were surgically treated at the Tikur Anbassa Referral Hospital in Addis Ababa. The economic and public health significance of the disease is discussed and pertinent conclusions are drawn.

Key words: Abattoir; economic loss, hydatidosis; prevalence; protoscoleces; Public health.

1. INTRODUCTION

Ethiopia is one of the countries very rich in livestock population in Africa. Ethiopia's livestock productivity, despite its huge population size, remains marginal due to high prevalence of animal diseases, malnutrition and management constraints. Parasitism represents a major obstacle to development of the livestock sector and hampers the poverty alleviation programs in livestock farming system in the country. Hydatidosis is one of the major parasitic diseases, which affects the health of food animals and human (Jobre *et al.*, 1996).

Hydatidosis is caused by the larval stage of *Echinococcosis granulosus* has a world wide distribution and occurs in various spp. of domestic animals including cattle, sheep, goats, pig and camels act as intermediate hosts whereas the dog and other carnivores are the definitive hosts of *E. granulosus* (Motassian *et al.*, 1977).

The disease is chronic and affects all kinds of food animals, including herbivorous and omnivorous mammals. It is characterized by the formation of variably sized cysts in the visceral organs of the intermediate host and tapeworm in the intestine of the definitive host (WHO, 1994).

The public health significance of hydatidosis lies on the cost of hospitalization, medical and surgical fees, loss of income and productivity, permanent or temporary incapacity to work, social consequence hydatidosiss of disability and mortality (Macpherson *et al.*, 1985). In food animals hydatidosis has an adverse effect on production causing decreased production of meat, milk, wool, reduction, growth rate and predisposition to other diseases (Hubbert *et al.*, 1975). It causes high economic losses in livestock industry, due to reduced productivity (wool, meat, milk), further economic losses incurred due to condemnation of infected organs and the cost of preventative and eradication programs (Macpherson *et al.*, 1985). Hydatidosis has been reported to occur in Northern Africa, and in many countries south of the Sahara (FAO/UNEP/WHO, 1982).

Hydatidosis is common in Asia, the Mediterranean, South America and Africa. In recent years the prevalence of the disease has increased in Europe. Hydatidosis has been reported from most countries in Africa. Several previous and recent studies indicated that *E. granulosus* in dogs and its larval stage hydatid cyst in livestock is very common in Africa (Eckert *et al.*, 2001).

In Ethiopia hydatidosis is one of the major infectious zoonotic diseases especially where sheep, goats, cattle, camel and pigs are still slaughtered traditionally and offals are easily accessible to scavenging dogs and other wild carnivores. Factors like absence of proper meat inspection procedures, poor management of food animals, traditional practices of backward farming system, poverty, lack of awareness about food borne diseases, lack of adequate number of abattoirs compared to the fast growth rate of human population are all thought to contribute significantly to the high prevalence of hydatidosis in Ethiopia. About 85 % Ethiopian population are rural inhabitants and mostly practice backyard slaughtering with improper disposal of affected organs with the hydatid cysts. As a result stray dogs have a free access to infected organs of slaughtered animals.

Significant economic losses due to liver and lung condemnation and carcass weight loss due to hydatidosis have been also reported in different parts of Ethiopia (Yilma, 1984; Roman, 1987; Fikre, 1994; Bersissa, 1994). Since the disease incurs enormous economic losses in meat sector, effective control and prevention measures should be introduced to minimize the risk of public health hazard and curb the incurred economic losses. In Ethiopia, hydatidosis is one of the highly prevalent diseases (Jober *et al.*, 1996). However, detailed studies and comprehensive assessments on its prevalence, economic losses and public health significance are still lacking. Hence the objectives of the present study were:

- To determine the prevalence of hydatidosis in cattle, sheep, goats and pigs slaughtered in Addis Ababa Abattoir.
- To assess the effect of risk factors like breed, origin, production system, sex and age of animals on the prevalence of the disease.
- To estimate the economic losses incurred due to hydatidosis in the slaughtered animals.
- To assess the public health importance of the disease.

2. LITERATURE REVIEW

2. 1. Taxonomy

Hydatidosis/ echinococcosis is a zoonotic infection caused by adult in final hosts and larval (metasestode) stages in the intermediate hosts of cestodes belonging to the Phylum Platyhelminthes, class cestoda, order Cyclophyllidea, family Taeniidae and genus Ehinococcus (Urquhart *et al.,* 1996).

Recently four species of the genus Echinococcus are regarded as valid taxonomically viz, *Echinococcus granulosus*, *Echinococcus multilocularis, Echinococcus oligarthrus* and *Echinococcus vogeli* (Soulsby, 1982).

2.2. Morphology

2. 2. 1. Adult parasite

Adult Echinococcus is a very short tapeworm only rarely more than 7 mm long and usually has no more than six segments. Like all tapeworms, Echinococcus has no gut and all metabolic interchange takes place across the syncytial outer covering tegument. Anteriorly, the adult Ehinococcus possesses an attachment organ, the scolex, which has four muscular suckers and two rows of hooks, one large and one small, on the rostellum (Thompson, 1986).

The body or strobila is segmented and consists of a number of reproductive units (proglottids), which may 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 which may vary depending on species and strain. There is a prominent cirrus sac, which may be horizontal or tilted anteriorly and the vitellarium is globular. The uterus dilates after fertilization, eventually occupying most of the terminal segment when the eggs are fully developed (Urquhart, *et al.,* 1996).

Figure 1. Adult *Echinococcus granulosus*, gravid worm. Arrow indicates the position of genital pore. Source: (Eckert *et al.*, 2001).

2. 2. 2. The Egg

The eggs are ovoid in shape and measures 30-40 μm in diameter consisting of hexacanth oncosphere surrounded by several envelops, the most noticeable one being the highly resistant keratinized embryophore, which gives the egg a dark striated appearance. The outer capsule quickly disappears once the eggs are liberated from the host (Soulsby, 1982).

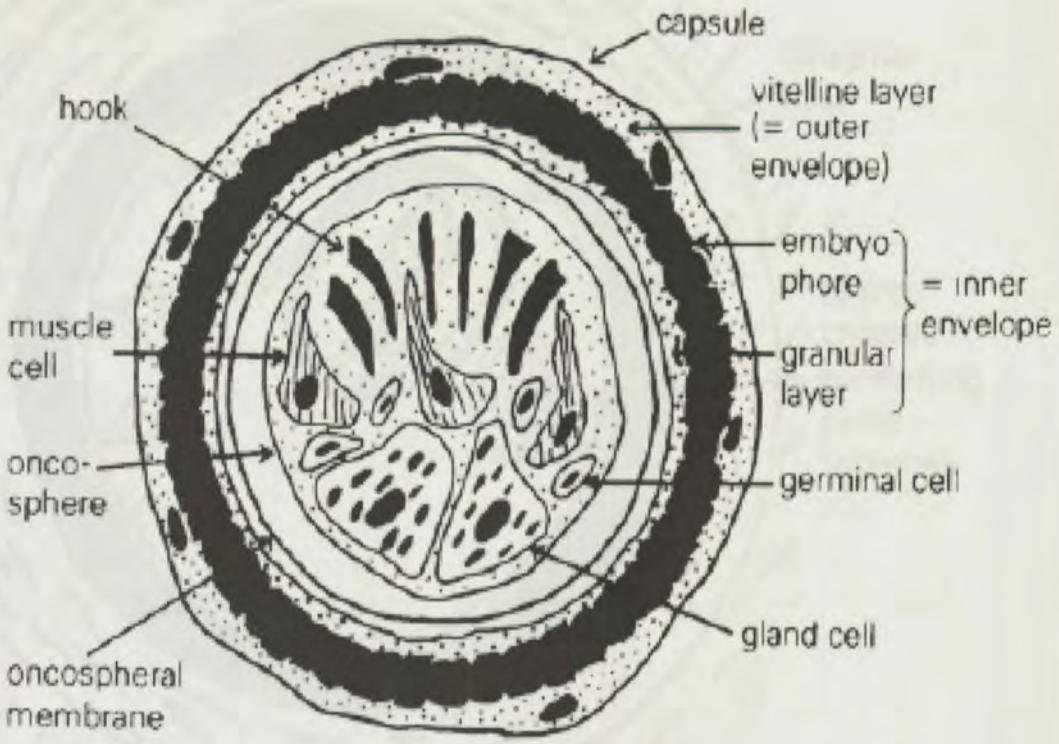

Figure 2. Diagram of the egg of Echinococcus. Source: (Thompson, 1986).

2. 2. 3. The Larva (Metacestode)

The metacestode, the larval stage, basically consists of a bladder with an external cellular laminated layer and an inner nucleated germinal layer, which gives rise to asexual budding to brood capsule (Soulsby, 1982).

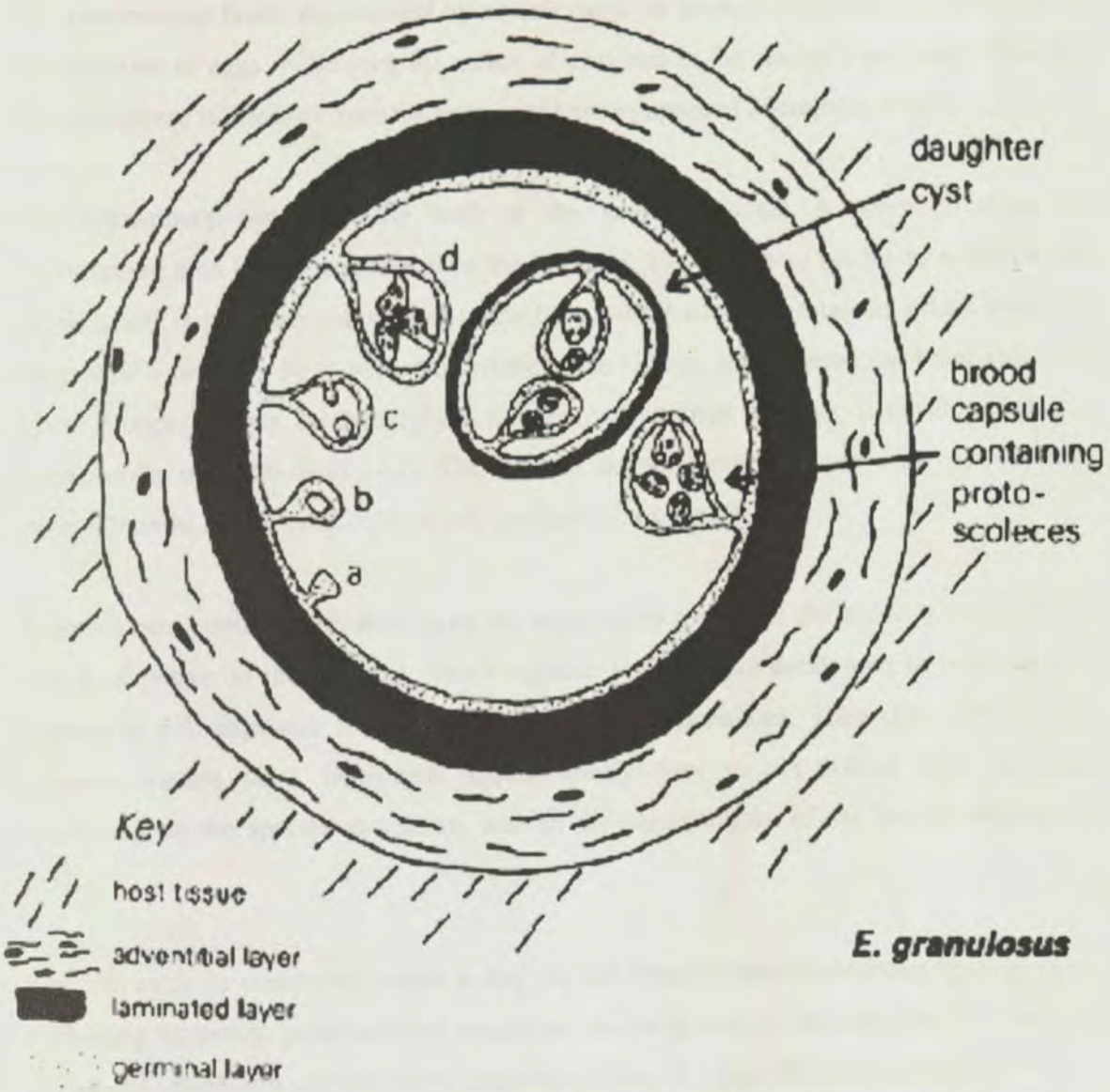

Figure 3. Metacestode of *Echinococcus granulosus*. Source: (Thompson, 1986).

2. 3. Life cycle

Echinococcus spp. requires two mammalian hosts for completion of its life cycle. Gravid proglottids or free eggs are passed along with the feces of the definitive host, a carnivore. The eggs are ingested by intermediate hosts like cattle, sheep, goats, pigs and camel in which the metasectode develops (Soulsby, 1982).

The intermediate hosts, represented by a wide range of mammals, acquire the infection by the ingestion of eggs. Following the action of enzymes in the stomach and small intestine, the onchsphere is released from the keratinized embryophore (Thompson, 1986).

The oncosphere penetrates the wall of the small intestine. A secretion from the onchosphere aids the penetration in to the intestine. Upon gaining access to a venule, the onchosphere is passively transported to the liver, where some are retained, others reach the lungs, and a few may be transported further to the kidney, spleen, muscles, brain and other visceral organs. Once the oncosphere has reached its final location, it develops into the metacestode stage (hydatid cyst). The time of development is variable and it may take several months before protoscoleces are produced (Soulsby, 1982).

Protoscoleces containing hydatid cysts are ingested by a suitable definitive host, due to the action of pepsin in the stomach, they evaginate in the upper duodenum in response to a change in pH, exposure to bile and to increased temperature. Then they develop into sexually mature adult tapeworm, approximately four to six weeks after infection, depending on the species and strain, and on the susceptibility of the host (Eckert *et al.*, 2001).

The life cycle is completed, when a dog ingests protoscoleces containing hydatid cysts. Following ingestion, protoscoleces evaginate, penetrate deeply between the villi in to the crypts of LieberKuhn and develop to maturity in about 47 days (Soulsby, 1982).

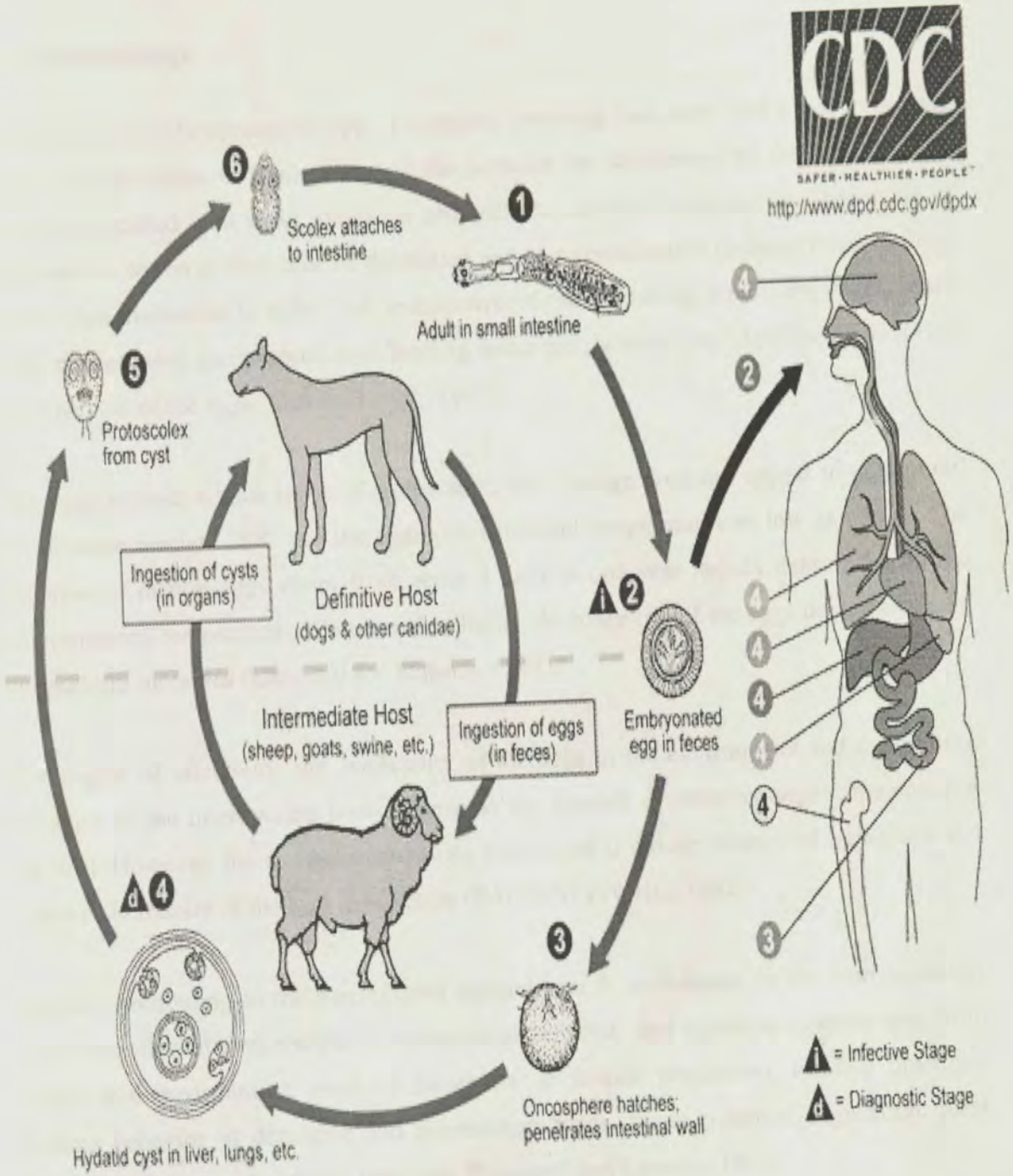

Figure 4. The life cycle of *E.granulosus.* Source: (CDC, 2005).

2. 4. Epidemiology

The life cycle of Echinococcus spp. is complex involving two hosts and a free-living egg stage. The dynamics of transmission of the parasites are determined by the interaction of factors associated with these two hosts and with the external environment. Dispersion of eggs occurs within a short time of deposition and to a considerable distance from the fecal mass. This dispersion is radial and irrespective of the prevailing winds. However, birds, flies, beetles, ants, earth worms and flooding water are the most important factors involved in dispersion of the eggs (Gemmell *et al.*, 1987).

The eggs tolerate a wide range of temperature and damage dose not appear to occur until temperature reaches 38°C and the eggs can withstand temperatures as low as –30°C. The life span of mature eggs varies from about 3 days to one year largely determined by the environmental temperature. Within certain limits, the longevity of the eggs decreases as the temperature increases (Gemmell and Roberts, 1995).

The degree of infectivity and availability of the eggs in the environment and the feeding behavior of the intermediate hosts determine the number of infective organisms entering the host. However, the number of parasites established is strictly controlled by natural and acquired immunity of the host to infection (FAO/UNEP/WHO, 1982).

Factors contributing to the transmission dynamics of *E. granulosus* in the farm situations are environmental temperatures, environmental humidity, and agents to disperse eggs from faeces into environment, level of awareness of human population, farming practices, feeding behavior of definitive and intermediate hosts, biotic potential, legislation, meat inspection, innate and acquired immunity (Gemmell and Lawson, 1986).

In the endemic areas, there is no density-dependent constraint in the form of acquired immunity and the intermediate hosts remain susceptible to infection throughout their lifetime. Once treating dogs reduces the infection pressure, the prevalence declines rapidly in both young and old intermediate hosts. This is also the case with *E. granulosus* in

children and adults. In practical terms, it seems that in the endemic areas, there is neither age nor acquired resistance in animals and humans and a vigorous control effort should benefit the whole community of all age groups (Beard, 1988).

2. 4. 1. Geographical distribution

Echinococcus ganulosus has a very wide geographical distribution (Soulsby, 1982). *E. granulosus* has a worldwide geographic range and occurs in all continents including circumpolar, temperate, subtropical and tropical zones (Craig *et al.*, 1995).

2. 4. 2. Prevalence

The highest prevalence of the parasite is found in parts of Eurasia, Africa, Australia and South America (Craig *et al.,* 1996). In Europe, *E. granulosus* has an uneven geographic distribution with very low prevalence rates in some of the northern and central countries, but with medium or high prevalence in regions of southern, southeastern and eastern regions. Iceland and Greenland are free of the parasite (Eckert, 1996).

E. granulosus has been recorded from most of the sub-Saharan countries over a vast area stretching from the Sahel Zone to Southern Africa. Reports indicate wide variations in the prevalence of *E. granulosus* in dog and/or livestock populations in various countries. Areas of high endemic are known to occur in eastern Africa, including at least parts of Sudan, Ethiopia, Kenya and Uganda (Craig *et al.,* 1996).

Large parts of western, central and southern Africa apparently have lower prevalence, but an accurate assessment is difficult, due to lack of data. Several strains of *E. granulosus* have been identified in various parts of Africa viz, the sheep, cattle, horse, and lion strains. Wildlife-cycles exists involving a number of wild carnivores (jackal spp. hyena, lion, etc.) and wild ruminants and pigs (Macpherson and Wachira, 1997).

In humans, several ultrasound surveys have confirmed high prevalence of hydatidosis in certain population groups and areas. In 1985-1987, a large study was performed in semi-

desert regions of Sudan, Ethiopia, Kenya and Tanzania involving 18,565 persons of various ethnic groups. The average prevalence of hydatidosis was 1.8 %, with a range between 0 and 5.6 in various regions and population groups (Macpherson *et al.*, 1989).

In Mauritania, the annual incidence of hydatidosis was estimated to be 1.2 per 100,000 populations for the period 1996-1997, based on the number of cases diagnosed at the National Hospital in Nouakchott (Beurdeley *et al.*, 1997).

In Northern Africa, high prevalence was reported and host parasite factors are similar to those in the Middle East. High prevalence is also recorded from many African countries south of the Sahara like Uganda, Rwanda, Burundi, Togo, Nigeria, Zimbabwe, Zaire, Kenya, Ethiopia and South Africa (FAO/UNEP/WHO, 1982).

High prevalence was also reported from northeastern Turkana in Kenya with approximately 7.5% before 1983 and 3.1% in 1992, 10 years after the initiation of control measures (Macpherson and Wachira, 1997). The prevalence of hydatidosis in Ethiopia on different food animals recorded by different authors in regions and abattoirs is compiled in table 1 below.

Table 1. Prevalence of hydatidosis in ruminants recorded in different Abattoirs in Ethiopia.

Abattoir Name	Animals spp.	Prevalence (%)	Author	Year
Debre Zeit	Cattle, sheep and goats	46.5, 12.5 and 12.5	Yilma	1984
Wollaita	Cattle	32.33	Abel	1985
Gonder	Cattle, sheep and goats	33.7, 8.7 and 4.6	Tamane	1986
Melga wondo	Cattle	42.9	Getahune	1987
Gondar	Cattle	24.3	Roman	1987
Hararge	Cattle, sheep and goats	22.9, 9.4 and 6.5	Woubiet	1987
Nekamte	Cattle	31.19	Fayessa	1987
Gamo Gofa	Cattle	25.88	Mohammed	1988
Jimma	Cattle and sheep	33.6 and 10.1	Abdualjewad	1988
Robe	Cattle	63	Woubet	1988
Melga wondo	Cattle	42.9	Muktar	1988
Addis Ababa	Cattle, sheep and goats	21.2, 14.7 and 7.1	Gemeda	1988
Addis Ababa	Sheep	16.4	Tekleye *et al.*	1988
Desse	Sheep	4.4	Yilikal	1989
Arsi	Cattle and sheep	54.8 and 2.2	Alemayehu	1990
Baherdar	Cattle	54.9	Nebiyehu	1990
Nazreth	Cattle, sheep and goats	37.7, 6,6 and 2.7	Yemane	1990
Awassa	Cattle	34.3	Getachew	1991
Soddo	Cattle	32.6	Abduljelal	1992
Asela	Cattle	50.29	Desie	1992
Konso	Cattle, sheep and goats	25.7, 18.8 and 9.3	Fikre	1994
Nekamte	Cattle and sheep	34.9 and 22.2	Bersissa	1994
Diredawa	Cattle and sheep	14.8 and 12.7	Daniel	1995
South wollo	Cattle and sheep	28.3 and 15.1	Asrat	1996
Assela	Cattle and sheep	72.4 and 53.5	Fekadu	1997
ELFORA (Debre Zeit)	Cattle	55.7	Abera	2007
Mekale	Cattle	31.2	Hagos	2007

Source: DVM, Theses, AAU, FVM, Debre Zeit, Ethiopia (1984 – 2007).

2. 5. Clinical signs and pathology

2. 5. 1. Clinical signs

Reports on clinical aspects of *E. granulosus* in canines are rare and consist mainly of observations from experimental infections concerned with aspects of the biology of Echinococcus. The presence of Echinococcus spp. does not appear to cause any major ill

effects to the definitive host even in individuals with heavy infection (FAO/UNEP/WHO, 1982).

In intermediate hosts, infections with the metacestode (hydatid cysts) develop predominantly in visceral organs. Larval stage of *E. granulosus* infection in intermediate hosts (sheep, cattle, pigs, etc.) is typically asymptomatic, but symptoms have been described in severe cases, for example in horses. In intermediate host domestic animals, hydatids in the liver or lungs are usually tolerated without any clinical signs and the majority of infections are only detected at the abattoir. Where oncospheres have been carried in the circulation to different organs such as the kidney, pancreas, CNS or marrow cavity of long bones, pressure by the growing cyst may cause a variety of clinical signs (Eckert *et al.*, 2001).

In contrast, when man is involved as an intermediate host, hydatids in the lungs or livers are highly pathogenic. One or both lungs may be affected causing respiratory symptoms and if several hydatid cysts are present in the liver, there may be gross abdominal distention. If a cyst should rapture there is a risk of death from anaphylaxis or if the person survives, released daughter cysts may resume development in other regions of the body (Soulsby, 1982).

2. 5. 2. Pathology

In the small intestine, Echinococcus penetrates deeply between the villi into the crypts of Lieberkühn attaching with the suckers and rostellar hooks to the epithelium. This intimate parasite-host relationship normally does not cause significant pathology. Minor changes may occur, such as local flattening of epithelial cells slight cellular infiltration of the mucosa and increased mucus production. Excretory products released from the scolex region of the parasite may induce the production of circulating antibodies (Thompson, 1986).

The cysts of *E. granulosus* vary greatly in size and shape (typically unilocular, but sometimes multilobed or multilocular), and may be present in large numbers in one or several organs. The location of cysts and cyst morphology is controlled not only by 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 resolves and cause 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 the intermediate host is protracted resulting in the death of the parasite (Thompson and Allsopp, 1988).

2. 6. Diagnosis

2. 6. 1. Echinococcosis in dogs

Proglottids of *E. granulosus* spontaneously discharged by dogs are detected mostly on the surface of faecal samples, may allow a correct morphological diagnosis, if they are in a good condition. Treatment of dogs with arecoline hydrobromide has the advantage that, if a purge is induced, there is probability that some of the worm burden will be expelled and data for epidemiological studies and for education can be obtained. The strength of the arecoline test is its absolute specificity, which produces 100 % positive predictive values throughout the range of possible prevalence, whereas the negative predictive values are much lower at 68 % after one dose and 85 % after a second dose. However, the arecoline test should not be used on pregnant bitches, aged dogs or young puppies (Schantz, 1997).

Eggs can be detected in faecal samples using routine flotation techniques or in the per anal skin, using clear adhesive tape which is pressed to the skin, transferred to a microscopic slide and examined (Deplazes and Eckert, 1988).

The small intestine for diagnostic examination should be removed as soon as possible after death of the definitive host, tied at both ends and placed in a plastic labeled bag or metal container. The material can be deep-frozen until examination at –20°C or at –70°C to –80°C. At the lower temperatures, the eggs of *E. granulosus* will be killed. For transporting over long distances, the material can be placed on ice (Baronet *et al.*, 1994).

For the immunodiagnosis of Echinococcus spp. the detection of the parasite antigens in the faeces (coproantgen) and the serum antibody detection are the two main methods in use. For coproantigen tests, faecal samples are directly taken from the rectum and mixed with buffer solution. The coproantigen test can be used for identifying infected dogs during control programs, including pregnant bitches, old dogs and young puppies (Baronet *et al.*, 1994).

Coproantigen is highly specific for the genus Echinococcus and can be detected by antibody capture ELISA in dogs experimentally infected with *E. granulosus* or *E. multilocularis* within 5-10 days post infection and therefore does not depend on presence of eggs. Faecal antigen conversion to negative status occurred with five days of praziquantel treatment. Detection of specific antigen(s) in faecal samples from definitive hosts has the advantage over serum antibody detection due to the high probability of correlation with current infection (Deplazes *et al.*, 1992).

2. 6. 2. Hydatidosis in intermediate hosts

There is no satisfactory technique available for the immunodiagnosis of echinococcosis in domestic or wild animals. Hydatidosis in food animals is detected by performing post mortem examination of visceral organs such as livers, lungs and others (FAO/UNEP/WHO, 1982).

Hydatid cysts in intermediate hosts occur most frequently in livers and lungs, but they can also develop in other internal organs including the CNC, the skeletal muscles and in the marrow cavity of bones. Sheep are typically infected with multiple, pleomorphic *E. granulosus* cysts mainly localized in the liver and lungs, but the spleen, heart, kidneys, the omentum and other organs can also be affected (Orlando, 1997). In addition, in goats, the liver and lungs are the main predilection sites (Rausch, 1995).

In cattle, cysts are often multiple and unilocular, and the livers and lungs are the organs most commonly affected. Cattle infected with the cattle strain, cysts predominantly located in the lungs. Less frequently, cysts have been recorded in the spleen, heart, brain and the marrow cavity of bones. Multicystic structures, composed of several smaller vesicles, are not

cavity of bones. Multicystic structures, composed of several smaller vesicles, are not uncommon in cattle and have repeatedly been misidentified as the metacestode stage of *E. multilocularis* (Rausch, 1995).

Hydatid cysts grow slowly and usually take several years to develop to a size, where they may cause disease and symptoms in animals. Fertile cysts may occur within about 6 months in mice, 10-12 months in pigs, but about 2-4 years in sheep (but only 50 % of *E. granulosus* cysts are fertile by 6.65 years). Cysts are rarely fertile in cattle in most countries, except where the cattle strain is present (Thompson, 1986).

2.7. Treatment of hydatidosis in dogs and intermediate hosts

The most promising results have been obtained with anthelmintics of the benzimidazole group. At present, there is no routine treatment of domestic animals against hydatidosis since the application of benzimidazoles in effective dosages would be too expensive. To date, there is only one report that a benzimidazole compound (albendazole) has been used for the treatment of sheep with alveolar echinococcosis in the liver (Deplazes and Eckert, 2001; Haller *et al.*, 1998). Praziquantel is effective against protoscoleces of *E. multilocularis* in rodents after prolonged periods of treatment (Eckert, 1986), and protoscoleces of *E. granulosus* are susceptible to the drug *in vitro* and *in vivo* (Morris and Richards, 1992; Thompson *et al.*, 1986).

2. 8. Hydatidosis in man

Hydatidosis in human is an infection, caused by a larval hydatid cyst stage of the tapeworm *E. granulosus* or *E. multilocularis* (Aletras and Symbas, 2000). Although, hydatid cysts may be asymptomatic for many years, more commonly, the disease is slowly progressive, and pressure effect symptoms and complications eventually arise (Timothy *et al.*, 2001). The metacestodes of all the four recognized Echinococcus spp. could infect humans and cause various forms of echinococcosis. Among these forms cystic and alveolar echinococcosis are of special medical importance (WHO, 1996).

Metacestodes develop in various organs of the human body. In CE, cysts may establish in virtually all-anatomical sites, but the liver and the lung are the most frequently affected organs. Metacestode material spreads from the primary site to adjacent or distant organs and proliferates. In hydatidosis, this form occurs after release of viable parasite material (protoscoleces, small daughter cysts) during spontaneous or trauma-induced cyst rupture (WHO, 1996). Secondary echinococcosis in AE is caused by the tumor-like proliferation of the metacestode with direct infiltration of adjacent organs or by metastasis formation in distant organs, due to spreading of parasite cells via lymph and blood vessels (Motassian *et al.*, 1977).

2. 8. 1. Diagnosis of hydatidosis in man

Immunodiagnostic tests are commonly used in the diagnosis of human hydatid disease. Tests such as indirect haemagglutination, indirect immuno- florescence, latex agglutination and enzyme linked immunosorbant assay (ELISA) are highly sensitive in detecting circulating antibodies in sera from patients with hydatid diseases. Immuno electrophoresis and double immunodiffusion tests are also used. The interadermal test is less specific. Radiographic and ultra sound techniques are also helpful (WHO, 1996).

2. 8. 2. Treatment of hydatidosis in man

Surgery is still the treatment of choice to remove *E. granulosus* cysts and leads to complete cure. It can be performed successfully in up to 90% of patients, if a cyst does not have a risky localization or, if the disease is not too far advanced. However, surgery may be impractical in patients with multiple cysts localized in several organs and if surgical facilities are inadequate (WHO, 1996).

The introduction of chemotherapy and of the PAIR technique (puncture – aspiration – injection respiration) offers an alternative treatment, especially in inoperable patients and for cases with a high surgical risk (Ammann and Eckert, 1995). Cysts with homogeneously calcified walls need probably no surgery, but only a 'wait and observe' approach. The choice of an optimal treatment should be carefully assessed in each case (Morris and Richards, 1992).

2.9. Public health and economic significance

The importance of the hydatidosis can be evaluated both from the public health and from economic losses point of view. The economic significance of hydatidosis in the meat sector is due to condemnation of livers, other organs or even whole carcasses. In severe infection, the parasite may cause retarded performance and growth, reduced quality and yield of meat, milk or wool, for example, in Yugoslavia 10 percent reduction in milk yield and 5 percent carcass weight loss due to hydatidosis have been described. Hydatidosis in livestock leads to considerable economic losses due to condemnation of edible offals, primarily liver, lung and decreased in carcass weight (FAO/UNEP/WHO, 1982).

The estimated economic losses recorded in figures are of considerable variations. In Chile a loss of USD 500,000.00; In Kazhaistan more than 25 metric tons of offal was condemned during 1955-58; In Australia USD 1,000,000.00 and in Chile again the cost for hospitalization for days ranged from 300,000.00-500,000.00. In Cyprus in 1972, the cost for discarding viscera was in the range of USD 75,000.00-90,000.00 while the loss due to diminished production amounted to USD 450,000.00 in sheep, 150,000.00 in cattle and 45,000.00 in goats (Polydrous, 1981). Few authors estimated economic losses due to hydatidosis in some parts of Ethiopia. In this regard, for a comprehensive study recorded data has been described in (table 2) as follows.

Table 2: Economic losses due to hydatidosis in slaughtered cattle at different Abattoirs in Ethiopia

Losses in ETB	Name of the abattoir	Authors name	Year
813,526.46	Debre Zeit	Yilma *et al*	1984
3,714.55	Wollaita Soddo	Abel	1985
2,833.89	Gondar	Tamene	1985
9,507.78	Nekamte	Feyissa	1987
290,260.00	Melga Wondo	Getahun	1987
90,644.95	Gondar	Roman	1987
64,920.10	Hararga region	Woubet	1987
431,907.44	Addis Ababa	Gemeda	1988
21,054.58	Gamo Goffa	Mohammed	1988
1,385.36	Robe	Woubet	1988
5,892.00	Dessie	Yilkal	1989
8,798.50	Arsi region	Alemayehu	1990
7,331.94	Bahrdar	Nebiyou	1990
10,879.64	Nazret	Yemane	1990
56,243.20	Soddo	Abduljelal	1992
69,355.52	Asela	Desie	1992
77,587.00	Nekamte	Bersissa	1994
220,922.90	Diredawa	Danial	1995
64,422.60	South wollo	Asrat	1996
162,743.38	Assela	Fekadu	1997
55,443.59	ELFORA (Debre Zeit)	Abera	2007
494,663.90	Mekale	Hagos	2007

Source: DVM, Theses, AAU, FVM, Debre Zeit, Ethiopia (1984 – 2007).

In addition to causing high economic losses in food animals, the disease has great public health hazard. The economic significance of hydatidosis in the public health sector include medical and surgical fees and cost of hospitalization, nursing, drugs and convalescence, loss of income and productivity, absence from work, reduced capacity for work or permanent incapacity,

losses due to mortality and social consequences of disability and mortality (WHO, 1996). Data on human health aspect of the disease is still not available. The incidence in Uruguay was 20.7 %, Cyprus 12.9 %, Chile 7.5 %, Greece 7.5- 8.5 %, Algeria 5.6-6.1 %, 3.7 % in Yugoslavia and 143 cases in Rigo Negro in Argentina per 100,000 people (FAO, 1982). The Turkana region in Kenya has the highest endemicity in the world (Macpherson, 1983).

2.10. Control and Prevention

Hydatidosis can be controlled by avoiding dog access to infected raw offals through proper disposal of condemned offals at abattoirs, local slaughterhouses 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 offals and sterilization of offals, if it is to be used as dog food. The reduction in the parasite bio mass forms the second important measure in the control of hydatidosis. The methods that can be applied include, control of dogs by registration (collar/ tattoo); reduction of dog population through banning of dogs from restricted areas, mass killing of stray dogs and reduction of tapeworm population by mass drug treatment or test and penalize (FAO/UNEP/WHO, 1982).

3. MATERIALS AND METHODS

3.1. Study area

The study was carried out in Addis Ababa Administrative region. Addis Ababa is the capital city of Federal Democratic Republic of Ethiopia. Addis Ababa city has an area of 51,000 hectare in the central highlands with an average altitude of 2000 – 2560 meters above sea level. The area is characterized by bimodal rainfall with an average of 1100mm, the highest percentage of rain falls during the long rainy season from June to September. The short rainy season is from February to April. The average annual daily temperature ranges from 8°c to 22°c minimum and maximum respectively, and relative humidity varying from 70 % to 80 % during the rainy season and from 40 % to 50 % during the dry season. Addis Ababa has an estimated human population of 3.15 million (CSA, 2007).

3.2. Study animals

The study was undertaken on both sexes of local breeds of cattle, sheep, goats, and on some exotic breeds of pigs brought from different agro ecological zones of Ethiopia that were slaughtered at Addis Ababa Abattoir.

The information obtained from the abattoir indicated that the abattoir has average annual slaughtering capacity was 200,000 food animals per year. The origins of slaughtered animals are from different parts of the country and livestock marketing areas like Borana, Arsi, Wollega, Kaffa, Southern part of the country (Wolieta, Gamogofa, Kambata, Hadiya and Gurage), Wollo, Gerruy, Afar, Harrarge, Addis Ababa and its peripheries.

3.3. Sampling method, study design and sample size

The cross sectional abattoir survey study was conducted on slaughtered cattle, sheep, goats and pigs to determine the prevalence of hydatidosis by post mortem examination of visceral organs like liver, lung, heart, kidney and spleen. A simple random sampling method was employed on

the selection of the sampling units at the abattoir and sample units were clustered by origin, breed, age and sex. The study animals were selected from those registered animals for slaughter. The required sample size for the study for each species of animals were determined by the formula given in (Thrusfield, 1995), with 95 % confidence interval and at 5 % desired absolute precision.

Therefore, the determined sample size was 1209 cattle, 1033 sheep, 639 goats and 549 pigs. The study animals were randomly selected and the data like origin, breed, production ystem, sex and age of each study animal was recorded during the abattoir survey. During ante mortem examination each study animal was given an identification number before slaughtering. The age of each study animal was estimated based on the dentition formula described by (Gatenby, 1991; Mike, 1996; FAO, 1994 and Merck, 2000). The study was carried out from November 2007 to April 2008 regular visits were made to Addis Ababa Abattoir three days per week. All laboratory studies were conducted at Shola Zonal Veterinary Diagnostic laboratory located at Addis Ababa Urban Agricultural Development office.

3. 3. 1. Examination of visceral organs

A total of 3430 cattle, sheep, goats and pigs were examined by post mortem for the presence of hydatid cyst routine meat inspection procedures was conducted whereby livers, lungs, hearts, kidneys and spleens were visualized, palpated and incised to detect the presence of cysts. The infected organs from each animal were collected and recorded. The total number of hydatid cysts were counted and recorded. The size of the diameter of collected hydatid cysts was measured and classified as small (diameter less than 5 cm), medium (diameter between 5 cm and 10 cm) and large (diameter greater than 10 cm) as described by (Oostburg *et al.*, 2000).

3. 3. 2. Fertility and viability study

Of the collected hydatid cysts, individual cysts were carefully incised and examined for protoscoleces, which look like white dots on the germinal epithelium; such cysts were

characterized as fertile cysts. Fertile cysts were subjected to viability test. A drop of the sediment containing the protoscoleces were placed on the microscopic slides, covered with cover slips, and observed for amoeboid like peristaltic movements with 40X objective. For clear vision a drop of 0.1 % aqueous eosin solution was added to equal volume of sediment containing of protoscoleces in hydatid fluid on microscopic slide with the principle that viable protoscoleces should completely or partially exclude the dye while the dead ones take it up (Macpherson *et al.*, 1985). The technique differentiates between dead (red stained) and alive (unstained) protoscoleces (FAO/UNEP/WHO, 1982). Furthermore, infertile cysts were further classified as sterile or calcified. Sterile hydatid cysts were characterized by their smooth inner lining usually with slightly turbid in its content. Typical calcified cysts produce a gritty sound feeling up on incision (Soulsby, 1982).

3. 3. 3. Economic loss study

The economic loss study due to hydatidosis in slaughtered cattle, sheep and goats were included in this study, where as economic losses for slaughtered pigs not included in this study due to scant information's. An attempt was made to estimate the economic significance of hydatidosis in slaughtered cattle, sheep and goats from the counted number of condemned livers and lungs. The estimation of economic losses for the rest of condemned organs like heart, kidney and spleen due to hydatid cyst was not estimated in this study, because compared to liver and lung there values are insignificant. The carcass weight losses caused due to hydatid cyst in slaughtered cattle, sheep and goats was also estimated. The variables for economic loss estimation were described as follows:

- The retail market price of average sized zebu cattle, local breeds of sheep and goats (liver and lung) and the price of 1 kg of beef and 1 kg of mutton were estimated based on information collected by structured questioner survey from butchers and customers.
- Average annual slaughter rate of cattle, sheep and goats was obtained from registered meat inspection record book of Addis Ababa abattoir from 10 years retrospective data (1998-2007) which was presented in table (12).

- The average live weight of indigenous Ethiopian cattle is 250 kg (FVM/AAU, 1996), 227 kg for Abyssinian Zebu breed (Alberto and Haile-Mariam, 1982) and 272 kg for Borana breed (Alberto and Haile-Mariam, 1982), carcass yield of 55 % averaged sized zebu (Abyssinian zebu and Fogera) (FVM/AAU, 1996) and 52 % for Borana (Alberto and Haile-Mariam, 1982). Based on the above informations for estimation of economic loss of cattle carcass (250 kg + 227 kg + 272 kg) / 3 = 250 kg body weight for slaughtered Borana, Abyssia zebu and Arsi breeds. For cattle carcass yield estimation (55 % + 52 %) / 2 = 54 % was computed. So by computation 250 kg X 54 percentage = 135 kg was estimated as an average carcass weight for adult Ethiopian local breed slaughtered in Addis Ababa abattoir.
- Although a 5 % estimation of carcass weight loss in individual cattle due to bovine hydatidosis (Polydorous, 1981) was taken in to account to determine the carcass weight loss of cattle.
- Most tropical breeds of sheep possess at mature live weight from 20 - 45 kg and average dressing out percentages for tropical type sheep are with in the range of 40 to 48 % (Williamson and Payne, 1978). Adult tropical goats live weight of large breeds weighed 20 to 63 kg, medium breeds weighed 19 to 37 kg and small breed goats weighed 18 to 25 kg (Williamson and Payne, 1978).
- Ethiopian goat breeds like the Afar, Central highland and long-eared Somali have dressing percentages on a slaughter body weight in the range of 42.5 %- 46.6 % (Sebsibe *et al.*, 2007). According to the above mentioned information in this study the average slaughtering body weight for adult slaughtered breeds of Ogaden Black head, Adal and Abyssinian sheep was determined 32.5 kg and the dressing out percentage was 44 % while for slaughtered breeds of Arsi-Bale and Keffa adult goats slaughtering body weight and dressing out percentage was 30.4 kg and 44.5 % respectively. By computing this values the average carcass, weight for sheep (32.5 kg X 44 % = 14.3 kg) and for goats (30.4 kg X 44.5 % = 13.5 kg) was determined. In addition, according to previous study reduction in dressing carcass weight of infected sheep and goats due to hydatidosis carcass loss of sheep and goats 2.5 % (Polydorous, 1981) was computed in this study.
- The annual loss of livers and lungs condemnation and carcass weight loss due to hydatid cyst was estimated using the following formula set by (Ogunrinade *et al.*, 1980) as follows:

  $ACLLC = (CSR * PL_1C * L_1C) + (CSR * PL_2C * L_2C)$, Where:

  ACLLC = Annual Cost of Liver and Lung Condemned

CSR = Average number of Slaughtered animals per annum Rate in Addis Ababa Abattoir

PL_1C = Percent of Liver Condemned

L_1C = Mean price of one Liver in Addis Ababa market

PL_2 C = Percent of Lung Condemned

L_2C = Mean Price of one Lung in Addis Ababa market

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* Multiplication symbol

➢ The annual carcass weight loss due to hydatid cyst was estimated by using the following formula set by (Polydorous, 1981) as follows:

ACW = CSR * CL * BC * P, Where:

ACW = Annual loss from Carcass Weight due to hydatidosis

CSR = Average number of Slaughtered animal per annum in Addis Ababa Abattoir

CL = Carcass weight Loss in individual due to hydatidosis

BC = Average market price of 1 kg beef/mutton in Addis Ababa market

P = Prevalence rate of hydatidosis in Addis Ababa Abattoir

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* Multiplication symbol

Using the above two, formula the direct economic loss due to condemnations of liver and lung and the indirect loss due to carcass weight loss from hydatid cyst infection was estimated by summation of annual condemned liver and lung by average cost for each organs as well as cost of carcass due to carcass weight loss.

3.3.4. Public health significance study

The public health significance study was under taken to assess the current infection rate of hydatid cysts in man. For this purpose, structured questionnaire survey developed was distributed to 30 physicians working in different hospitals and health centers in Addis Ababa city. Parallel with questioner survey, interview was done with selected surgeons in Tikure Anbassa, Yekatit and Minilik hospitals. In addition, repeated visits were made to Department of surgery of Tikure Anbassa hospital to interview senior surgeons and to collect surgical and radiographic case records to asses the regional frequency on occurrences of hydatid disease case in Ethiopia.

3.4. Data analysis

All the data collected from the abattoir was recorded and entered in to excel sheet. The data was analyzed using SPSS 13.0 for widows soft ware. The prevalence of hydatidosis was computed as the number of affected organs per slaughtered animal divided by the total number of sampled animals and multiplies by 100 for each spp. Potential risk factors for each species of animals in four age categories, breed, sex, origin and livestock production system were assessed for any effect on the prevalence of hydatidosis in the study animals.

Chi square (x^2) statistical test was applied to determine the association between the various potential risk factors like age, breed, sex, origin and management and the prevalence of hydatid cyst. A statistically significant association between variables were said to exist if the P value is less or equal to 0.05 at 95 % confidence interval.

4. RESULTS

4.1. Prevalence of hydatidosis in slaughtered animals

In the current study a total of 3430 food animals consisting 1209 cattle, 1033 sheep, 639 goats and 549 pigs slaughtered at Addis Ababa Abattoir were examined for presence of hydatid cyst infection. Out of these total examined animals 254 (21 %), 206 (19.9 %), 102 (16 %) and 77 (14 %) cattle, sheep, goats and pigs, respectively were found infected with hydatid cysts (Table 3). The study showed the presence of statistically significant variation ($p = 0.001$) in the overall prevalence of hydatid cyst infection among the spp. of animals examined during the study period.

Table 3. Overall prevalence of hydatidosis in cattle, sheep, goats and pigs slaughtered at Addis Ababa Abattoir.

Animal spp.	No. examined	Infected animals	
		No.	%
Cattle	1209	254	21
Sheep	1033	206	19.9
Goats	639	102	16
Pigs	549	77	14
Total	3430	639	18.6

$x^2 = 16.37$; P=0.001

In the study prevalence of hydatidosis in Borana breed, Arsi breed and Abyssinian Zebu breed cattle were (132) 20.9 %, (85) 22.4 % and (37) 18.7 % respectively (Table 4). There was no statistically significant variation ($p = 0.59$) in cattle of different breeds. Likewise the prevalence of cattle from midland and lowland was (124) 21.6 % and (130) 20.5 %, respectively. In addition, there was no significant variation in cattle of different origins. The study also revealed the prevalence of hydatidosis of (132) 20.8 % and (122) 21.3 % in cattle kept under pastoral and mixed crop livestock production system, respectively (Table 4). There was also no significant variation in cattle kept under different production systems. Also prevalence of (1) 0.3 %, (11) 2.6 %, (125) 37.1 % and (117) 95.9 % in cattle <2, 2-4, 4-6 and >

6 years cattle was recorded. There was significant ($p < 0.001$) variation in the prevalence of hydatid cyst infection in age categories of cattle studied.

Table 4. Prevalence of hydatidosis in relation to potential risk factors in cattle slaughtered at Addis Ababa Abattoir.

	Factors	No examined	Affected cattle	
Breed			No	%
	Borana	631	132	20.9
	Arsi	380	85	22.4
	Abyssinian zebu	198	37	18.7
Origin				
	Mid land	575	124	21.6
	Low land	634	130	20.5
Sex	Male	1198	254	21.2
	Female	11	0	0
Production system	Pastoral	636	132	20.8
	Mixed crop livestock	573	122	21.3
Age *				
	< 2 years	328	1	0.3
	2 – 4 years	422	11	2.6
	4 - 6 years	337	125	37.1
	> 6 years	122	117	95.9
Overall		1209	254	21

* Significant variation, $p<0.001$

In the current study the prevalence of hydatid cyst of 8.5 % (88), 5.1 % (53) and 6.3 % (65) in Black head Ogaden, Adal and Abyssinian breed sheep was recorded, respectively (Table 5). Likewise, a prevalence of 6.1 % (63) and 13.8 % (143) was recorded in midland and lowland sheep orgion, respectively (Table 5). And also a prevalence of 14.6 % (151) and 5.3 % (55) of hydatid cyst in male and female sheep was observed, respectively. The prevalence of hydatid cyst of 6.1 % (63) and 13.8 % (143) sheep kept in pastoral and mixed crop livestock production system was obtained respectively (Table 5). Similarly a prevalence of 7.4 % (77), 8.5 % (88),

2.9 % (30) and 1.1 % (11) was recorded in < 1 year, 1-2 years, 2-3 years and > 4 years of sheep respectively (Table 5).

Table 5. Prevalence of hydatidosis in slaughtered sheep in relation to some potential risk factors

Factors		No. of examined	No. Affected	
			No	%
Breed	Black head Ogaden	397	88	8.5
	Adal	330	53	5.1
	Abyssinian	306	65	6.3
Origin	Mid land	303	63	6.1
	Low land	730	143	13.8
Sex	Male	824	151	14.6
	Female	209	55	5.3
Production system	Pastoral	713	63	6.1
	Mixed crop livestock	320	143	13.8
Age *	< 1 year	457	77	7.4*
	1-2 years	468	88	8.5*
	2-3 years	80	30	2.9*
	> 3 years	28	11	1.1*
Over all		1033	206	19.9

* Significant variation, P<0.001

In the study a prevalence of 8.3 % (53) and 7.6 % (49) of hydatid cyst in Arsi, Bale and Keffa goat breeds was observed, respectively (Table 6). Similarly, 10.1 % (65) and 5.8 % (37) prevalence of hydatid cyst infection in midland and lowland goats was recorded, respectively.

Hydatidosis in slaughtered goats includes 373 Arsi-Bale and 266 Keffa breeds and out of them 53 and 49 were affected by hydatidosis with the prevalence of 8.3 % and 7.6 % respectively. From the total slaughtered goats, 490 were midland and 149 were originated from lowland. From these origins, 65 and 37 goats were affected by hydatidosis that constitutes prevalence of 10.1% and 5.8% respectively. In addition, a respective prevalence of 11.7 % (75) and 4.2 % (27) of hydatid cysts infection was observed in male and female goats (Table 6). Whereas a prevalence of 4.5 % (29) and 11.4 % (73) in goats kept under pastoral and mixed crop livestock production system was recorded respectively. In the study also a prevalence of 0 % (0), 2.2 %

(14), 9.7 % (62) and 4 % (26) was recorded in < 1 year, 1-2 years, 2-3 years and > 3years of goats respectively (Table 6).

Table 6.Prevalence of hydatidosis in slaughtered goats in relation to some potential risk factors.

Factors		No. examined	No. Affected	
			No	%
Breed				
	Arsi - Bale	373	53	8.3
	Keffa	266	49	7.6
Origin	Mid land	490	65	10.1
	Low land	149	37	5.8
Sex *	Male	542	75	11.7*
	Female	97	27	4.2
Production system	Pastoral	128	29	4.5
	Mixed crop livestock	511	73	11.4
	< 1 year	178	0	0
Age *	1-2 years	338	14	2.2*
	2-3 years	97	62	9.7*
	> 3 years	26	26	4*
Overall		639	102	16

* Significant variation, P<0.001

In this study a prevalence of 12.4 % (68) and 16 % (9) was recorded in exotic breed and local breeds of pig, respectively (Table 7). Likewise, the respective prevalence of 10.9 % (60) and 3.1 % (17) was observed in male and female pigs during the study period. Similarly, a prevalence of 4 % (2.2 %) and 10 % (55) was observed in pigs kept under intensive and backyard system, respectively. A prevalence of 0 % (0), 10.9 % (60) and 3.1 % (17) was recorded in pigs of < 1 year, 1-2 years and 2-3 years respectively.

Table 7. Prevalence of hydatidosis in slaughtered pigs in relation to potential risk factors.

Factors		No of examined pigs	Affected pigs	
			No	%
Breed				
	Exotic breed	549	77	14
Sex *	Male	410	60	10.9*
	Female	139	17	3.1
Production system	Intensive	95	22	4
	Backyard	454	55	10
	<1year	1	0	0
Age *	1-2yrs	425	60	10.9*
	2-3yrs	123	17	3.1*
Overall		549	77	14

* Significant variation, P<0.001

4.2. Distribution, intensity and size of hydatid cysts

The study showed that livers and lungs were the most affected organs in all spp. of the study animals (Table 8 and 9). Significantly (p=0.000) greater numbers of hydatid cysts were encountered on the lungs than the liver as shown in table 8 and 9. In the study a total of 2071 cysts from cattle, 1114 from sheep, 473 from goats and 340 cysts from pigs were collected from infected organs and differentiated into small, medium or large sized cysts as presented in tables 7 and 8.

Table 8.Cyst size and count in relation to involved organs in infected cattle slaughtered at Addis Ababa Abattoir.

Organs	No of cysts examined	Cyst count in terms of size							
		Small		medium		Large		Total	
		No	%	No	%	No	%	No	%
Lung *	1324	590	28.5	466	22.5	268	12.9	1324	63.9
Liver *	734	404	19.5	245	11.8	85	4.1	734	35.4
Kidney	10	10	0.5	0	0	0	0	10	0.5
Heart	3	3	0.2	0	0	0	0	3	0.2
Total	2071	1007	48.6	711	34.3	353	17	2071	100

x^2 =31.84, P=0.000 ; * significance

The study revealed that in pigs hydatid cysts are significantly higher in livers than harbored by lungs described in table 9 below.

Table 9. Cyst size and count in relation with organs involved in infected sheep, goats and pigs slaughtered at Addis Ababa Abattoir.

organs	No of cysts examined	Cysts count in terms of size					
		Small		Medium		Large	
		No	%	No	%	No	%
Sheep							
* Lung	710	259	67.3	264	56.5	187	71.4*
* Liver	402	124	32.2	203	43.5	75	28.6*
Kidney	2	2	0.5	0	0	0	0
Total	1114	385	100	467	100	262	100
Goats							
Lung	277	70	58.3	139	55.6	68	66
Liver	196	50	41.7	111	44.4	35	34
Total	473	120	100	250	100	103	100
Pigs							
* Lung	122	30	37.5	67	35.8	25	20.5*
* Liver	218	50	22.9	120	55	48	22*
Total	340	80	100	187	100	73	100

x^2 =19.63, P=0.000, * significant variation

Table 10. Overall organ distribution of hydatid cysts recovered from slaughtered animals in Addis Ababa Abattoir.

Animal spp.	Infected organs											
	Liver		Lung		Liver and lung		kidney, liver and lung		heart, liver and lung		Cysts/organ (Mean/Range)	
	No	%	No	%	No	%	No	%	No	%	Lung	liver
Cattle	223	87.8	241	94.8	152	59.8	10	3.9	3	1.2	5.2 (2-17)	2.8 (2-10)
Sheep	156	75.7	198	96	112	54.4	2	0.9	0	0	3.5 (1-7)	2 (2-4)
Goats	48	47	93	91.2	54	52.9	0	0	0	0	2.7 (2-6)	1.9 (1-4)
Pigs	73	94.8	39	50.6	27	35.1	0	0	0	0	1.5 (1-4)	2.8 (2-5)

4.3. Fertility, viability and sterility of hydatid cysts

In this study a total of 396 cysts were found from cattle, 1079 from sheep, 437 cysts from goats and 306 cysts from pigs were collected from different infected organs and subjected to fertility and viability studies and results are presented in tables 11 and 12. The study showed that their is no significant variation in viability of cysts collected from livers and lungs ($p>0.05$).

Of the fertile cysts in sheep 751 (77.2 %) were viable and 222 (22.8 %) were non-viable. In goats from 437 cysts, 314 (66.4 %) were fertile and 123 (26 %) were sterile. Whereas in pigs of examined hydatid cysts 251 cysts (73.8 %) were fertile and 55 (16.2 %) were sterile as given in table 12. The study showed that significantly higher numbers of fertile cysts were harbored in the lungs than by livers in both sheep and goats. However, in pigs higher proportion of fertile cysts were recorded in the liver than the lungs.

Table 11. Condition of hydatid cysts in different organs of infected cattle slaughtered in Addis Ababa Abattoir.

Organs	No of cysts examined	Fertile						Sterile		Calcified	
		Total no of fertile		Viable		Non viable		No	%	No	%
		No	%	No	%	No	%				
Liver *	171	103	26	87	84.5	16	15.5	37	9.3	31	7.8*
Lung *	212	114	28.8	98	86	16	14	87	22	11	2.7*
Kidney	10	0	0	0	0	0	0	9	2.3	1	0.3
Heart	3	0	0	0	0	0	0	0	0	3	0.8
Total	396	217	54.8	185	85.3	32	17.3	133	33.6	46	11.6

For fertility: x^2 =26.15, P=0.000; for viability: x^2 =0.097, P=0.76

Table 12. Condition of hydatid cysts in different organs of infected sheep, goats and pigs slaughtered in Addis Ababa Abattoir.

Spp. of animals and affected organs	Fertile						Sterile	
	Total fertile cysts		Viable cysts		Non viable cysts		No	%
	No	%	No	%	No	%		
Sheep Liver	329	81.9	223	67.8	106	32.2	48	11.9
Lung	644	90.7	528	82	116	18	58	8.2
sub total	973	87.3	751	77.2	222	22.8	106	9.5
Goats Liver	121	61.7	75	62	46	38	54	27.6
Lung	193	73.8	142	73.6	51	26,4	69	24.9
sub total	314	66.4	217	69.1	97	30.9	123	26
Pigs Liver	165	75.7	133	80.6	32	19.4	30	13.8
Lung	86	70.5	74	86	12	14	25	20.5
sub total	251	73.8	207	82.5	44	17.5	55	16.2

4.4. Economic losses

In this study both direct and indirect economic losses due to infection by hydatid cysts in cattle, sheep and goats were estimated. Direct losses refer the losses due to condemnation of visceral organs infected by hydatid cyst infection. In the study, it was indicated the lung and livers are the two most common organs usually infected and condemned due to hydatid cyst. As a result, economic assessment was computed for these two most commonly involved organs.

For both direct and indirect economic loss estimation ten years, retrospective data survey had been collected from Addis Ababa Abattoir meat inspection record book and presented in table 13. From the data analysis, inference made to determine the number of average per annum slaughtered cattle, the number of average annum condemned organs of livers and lungs as well as the percentage of condemned organs.

The average annual number of slaughtered cattle, sheep and goats at Addis Ababa abattoir was 142,535; 41, 469; 5,590 respectively and the average number of annual condemned organs of livers and lungs due to hydatid cyst were16, 249 (11.4%) and 22,236 (15.6%) for cattle; 2,862 (6.9 %), 4, 354 (10.5 %) for sheep and 352 (6.3 %) and 486 (8.7 %) for goats respectively (Table 13).

In this study, the annual direct economic loss due to the cost of condemned livers and lungs infected by hydatid cysts in cattle was obtained by computation of average annual slaughtered cattle (142,535) by the percentile of condemned organs of livers (11.4 %) and lungs (15.6 %) due to hydatid cysts. Computed direct economic losses from condemned livers and lungs, was estimated at ETB 1,056,184.00 and ETB 333,532.00 for livers and lungs, respectively, which when summed up gives a total estimation of for the two organs ETB 1,389,716.00. By the same procedure computed direct, economic a loss from condemned livers and lungs of sheep and goats was summed up gives a total estimation of for the two organs ETB 77.287.00. This was calculated from the current mean retail market price of cattle liver (ETB 53.00), cattle lung (ETB 15.00), sheep and goats liver and lungs were 12.00 and 8.00 ETB, respectively in Addis Ababa city 2008 (Table 13 and 14).

Indirect economic loss due to hydatidosis, that affects carcass weight gain of cattle by 5 % loss, for sheep and goats by 2.5 % loss (Polydorous, 1981). For this analysis, the average annual number of slaughtered cattle (142,535), computed by overall prevalence of hydatidosis in cattle (21 %) with average carcass weight of 135 kg multiply by 5 % and the current price of 1 kg beef was 46.00 ETB in Addis Ababa City. Carcass weight loss due to hydatid cysts was estimated the economic loss of ETB 9,362,839.00 per annum. By the same procedure average annual number of slaughtered sheep (41,469) by overall prevalence of hydatidosis in sheep (19.9 %) with average carcass weight of 14.3 kg, multiply by 2.5 % with current value of 1 kg mutton was 50.00 ETB and average annual number of slaughtered goats (5,590) by overall prevalence of hydatidosis (14.4 %) with average carcass weight of 13.5 kg, multiply by 2.5 %current value of 1 kg mutton 50.00 ETB which was calculated the sum of economic loss incurred through carcass yield loss in both of sheep and goats ETB 162,603.00. Therefore, the total estimated direct and indirect annual economic loss of cattle, sheep and goats slaughtered at Addis Ababa Abattoir due to hydatidosis estimated to be the sum of Direct and Indirect losses (1,389,716.00 + 9,293,995.00 + 239,890.00) ETB 10,923,601.00, which is equivalent to USD 1,148,643.64. The economic loss assessment in this study showed that both from direct and indirect losses about 357.00 ETB (37.23 USD), 60.00 ETB (6.26 USD) and 56.00 ETB (10.02 USD), was lost per every slaughtered cattle, sheep and goat. Considering the fact that this estimated figure is only for a single abattoir, where as on nationwide scale it is clear that the country loses very big amount of economic resources due to hydatidosis in cattle, sheep and goats. Comparing the ten years retrospective data indicates that the number of slaughtered animals at Addis Ababa abattoir was mainly cattle and the number of slaughtered small ruminants were very small amount which indicates that most of small ruminants mainly slaughtered in back yard or home slaughtering that is common with out any meat inspection possibilities and it is common that infected organs with hydatid cysts will through away for domestic dogs and cats and this conditions indicates simple way for the continuation of life cycle of hydatidosis with in intermediate and definitive hosts.

Table13. Ten year's (1998-2007) retrospective data on condemned organs due to hydatid cyst in different spp. of animals slaughtered at Addis Ababa Abattoir

Years	Species	Animals slaughtered	Condemned organs due to hydatid cyst				
			Liver	Lung	Heart	Kidney	Spleen
1998	cattle	117914	11045	25286	98	1033	640
	sheep	39381	2983	5907	7	17	11
	goats	3376	506	823	2	4	0
1999	cattle	125750	10064	28545	88	1100	410
	sheep	46607	3294	6991	8	23	5
	goats	3843	374	307	0	0	0
2000	cattle	131225	9218	24162	60	1017	690
	sheep	51034	3427	5612	3	34	14
	goats	3408	273	443	0	0	0
2001	cattle	137324	7925	8220	57	1098	601
	sheep	37779	2644	2685	3	42	38
	goats	7188	413	419	0	4	5
2002	cattle	148708	5934	18791	50	1016	550
	sheep	28820	2170	3643	2	54	22
	goats	2585	206	305	0	6	0
2003	cattle	147178	17005	19437	0	1938	135
	sheep	28715	1871	860	0	0	0
	goats	2417	300	89	0	0	0
2004	cattle	153686	28515	25937	299	317	85
	sheep	44959	3110	5429	3	0	0
	goats	6976	124	219	0	0	0
2005	cattle	149229	24930	24676	115	548	0
	sheep	39934	3073	4700	6	0	0
	goats	10668	585	951	0	0	0
2006	cattle	142880	24109	21341	143	462	0
	sheep	44301	2323	3590	0	12	0
	goats	7021	329	704	0	0	0
2007	cattle	171456	23426	25783	73	508	0
	sheep	53161	3878	4042	0	0	0
	goats	8425	402	584	0	0	0
Average number of annual slaughtered food animals at Addis Ababa Abattoir							
	cattle	142,535	16,249	22,236	98	905	311
	sheep	41,469	2,862	4,354	4	18	9
	goats	5,590	352	486	2	2	2

Source: Meat inspection record book of Addis Ababa Abattoir (2008).

Table 14. Average annual number of slaughtered animals, organs condemned at Addis Ababa abattoir, current value of organs and beef/mutton/kg in Addis Ababa city (2007-2008).

Animal spp.	Annual		No of organs condemned						
	Slaughtered	overall prevalence	Liver		Lung		Retail price (Eth Birr)		
	No	%	No	%	No	%	Liver/ organ	Lung/ organ	Beef, Mutton /kg
Cattle	142,535	21	16,249	11.4	22,236	15.6	53.00	15.00	46.00
Sheep	41,469	19.9	2,862	6.9	4,354	10.5	8.00	4.00	50.00
Goats	5,590	16	352	6.3	486	8.7	8.00	4.00	50.00

Source: Data collected during the survey period (2007/2008).
One USD = 9.59 ETB, Source: National Bank of Ethiopia.

Table 15. Computed economic losses.

Variables	Computed values	Ethiopian Birr (ETB)	United States Dollar (USD)
Cattle			
Lung	142,535 X 15.6 % X 15.00 ETB	333,532.00	34,779.15
Liver	142, 535 X 11.4 % X 65.00 ETB	1,056,184.00	110,133.89
Carcass	142,535 X 21 % X 135 kg X 5 % X 46.00 ETB	9,293,995.00	969,133.99
Sub total		10,683,711.00	1,114,047.03
Sheep			
Lung	41,469X 10.5 % X 8.00 ETB	34,834.00	3,632.33
Liver	41,469X 6.9 % X 12.00 ETB	34,336.00	3,580.40
Carcass	41,469X 19.9 % X 14.3 kg X 2.5 % X50.00 ETB	147,510.00	15,381.65
Sub total		216,680.00	22,594.37
Goats			
Lung	5,590 X 8.7 % X 8.00 ETB	3,891.00	405.74
Liver	5,590 X 6.3 % X 12.00 ETB	4,226.00	440.67
Carcass	5,590 X 16 % X 13.5 kg X 2.5 % X 50.00 ETB	15,093.00	1,573.83
Sub total		23,210.00	2,420.23
Grand total		10,923,601.00	1,139,061.63

One USD= 9.59 ETB, Source: National Bank of Ethiopia.

4.5. Public health significance

Results of the questioner survey, interviews made with physicians and analysis of available case records in Tikure Anbassa referral hospital of Medical Faculty of Addis Ababa University indicated that a total of 234 patients were suffered from hydatidosis during the last ten years, from Septembere1995 - August 2005 (Mesfin *et al.*, 2007) and (Hagos *et al.*, 2006). According to this study out of 234 patients, 145 (62 %) were from Rural and 89 (38 %) were from Urban parts of the country (Table 15). In the study of the total 234 patients, 123 (52.6 %) were males wheras 111 (47.7 %) were female. Hundred thirty-three (56.8 %) belong to the age spectrum of 21-30 years. The study also showed that 71 (49 %) were from Oromya regional state. sixty nine patients (29.5 %) had a long history of close contact with domestic animals, such as dogs and cats. In that study all of the 234 cases handled and treated by surgical treatments. The average estimated cost hospitalization in government hospitals was 700.00-1000.00 ETB, whereas in private hospitals it costs 3500.00-5000.00 ETB. All infected patients with hydatid cysts had no knowledge about the source of infection, its mode of transmission and means of prevention.

Table 16. Regional distribution of human hydatidosis in Ethiopia.

Region	Number of Patients (%)			
	Rural		Urban	
	No	%	No	%
Oromiya	71	30.3	24	10.3
SNNPR*	37	15.8	17	7.3
Amhara	28	12	17	7.3
Addis Ababa	0	0	26	11.1
Tigray	3	1.3	3	1.3
Somali	3	1.3	0	0
Afar	2	0.9	1	0.4
Diredawa	1	0.4	1	0.4
Total	145	62	89	38.1

Source: (Mesfin *et al.*, 2007). *SNNPR: South Nations, Nationalities and Peoples Region

5. DISCUSSION

The present study revealed that hydatidosis was highly prevalent among cattle, sheep, goats and pigs slaughtered at Addis Ababa abattoir. The high occurrence of infection in the intermediate hosts suggests the presence of environmental contamination with eggs of the adult tapeworm *E.granulosus* from final host like the dogs.

The high prevalence hydatid cyst recorded in this study (21 %, 19.9 %, 15.9 %, and 14 % in cattle, sheep, goats and pigs respectively) is in agreement with the previous work of Gemeda (1988), Woubiet (1987), Tekley *et al.* (1988), Bersissa (1994) and Fikre (1994) who conducted their studies in different parts of Ethiopia. In general, terms, worldwide, there is variation in the prevalence of hydatidosis in cattle with low, medium and high values of occurrences. In sheep and goats the findings of the present study is comparable to other previous studies. However, the present study is lower than the observations of Ernest (2004) who reported higher prevalence of 48 % in cattle, 63.8 % in sheep and 34.7 % of goats and in another study in Burdur in Turkey Umur (2003) reported a prevalence of 26.6 % in sheep and 22.1 % in goats. The prevalence in goats in the current study was slightly higher than the previous reports by Gemeda (1988), Jober *et al.* (1996) and Fikre (1990). The most probable reason is that most of the slaughtered goats in the current study were adults. It is a well-established fact that prevalence of hydatidosis increases as the age of animal increases (WHO/OIE, 2001). Another possible explanation could be due to the presence of variation of strains of *E.* granulosus in different geographical locations. Majority of the slaughtered animals were old as a result they were exposed to the disease causative agents over a longer period of time with an increased possibility of acquiring infection as has been described by Torgerson *et al.,* (1998).

The observation of lack of significant variation of prevalence of hydatid cyst in cattle from midland and lowland suggests that hydatidosis is widely distributed with high adaptability in different environments due to cultural and religious taboos that favor keeping the keeping of dogs in close association with the family and farm animals. In addition, the number of stray dogs as well as wild canids is very high and dogs are not dewormed at all, which is responsible

to best suit the maintenance and further propagation of hydatid disease in Ethiopia. Backyard slaughtering of ruminants is very common and few cattle are slaughtered in abattoirs. Most cattle and almost all small ruminants are killed in backyard and roadsides.

The wide spread tradition of offering uncooked infected offals to pet animals around homestead, poor public awareness about the disease, the absence of proper fencing and disposal pits for slaughter houses that allows easy access of dogs and other carnivores and the habit of disposing dead wield or domestic animals, unburied and left over for scavenging carnivores create favorable condition for environmental contamination by maintaining the life cycle of *E. granulosus* in stray dogs and wield carnivores.

In the present study it has been established that hydatid cysts occur predominantly in the lungs and liver in all examined animals. This is explained by the fact that lungs and livers possess the first great capillaries sites encountered by the migrating echinococcus oncosphere that adapt the portal vein rout before any other peripheral organ is involved. This finding is in like with the observations of other previous workers like Tekley *et al.* (1988), Mersie (1993), Jober *et al.* (1996) who obtained similar results in Ethiopia. Other works from abroad also indicated that lungs were found to be the most infected organ in cattle, buffalo and sheep (Pandey *et al.*, 1988). In the current study the prevalence of hydatid cysts recorded in pigs (14 %) was the first work in Ethiopia. Other reports from abroad northern Tanzania (Ngowi *et al.*, 2004) indicated 4.3 % prevalence of hydatidosis in slaughtered pigs. The highest prevalence rate in this study comparing with Tanzanian is that the slaughtered pigs of age in Tanzanian slaughtered pigs were in the interval of 6 month to 1 year, whereas in current study group of the slaughtered pigs age category was included between 1-3years and >3 years. In addition to this depends on production management, feeding behavior and close intimate with definitive hosts of domestic dogs.

In the present study higher fertility of cysts 81-90 % in sheep and 61-73 % in goats was most probably due to the old age of animals that favors great fertility of hydatid cysts and is in agreement with the findings of Jober *et al.* (1996) and Umur (2003). The fertility of cysts is an important factor that can influence the transmission of *E. granulosus*. In addition geographical

situations, the nature of infected hosts and the sites of infection, cysts may have different fertility rates.

In the current study the economic losses due to hydatidosis in animals slaughtered at Addis Ababa abattoir is strongly considerable and seriously affect wanting urgent control strategy. In this study, high economic loss was incurred due to hydatid disease with an estimated annual loss of ETB 10,683,711.00 that is equivalent to 1,114,047.03 USD and about 357.00 ETB (37.23 USD) is lost per every slaughtered cattle. Different amount of economic losses due to hydatidosis in cattle is reported from different parts of the country. For instance, among previous study reports 813,526.46 ETB at Debre ziet abattoir (Yilma, 1984), 90,644.95 ETB at Gonder abattoir (Roman, 1987), 77,587.02 ETB at Nekmet abattoir (Bersissa, 1994). Among several indirect effects of the disease, for instance the reduction in working capacity of oxen, are not included in this assessment. Polydorous (1981) reported losses due to hydatidosis reaching up to 10 % in milk yield, 5 % in meat production, 16 % in live weight gain, 40 % in wool harvest and 25 % in birth weight of calves from infected dams.

Hdatidosis in human is not uncommon in rural communities of Ethiopia, particularly in Oromiya and SNNP Regional states due to large number of livestock production in these regions. In addition to this shepherds and livestock owners have develop to adopt the habit on keeping of more number of domestic dogs for different purposes, such as for guards of different livestock animals, for homestead guard, for social taboos and these indicates that a probable possibilities of large population of domestic dogs in these two regions. Human infection with hydatidosis is confined to geographic areas in which there is intimate contact between humans and certain domestic dogs and some ungulates of food animals including cattle, sheep, goats, camels, buffalo and pigs (Schantz *et al.,* 1993). In Ethiopia, Fuller (1976) and Makuria (1995) have reported human hydatidosis is more common in Southern parts of Ethiopia. All infected patients with hydatid cysts had no knowledge about the source of infection, its mode of transmission and means of prevention. Therefore, it needs considerable attention to control the distribution of hydatid disease in both public health sectors as well in livestock production development in the country. Further, a community-based study is required to know the actual magnitude of hydatid disease of human in Ethiopia.

6. CONCLUSION AND RECOMENDATIONS

Hydatidosis is prevalent in cattle, sheep, goats and pigs with significant variation between the four species of food animals. The difference in prevalence is highly significant between young and aged. Aged cattle, sheep, goats and pigs being more infected. Male goats and pigs are more infected than female animals. The lung harbors more cysts than the liver in both large and small ruminants. More fertile cysts are found in different organs than sterile cysts. Hydatidosis incurs sever economic losses in the livestock and poses hazards in the public health sectors.

Based on the above conclusions the following recommendations are suggested:

- As the prevalence of hydatidosis in animals is relatively high, effective control measures need to be introduced to curb the direct and indirect economic losses.
- Animal identification system should be put in place and implemented to be able to trace back the origin of the animal so as to control the infection and to aware the livestock owner on the out come of meat inspection results and cooperates in the control of the disease.
- Stray dogs should be eliminated by strychnine poisoning or any suitable means and persons who own dogs should be advised to confine their dogs within their premises to reduce the rate of contamination of the pasture with the eggs of the parasite.
- The public should be made aware about the routs of infection, to maintain personal hygiene, especially to wash hands after handling dogs and their feces.
- Coordinated research should be conducted on hydatidosis to generate base line data that can be used to control the disease allover the country.

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8. ANNEXES

8.1. Dentations formula for sheep, goats, cattle and pigs

1. Dentation's formula to estimate the age of the goat (Mike steel, 1996)

Age group	Teeth condition
Kid under 1 year	Eight sharp incisors (no permanent teeth)
Yearling (1-2 years)	Central pair of baby teeth replaced by permanent once
Young adult (3-4 years)	4 permanent teeth
Adult (4-5 years)	8 permanent teeth
Older adult (> 5 years)	Worn teeth and some missing

2. Estimation of the age of sheep based on dentation's formula (Gatenby, 1991)

Age of sheep	Teeth condition
Less than 1 year and 3 months	None
1 year and 3 months up to (< 1 years and 10 months)	1 pair
1 year and 10 months up to < 2 years and 4 months	2 pairs
2 years and 4 months up to 3 years	3 pairs
More than 3 years	4 pairs

(3) Estimation of the age of cattle based on dentation's formula (FAO, 1994)

Age group	Teeth condition
Less than 2 years old	No permanent teeth
3 years old	4 permanent teeth
3 years 6 months	6 permanent teeth
4years	8 permanent teeth
old animals	over 4 years old

4. Estimation of the age of pigs based on dentation's formula (Merck 8th edition, 2000)

Age group	Teeth condition
1 year old	Eruption of 1 incisor
16- 20 months	Eruption of 2 incisor
12- 15 months	Eruption of 3-4 premolars
8-12 months	Eruption of 2 molars
12 – 18 months	Eruption of 3 molars

8.2. Recording sheet for abattoir survey of cattle, sheep, goats and pigs

Animal type: cattle

Date----------

Animal Code (ID) No	Breed	Origin	Sex	Age in years in examined cattle				Examined organs					Type of examined cysts			
													Fertile		Ster	Cal
				< 2	2-4	4-6	>6	Liv	Lug	H	Kid	Spl	Vi	Non vi		

Key: ID- animal Identification Number, Vc- Viable Cyst, Cal - Calcified Cyst, Liv- Liver, Lug- Lung, H- Heart, Kid- Kidney, Spl- Spleen, Non vi -None viable, Ster- Sterile

Animal type: sheep

Date----------

Animal Code (ID) No	Breed	Origin	Sex	Age in years in examined Sheep				Examined organs					Type of examined cysts			
													Fertile		Ster	Cal
				< 1	1-2	2-3	>3	Liv	Lug	H	Kid	Spl	Vc	Non vi		

Key: ID- Animal Identification Number, Vc- Viable Cyst, Cal - Calcified Cyst, Liv- Liver, Lug- Lung, H- Heart, Kid- Kidney, Spl- Spleen, Non vi -None viable, Ster- Sterile

Animal type: goats

Date----------

Animal Code (ID) No	Breed	Origin	Sex	Age in years in examined goats				Examined organs					Type of examined cysts			
													Fertile		Ster	Cal
				<1	1-2	2-3	>3	Liv	Lug	H	Kid	Spl	Vc	Non vi		

Key: ID- Animal Identification Number, Vc- Viable Cyst, Cal – Calcified Cyst, Liv- Liver, Lug- Lung, H- Heart, Kid- Kidney, Spl- Spleen, Non vi– None viable, Ster- Sterile

Animal type: pigs

Date----------

Animal Code (ID) No	Breed	Origin	Sex	Age in years in examined pigs				Examined organs					Fertile		Ster	Cal
				< 1	1-2	2-3	>3	Liv	Lug	H	Kid	Spl	Vc	Non vi		

Key: ID- Animal Identification Number, Vc- Viable Cyst, Cal - Calcified Cyst, Liv- Liver, Lug- Lung, H- Heart, Kid- Kidney, Spl- Spleen, Non vi – none viable, Ster- Sterile

8.3. Questioner survey format sheet for economic loss study

For data collection on the current prices of meat market for liver, lung, kidney, heart and carcass of cattle, sheep, goats and pigs in Addis Ababa city to estimate economic losses due to hydatidosis.

Date ----------

1. Type of the enterprise: (abattoir, butcher, hotel, supermarket, other) please underline the relevant one.

2. Name of the enterprise ----------

3. address: sub city ---------- kebele ---------- house number ----------

4. When did the enterprise established? ----------

5. What are the reasons to run the enterprise? To sell raw meat, to sell raw meat and edible organs, to sell processed meat products, to sell products of prepared (cooked) foods items. To sell meat and meat by products. Please underline the relevant one.

6. From where did you bought the slaughtered animals for the previous five years? From local market of Addis Ababa city, from countryside, from pastoralist area, please underline the relevant one.

7. Where would you slaughter your purchased animals for meat enterprise? At private abattoirs or municipality abattoir; at backyard-slaughter slab; both at the private and municipality abattoirs. (Please underline your practical accessibility).

8. If you use backyard slaughter, who will undertake the meat inspection? Government meat inspectors; licensed meat inspectors; traditional animal killer; with out meat inspection. (Please underline your practical accessibility).

9. If you under take the backyard slaughter how do you dispose the infected organs like: lung, liver, heart, kidney, spleen, and other offal's? By burring; burning; sale to meat by product processing industries; simply threw away to dogs and scavengers. (Underline your practical accessibility).

10. If you are using the edible offal's (liver, lung, kidney and heart) at home, in which form do you youth them? raw offal's ---------- cooked offal's ---------- other --------

11. Do you know that hydatid disease is transmitted to dogs through ingestion raw offal's which are infected with hydatidosis? yes ---------- No ----------

12. If yes, what measures should be undertaken? Feed the dogs only cooked offal's and meat; protect the dogs from feeding raw offal's and meat; I have no any information what to do (Please underline your practical accessibility).

13. Who are the costumers for purchasing the offal's from your enterprise? Dogs owners and pet animals owners; home consumers; food processors, I have no information. (Underline your practical accessibility).

14. In your enterprise, the current price of one kilogram of cattle liver will be how much? ---------- Birr. Or the price of whole liver of one cattle would be how much? ---------- Birr.

15. In your enterprise, the current price of one kilogram of cattle lung will be how much? ---------- Birr. Or the price of whole lung both left and right of one cattle would be how much? ---------- Birr.

16. In your enterprise, the current price of one kilogram of cattle heart will be how much? ---------- Birr. Or the price of whole heart of one cattle would be how much? ---------- Birr.

17. In your enterprise, the current price of one kilogram of cattle kidney will be how much? ---------- Birr. Or the price of whole kidney of one cattle would be how much? ---------- Birr.

18. In your enterprise the current price of one kilogram of sheep or goats liver will be how much? ---------- Birr. Or the price of whole liver of one sheep or goats would be how much? ---------- Birr.

19. In your enterprise the current price of one kilogram of sheep or goats lung will be how much? ---------- Birr. Or the price of whole lung both left and right of one sheep or goats would be how much? ---------- Birr.

20. In your enterprise, the current price of one kilogram of sheep or goats heart will be how much? ---------- Birr. Or the price of whole heart of one sheep or goats would be how much? ---------- Birr.

21. In your enterprise the current price of one kilogram of sheep or goats kidney will be how much? ---------- Birr. On the other hand, the price of whole kidney of one sheep or goats would be how much? ---------- Birr.

22. In your enterprise, the current price of one kilogram of pig's liver will be how much? ---------- Birr. On the other hand, the price of whole liver of one pig would be how much? ----- Birr.

23. In your enterprise, the current price of one kilogram of pigs' lung will be how much? ---------- Birr. Or the price of whole lung both left and right of one pig would be how much? ---------- Birr.

24. In your enterprise, the current price of one kilogram of pigs' heart will be how much? ---------- Birr. On the other hand, the price of whole heart of one cattle would be how much? ---------- Birr.

25. In your enterprise, the current price of one kilogram of pigs' kidney will be how much? ---- Birr. On the other hand, the price of whole kidney of one pig would be how much? --------- Birr.

8.4. Questioner survey format sheet for public health study

For data collection on the current situation of hydatidosis in human health encountered in Addis Ababa city hospitals and health centers.

Date ----------

1. General information

Name of the health institution / Hospital: ----------

1. What are the commonly occurring zoonotic types of parasitic diseases? ----------
---

1.1. Do you know that hydatidosis can be transmitted to human through ingestion of raw or poorly cooked meat? Yes --------- no ----------

1.2. If yes which types of meat? Through ingestion of raw edible offal/ through ingestion of raw or poorly cooked carcass/, I have no information. (Please under line the relevant suggestion.)

1.3. Do you know any disease, which is transmitted through contact with dogs or with contamination of dogs fecal? Yes ---------- No ----------

1.4. If yes, describe the main once. ----------

1.5. Have you ever met a client (patient) with clinical symptom of hydatidosis? Yes --- No ---

1.6. If yes on which age groups it would be commonly occurred. ----------
---

1.7. In which sex groups the disease mostly occurred. Female/ male (please under line the relevant one).

1.8. If variation in sex in acquiring the disease what are the reasons----------
---

1.9. If you encounter with the case of hydatidosis which organs of human mostly affected. -----
---
---

2. on hydatidosis

2.1. Do you know that hydatidosis can be transmitted to human through ingestion of raw or poorly cooked meat? Yes --------- no ----------

2.2 .If yes which types of meat? Through ingestion of raw edible offal/ through ingestion of raw or poorly cooked carcass/, I have no information. (Please under line the relevant suggestion.)

2.2. Do you know any disease, which is transmitted through contact with dogs or with contamination of dogs fecal? Yes ---------- No ----------

2.3. If yes, describe the main once. ----------

2.4. Have you ever met a client (patient) with clinical symptom of hydatidosis? Yes / No

2.5. If yes on which age groups it would be commonly occurred. ----------

---

2.6. In which sex groups the disease mostly occurred. Female/ male (please under line the relevant one).

2.7. If variation in sex in acquiring the disease what are the reasons----------

---

2.8. If you encounter with the case of hydatidosis which organs of human mostly affected. ----------

---

2.9. Which type of treatment will be undertaken for hydatidosis in your health care institution / hospital? ----------

2.10. Do you think your clients (patients) know about the disease of hydatidosis? Yes ---------- No ----------

2.11. If no what is the reason based on your professional experiences. ----------

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2.12. How many clients (patients) surgically treated in your hospital for the last 5-10 years? ----------

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2.13. The average estimated cost for surgical treatment of hydatidosis per person would be how much? ----------

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3. What are your suggestions to be under taken for the control measures of hydatidosis? -------

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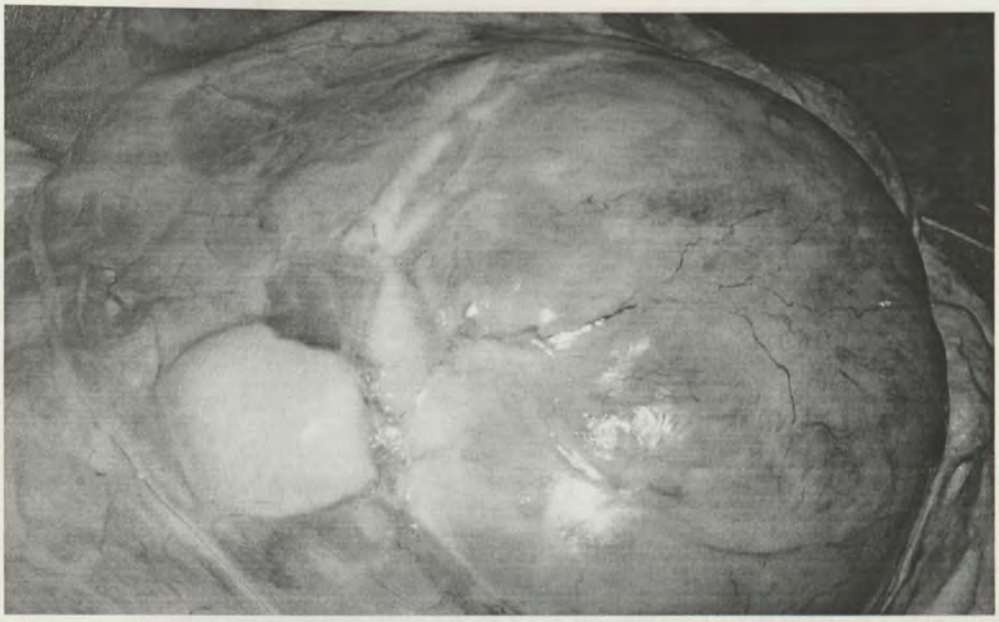

Figure 1. Hydatid cyst lesion from cattle lung measured 12 cm diameter.

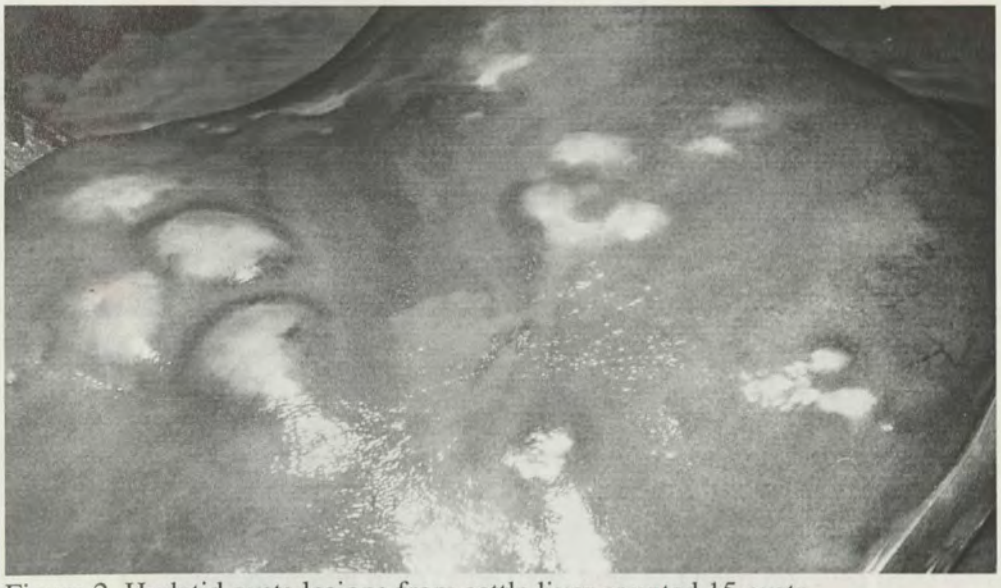

Figure 2. Hydatid cysts lesions from cattle liver counted 15 cysts.

Figure 3. Hydatid cyst lesion from cattle liver measured 15 cm diameter slaughtered at Addis Ababa abattoir.

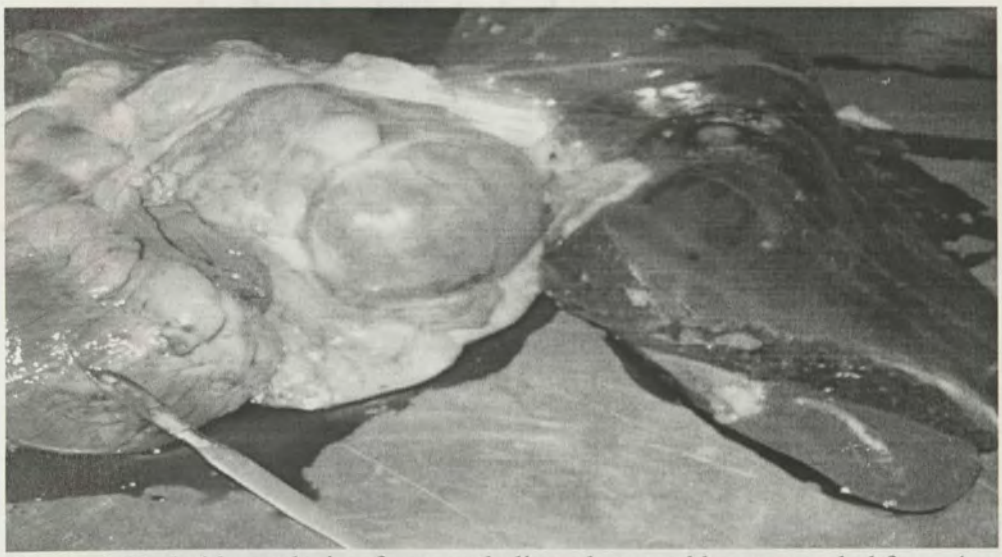

Figure 4. Hydatid cyst lesion from cattle liver, lung and heart revealed from 4-year age Borana cattle.

Figure 5. Hydatid cyst lesion from lung of cattle measured 15cm diameter and 125-milliliter liquid content slaughtered at Addis Ababa abattoir.

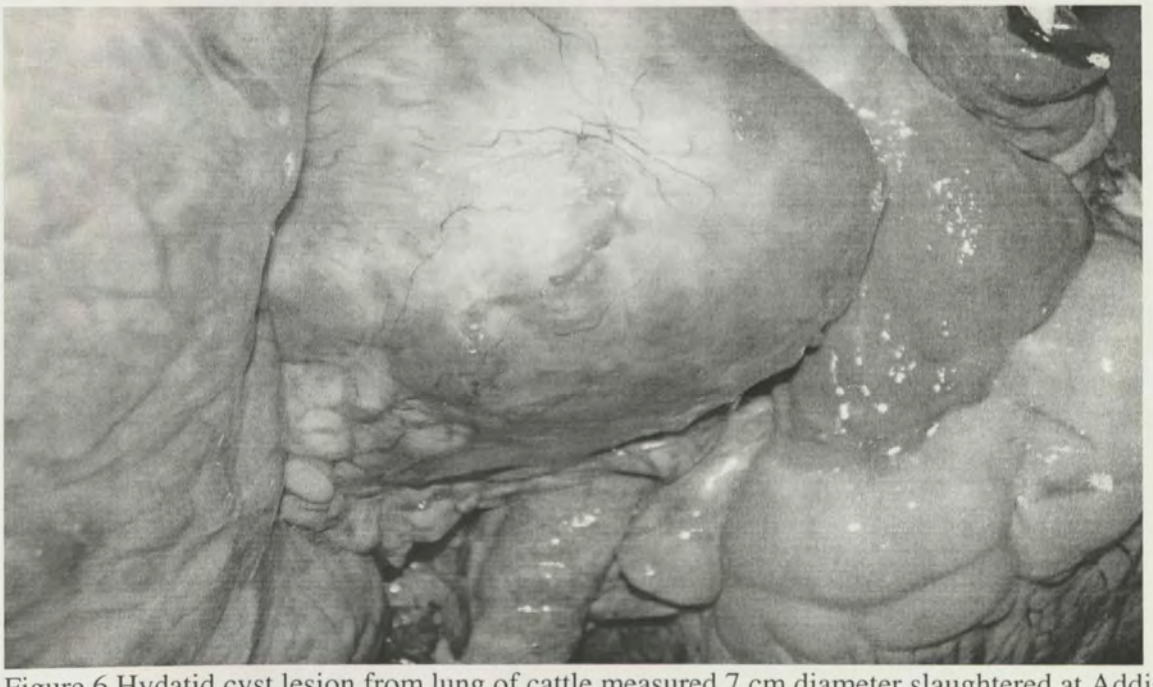

Figure 6.Hydatid cyst lesion from lung of cattle measured 7 cm diameter slaughtered at Addis Ababa abattoir.

Figure 7. Hydatid cysts lesion from kidney of sheep measured 2 cm diameter slaughtered at Addis Ababa industrial abattoir.

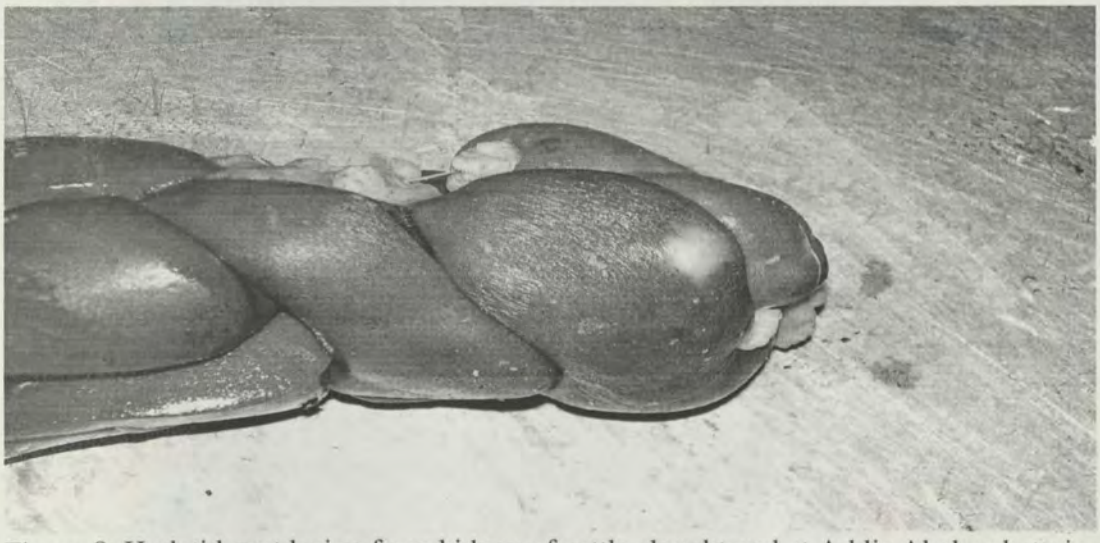

Figure 8. Hydatid cyst lesion from kidney of cattle slaughtered at Addis Ababa abattoir.

Figure 9. Hydatid cysts lesion from heart of cattle slaughtered at Addis Ababa abattoir.

Figure 10. Hydatid cysts lesion from liver and lung of pig slaughtered at Addis Ababa abattoir.

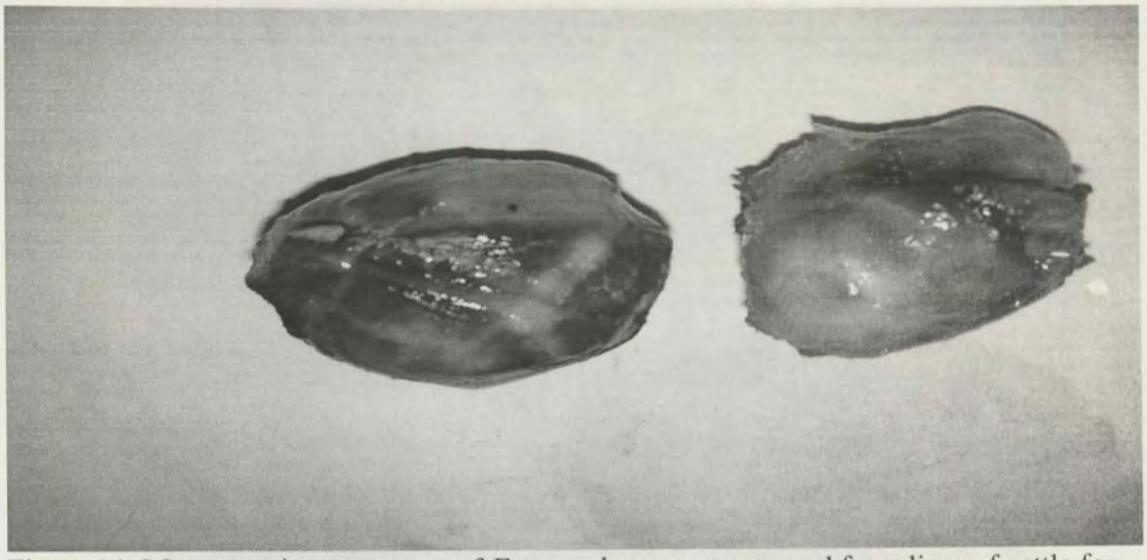

Figure 11. Macroscopic appearance of *E. granulosus* cyst removed from liver of cattle for fertility study, slaughtered at Addis Ababa abattoir.

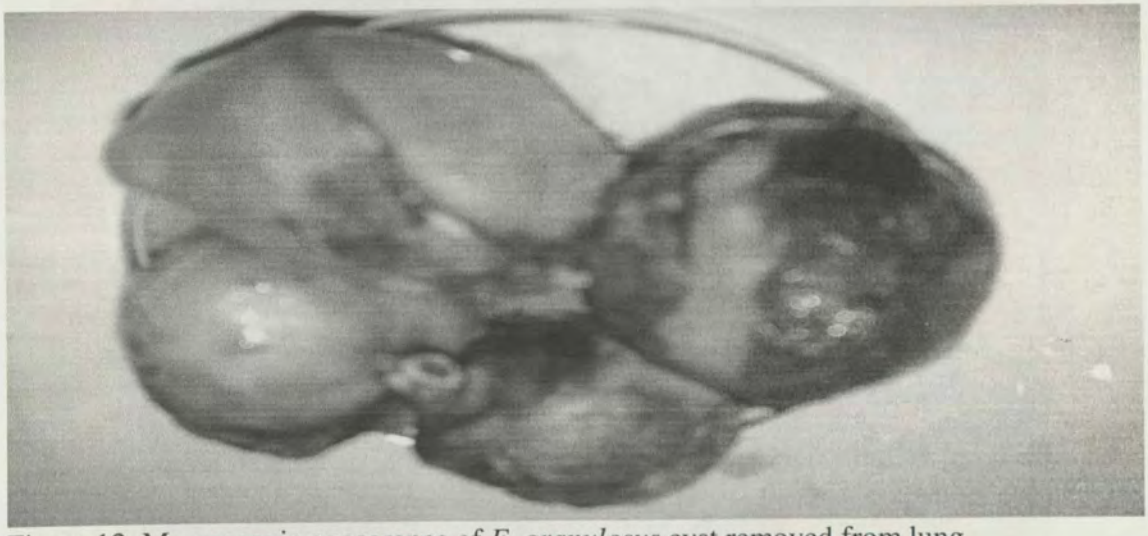

Figure 12. Macroscopic appearance of *E. granulosus* cyst removed from lung of cattle for fertility study, slaughtered at Addis Ababa abattoir

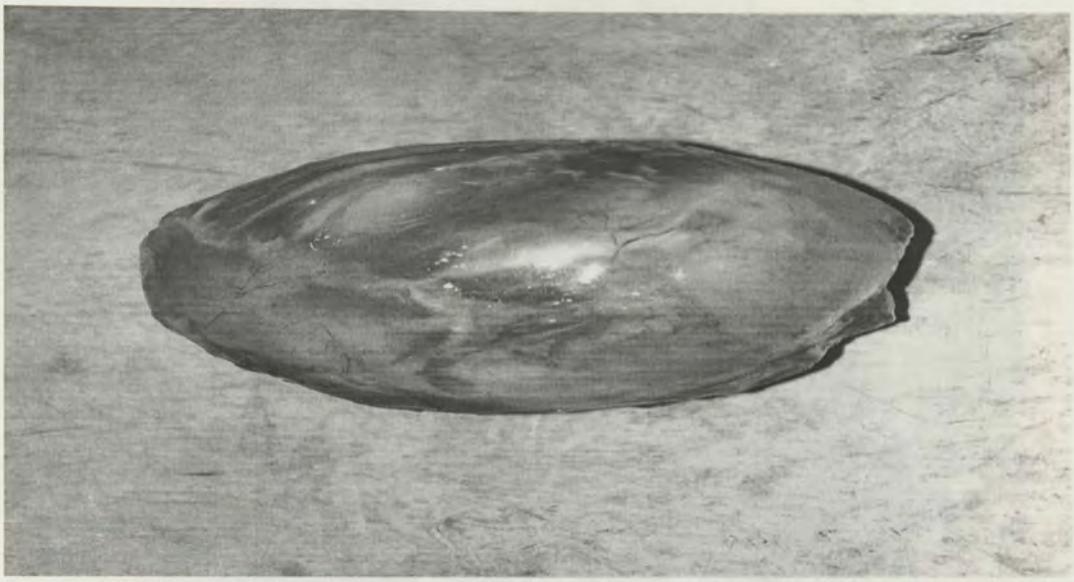

Figure 13. Macroscopic appearance of *E. granulosus* cyst removed from lung of cattle for fertility study, measured diameter of 12 cm, slaughtered at Addis Ababa abattoir.

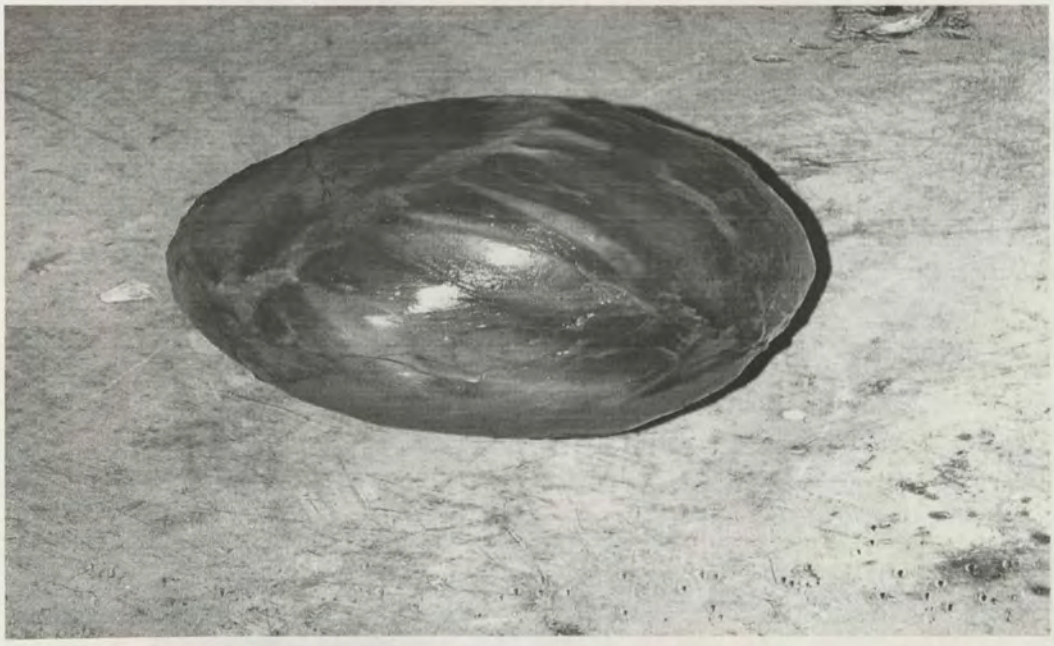

Figure14. Macroscopic appearance of *E. granulosus* cyst removed from lung of cattle for fertility study, measured diameter of 10 cm, slaughtered at Addis Ababa abattoir.

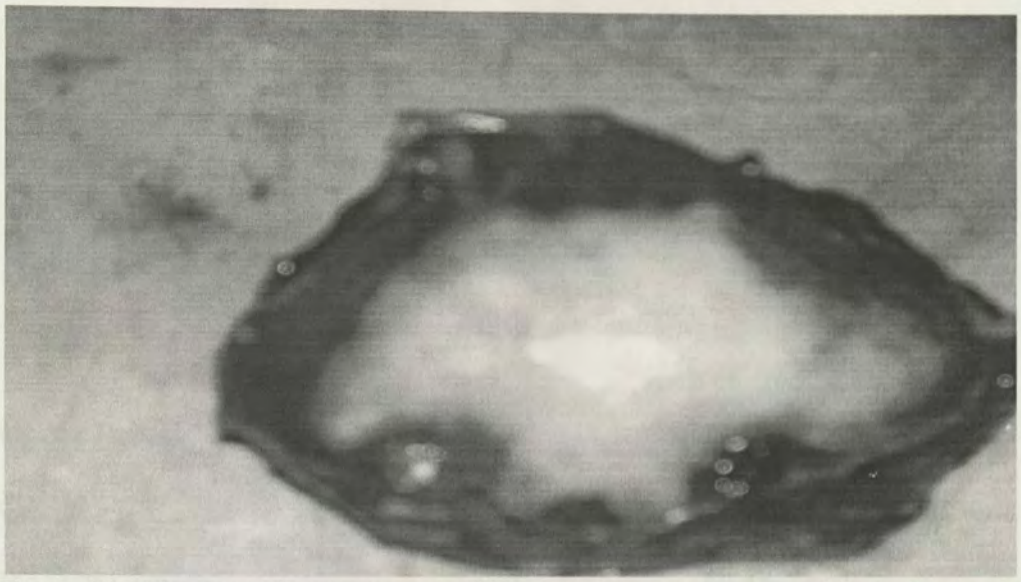

Figure 15. Macroscopic appearance of *E. granulosus* cyst removed from liver of cattle for fertility study, measured diameter of 8cm, slaughtered at Addis Ababa abattoir.

Figure 16. Macroscopic appearance of *E. granulosus* cyst removed from liver of cattle for fertility study, measured diameter of 10cm, slaughtered at Addis Ababa abattoir.

9. SIGNED DECLARATION SHHET

"This thesis is my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged".

Signature

Kebebe Erbeto

Advisor

Dr Girma Zewde