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ZOONOTIC IMPORTANCE OF HYDATIDOSIS IN CATTLE AND HUMANS IN SELECTED AREAS OF TIGRAY REGIONAL STATE

MSc Thesis

By

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A thesis submitted to the school of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the Degree of Master of Veterinary Science in Tropical Veterinary Public Health.

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1. INTRODUCTION

The world human population is growing at a rate much faster than food production the human population may reach 7.2 billion at the end of 2010. The increase will be mainly in developing countries, which are unable to assure adequate food for their people. Developing countries have nearly 2/3 of the world's livestock population, but produce less than a third of the world's meat and a fifth of its milk (ILRI/FAO, 1995). To feed their people developing countries need to intensify their livestock population production system. However, diseases such as tuberculosis, mastitis, echinococcosis and other internal parasites etc have hindered intensification.

Echinococcosis is one of the most important diseases not only due to its effect on animal production but also due to its public health significance. It is associated with severe morbidity and disability, and is one of the world's most geographically widespread zoonotic diseases. Hydatid cysts are endemic in farming regions of Mediterranean, Eastern Europe, Middle East, South America, Australia and South Africa. In Western Europe and the United States, it is extremely rare, because of the effective control measures applied; the disease has practically disappeared from most of the developed countries, remaining an increasingly serious problem of the developing world. *E. Granulosus* has been eradicated in Iceland, and the last human case of cystic echinococcosis was diagnosed in 1960. The parasite has never been recorded in Greenland (Craig *et al*., 2007; Cringoli *et al*., 2007).

Previous studies have shown that cystic echinococcosis in humans represented a considerable public health problem in the Russian Federation and the adjacent independent states. At present, it is difficult to obtain current information from this area as research and surveillance activities in this field have been greatly reduced since 1990.

Genus *Echinococcus* which belongs to the class cestoda, order cyclophillidea, family taeniidae, and species *Echinococcus granulosus* is important in ruminants and non-ruminants including man in Ethiopia (Soulsby, 1986).

In Tigray region total cattle population is estimated to be more than 3 millions. One of the major parasitic as well as zoonotic diseases prevailing in the region is echinococcosis /hydatidosis occurring both in domestic animals causing huge organ loses due to condemnation and humans. Therefore, knowledge of the epidemiology and extent of zoonosis both in human and domestic and wild animal population by the different species of *Echinococcus* would be of prime importance in targeting an effective control scheme in the country. In light with the above information and more specifically in order to address the prevalence, public health importance and control measures against echinococcosis /hydatidosis the present study was initiated and designed to be carried out in Tigray Regional State.

Hence, the objectives of this study include:

- Determine the prevalence, extent and distribution of hydatidosis in cattle in all six zones of Tigray Regional State.
- Estimate the economic losses incurred by hydatidosis.
- Determine the proportion of fertile, sterile and viable cysts as well as the sizes of hydatid cysts.
- Investigate the occurrence and current status of hydatidosis among human population in selected zonal hospitals of Tigray Regional State.

2. LITERATURE REVIEW

2.1. ETIOLOGY

2.1.1 Taxonomy of Echinococcosis

Echinococcosis is a zoonotic infection caused by adult or larval (metacestode) stages of cestode belonging to the *genus Echinococcus* and the family Taeniidae. At present four species of *Echinococcus* are recognized, namely: *Echinococcus granulosus, Echinococcus multilocularis, E. oligarthrus and E. vogeli.* The parasites are perpetuated in life cycles with carnivores as definitive hosts, which harbour the adult with egg producing stage in the intestine and intermediate host animals, in which the infective metacestode stage develops after per oral infection with eggs (Seimenis, 2003). Metacestodes may incidentally also develop in human causing various forms of *Echinococcus* such as: (Soulsby, 1986).

1. Cystic echinococcosis (causative agent of *Echinococcus granulosus*.).
2. Alveolar echinococcosis (causative agent of *Echinococcus multilocularis*).
3. Polycystic echinococcosis (causative agent of *Echinococcus vogeli*).
4. Polycystic echinococcosis (causative agent of *Echinococcus oligarthrus*).

Table1: Different forms of echinococcosis in animals.

Stage of *Echinococcus species*	Form of echinococcosis	Animal hosts involved
Adult and immature stage of *Echinococcus spp*	Intestinal echinococcosis	Exclusively definitive hosts (dog)
Metacestode stage (*Echinococcus Granulosus*)	Cystic echinococcosis	Intermediate and aberrant hosts rarely definitive hosts
Metacestode stage (*Echinococcus Multilocularis*)	Alveolar echinococcosis	Intermediate and aberrant hosts rarely definitive hosts
Echinococcus Vogeli	Polycystic echinococcosis	Intermediate hosts
Echinococcus Oligarthrus	Polycystic echinococcosis	Intermediate hosts

Source: (WHO/OIE, 2002).

2.1.2. General morphology

An adult *Echinococcus* is only a few millimeters long (rarely more than 7 mm) and usually has no more than six segments whereas species of *Taenia* can grow to several meters in length and consist of several thousand segments. Like all tapeworms, *Echinococcus* has no gut and metabolic interchange takes place across the syncytial outer covering the tegument (Soulsby, 1982). Interiorly an adult *Echinococcus* possesses a specialized attachment organ, the scolex that has four muscular suckers and two rows of hooks, one large and one small on the rostellum. The body or strobila is segmented and consists of a number of reproductive units (proglottids), which may vary, in number from two to six (Bowman *et al.,* 1999). 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 girrus sac, which may be horizontal or tilted interiorly and the vitellarium is globular. The uterus dilates after fertilization eventually occurring most of the terminal segment when the eggs are fully developed (Chandler *et al.*, 1961).

The Eggs are ovoid (30 µm – 40 µm diameter) consisting of hexacanth embryo (oncosphere - first larval stage) surrounded by several envelops, the most noticeable one being the highly resistant keratinised empryophose, which gives the egg a dark striated appearance. The outer capsule quickly disappears once the eggs are liberated from the host. The eggs of *Echinococcus* are morphologically indistinguishable from those of other tapeworms of the genus Tania (Charles, 1998).

The metacestode (second larval stage) consists of a bladder with an outer acellular laminated layer and an inner nucleated germinal layer, which may give rise by asexual budding to brood capsules. Protoscoleces arise from the inner wall of the brood capsules. The structure and development of the metacestode differs between the four species of *Echinococcus* (Charles, 1998).

2.1.3. General life cycles

Echinococcus spp require two mammalian hosts for completion of their life cycle (McManus, 2006). Segments containing eggs (gravid proglottids) or free eggs are passed in the faeces of the definitive host, a carnivore then; the eggs are ingested by an intermediate host in which the metacestode stage and protoscolices develop. The life cycle is completed if such an intermediate host is eaten by a suitable carnivore (Chandler *et al.,* 1961).Figure (1) illustrates the life cycle of Echinococcus granulosus.

Infection of wild or domestic mammals by swallowing an egg of the E.granulosus

(Tape worm of carnivores)

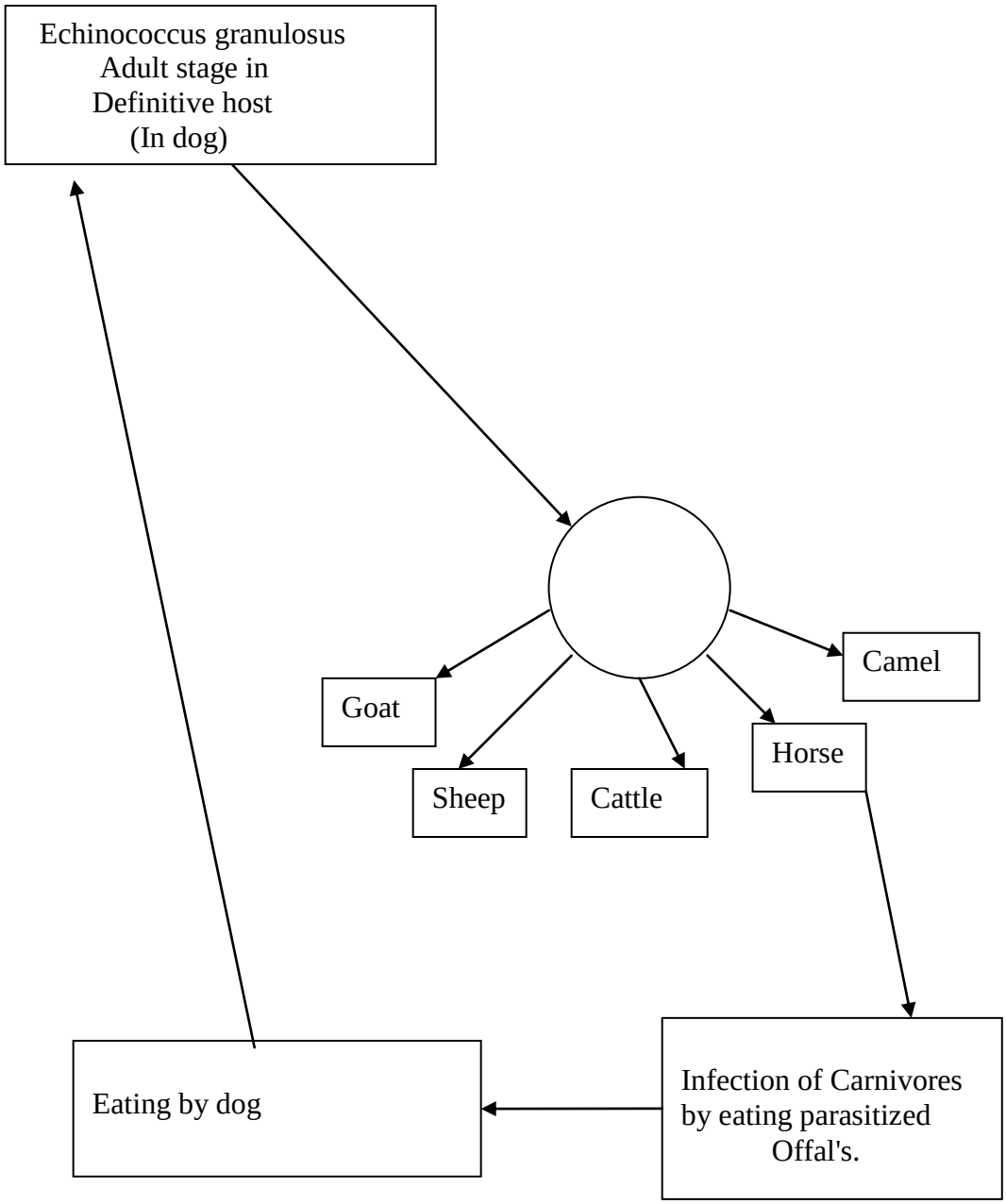


Figure 1: Larval Echinococcosis, life cycle.

Source: (Fisher, 1989).

2.1.4. Eggs in the environment

Eggs are highly resistant to environmental influences and can remain infective for many months or up to about 1 year in a moist environment at lower ranges of temperatures (4 to 15 ^{o}C). Eggs of *Echinococcus* are sensitive to desiccation. At a relative humidity of 25 %, eggs of *E. granulosus* were killed with in 4 days and at 0 % with in 1 day. Heating to 60 ^{o}C - 80 ^{o}C killed eggs of *Echinococcus granulosus* in less than 5 minutes. On the other hand, *Echinococcus* eggs can survive at freezing temperature (Reinecke, 1989).

2.1.5. Intermediate and aberrant (accidental) hosts

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 oncosphere is released from the keratinised embryophose (Bowman *et al.,* 1999). Bile assists in activating the oncosphere, which penetrates the wall of the small intestine. Penetration is then aided by the hook movements, and possibly by secretion, of the oncosphere. The oncosphere is passively transported to the liver, lungs and a few may be transported further to the kidneys, spleen, muscles, brain or other organs. All mammals (including man) in which metacestodes of *Echinococcus* species develop after infection with eggs are being referred to as intermediate hosts (Azizi *et al.,* 2000). From the epidemiological point of view, it might be useful to differentiate between intermediate hosts, which play a role in the perpetuation of the cycle, and aberrant or accidental hosts which represent " blind alley " for the parasite as the latter are not involved in disease transmission. This may be because metacestode stages do not become fertile in these hosts or because such hosts do not interact in the transmission cycle. With a few rare exceptions, humans belong to the group as " aberrant hosts " (Smith, 1994).

2.1.6. The metacestode stage

Once the oncosphere has reached its final location it develops into the metacestode stage it may take several months before protoscolices are produced (fertile metacestode).

There may be several thousand protoscolices with in a single cyst of *Echinococcus granulosus* or an aggregation of vesicles of *Echinococcus multilocularis (*Grant and McManus, 2003; Eckert and Deplazes, 2004; Parija, 2004). Each single protoscolex is capable of developing mature adult worm. Not all metacestodes produce protoscolices (sterile metacestode). When protoscolices are ingested by a suitable definitive host, following 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. They then develop to the sexually mature adult tapeworm approximately four to six weeks after infection, depending on the species and strain, and on the susceptibility of the host (Chandler *et al.,* 1961).

2.2. Epidemiology

2.2.1. Geographical distribution and prevalence

Due to the lack of representation in all documented data from many countries, it can only provide an incomplete and preliminary picture of the present geographic distribution of Echinococcosis and hence the epidemiological public health problem is numerous countries. From several regions, there are alarming indications of increasing human health risks caused by Echinococcosis. These facts should be reasons for health authorities to establish internationally coordinated systems of surveillance and risk assessment and to improve and support measures for control and presentation (Smith, 1994).

2.2.2. *Echinococcus granulosus*

Echinococcus granulosus has a worldwide geographic distribution and occurs in all continents. High parasite prevalence is found in parts of Mediterranean region, Russian Federation and adjacent independent states, the People's Republic of china, Africa (Northern and Eastern region), Australia and South America (Raush, 1995; Andersen *et al*., 1997; Dalimi *et al*., 2002; Jenkins *et al*., 2005).

In some European countries or regions, the annual incidence rates of hospital cases of human cystic Echinococcosis (CE) vary between 1.0 and 8.0 per 100,000 populations in 1990, but up to 42 per 100,000 in one of the countries (WHO/OIE, 2002). High incidence rates or prevalence's have also been recorded from countries in Northern and Eastern Africa (prevalence up to > 3 %) and South America (Uruguay annual incidence of 6.5 % per 100,000 population in 1997). The occurrence of *Echinococcus granulosus* is sporadic or has not been reported from other regions, including countries in Northern and Central Europe, in the pacific Region, and in the Caribbean (Urquhart *et al*., 1996).The prevalence rate of hydatidosis in Ethiopia is summarized in (table3).

2.2.3. *Echinococcus multilocularis*

Echinococcus multilocularis is distributed in the Northern hemisphere, including endemic regions in central Europe, most of northern and Central Asia, parts of North America and possibly an isolated focus in northern Africa (Tunisia). *Echinococcus Multilocularis* in red foxes varies from < 1 % to > 60 % presently (WHO/ OIE, 2002).

Human cases of Alveolar Echinococcosis (AE) were recorded in recent years from seven central European countries (0.02 % - 1.4 % cases per 100,000 population). Up to May 1999, more than 400 live Alveolar Echinococcosis patients from six countries were registered in an ongoing pilot study, most of them from France, Switzerland, Germany and Australia. In the Mediterranean region, human cases of Alveolar Echinococcosis are recorded from Turkey and Iran (Raush 1995; Andersen et al., 1997; Eckert and Deplazes, 2004). *Echinococcus Multilocularis* is endemic in large of the Russian Federation and adjacent countries (Belarus, the Ukraine, Moldova, Georgia etc) *Echinococcus multilocularis* is mainly distributed in the western and central parts.

2.2.4. *Echinococcus vogeli* and *Echinococcus oligarthrus*

The causative agents of human Polycystic Echinococcosis (PE) are endemic in central and South American countries. To date at least 96 human cases of polycystic Echinococcosis have been diagnosed in an area stretching from Nicaragua in the north to Chile, Argentina and Uruguay in the south, but it is assumed that the real extent of the disease is not yet fully assessed (Khuroo, 2002).

Table 2: Prevalence of *Echinococcus granulosus* in sub Saharan African countries.

Country	Period	Animal species	Number of animal examined/ infected	Percentage infected range
Mauritania	1995	Dog	-	Low rate
	-	Camel		4- 60
Nigeria	1988	Pig	360/12	3.3
	1990-1993	Camel	24,531/501	2.0
Sudan	1992-1996	Camel	400/159	4.3 -8.2 / year
Ethiopia	1996	Dog	110/-	14.5
	1996	Cattle	2717/-	24/--46
		Sheep	6301/-	2-26
Zambia	1984-85	Cattle	482/69	14.3

Source: (WHO/ OIE, 2002).

Table3: Summary of works so far conducted on ruminant hydatidosis / echinococcosis in Ethiopia.

Author(s) and year	Study area	Reported prevalence rates
Abel, M. (1985)	Welaita Sodo	33.35 % on cattle and 31.5 % Echinococcosis in dogs
Alemayehu, L. (1990)	Arsi Region	54.8 % on cattle, 2.18 % on sheep, 0 % on goats and 54.84% Echinococcus in dogs.
Getachew, J. (1991)	Awassa	34.3 % on cattle and 0 % Echinococcosis in dogs.
Mohammed, A (1988).	Gamugofa Region	25.88 % on cattle and 33.33 % Echinococcosis in dogs.
Roman, T. (1987)	Gondar	24.3 % on cattle and 24 % Echinococcosis in dogs.
Solomon, H. (1975)	official abattoirs statistics of Ethiopia	Pulmonary Hydatidosis.
Tamene, M. (1980)	Gondar	Incidence ranging from 33.78 % on cattle, 8.07 % on sheep and 4.64 % on Goats.
Yilma, J. *et al.*, (1996)	Gonder,Dere zeit,south Omo	24.3 %, 46.5 % and 25.7 % prevalence of bovine hydatidosis.and 65 (25.7 %) in sheep, 36 (9.3 %) in Goat in south Omo and 5(1.74 %) in Goat, 7 (2.45 %) in Sheep in Debre zeit.
Fikre, L. (1994)	Konso	Cattle 115(25.7 %) , Sheep 65 (18.8 %), Goat 36(9.3 %)
Yilma, J. (1985)	Debre Zeit	46.5 % , 12.46 % and 1.7 % in Cattle ,Sheep and Goat and 0 % in Dogs

The parasite population consists of three subpopulations: These are adults in the definitive host, larvae (metacestodes) in the intermediate host and eggs in the environment (Eckert and Deplazes, 2004; Radfar and Iranyar, 2004). The first step in understanding the transmission dynamics and problems of control of any members of this family is to determine the contribution made by the parasite and each host population to its stability. The second step must be to evaluate the role of intrinsic, and extrinsic and socio-economic factors in modifying this stability.

The third step involves quantifying the equilibrium steady state of the whole system in each socio-ecological situation (Urquhart *et al.,* 1996). *Echinococcus granulosus* has an over dispersed distribution that fits a series of negative binomial distributions in both hosts, with only a small number of animals harboring large numbers of worms or larvae. There is neither a "crowding" effect nor parasite induced host mortality, and this distribution does not contribute to the regulation of either adult or larval sub-populations.

The prepatent period is similar for all 3 species, potency being reached in dogs between 6 and 12 weeks. The larvae of *Echinococcus granulosus* grow slowly in sheep with only 50 % reaching fertility by 6.65 years. The parasite's major contribution to the transmission dynamics is its biotic potential. The generally reported mean worm burden for *Echinococcus granulosus* in its dog - sheep life cycle is about 200 - 400 (Charles, 1998). However, with such highly susceptible animals as Turkana dogs in Kenya and diagnosis in Australia, very high worm counts may be present in the majority of animals. With *Echinococcus multilocularis,* the time required to reach patency is about 28 days and the time taken to reach fertility in some rodents may be only 60 days. There are also large variations is worm burdens of *Echinococcus multilocularis*. For example, that in arctic foxes (*Alopex lagpus*) in Alaska is two orders of magnitude greater than that in the red fox (*Vulpes vulpes*) in Dakota (Soulsby, 1982).

2.3. Echinococcus in intermediate and aberrant hosts (biological aspects)

2.3.1. Biological aspects

Cysts of *Echinococcus granulosus* have been found in numerous animal species (intermediate and aberrant hosts), belonging to various groups, including Bovidae, Cervidae, Suidae, Equidae, Camelidae, Giraffidae, Elephantidae, Hippopotamidae, Leporidae primate marsupials, rarely, dogs and cats have been identified as hosts for the metacestode stage of *Echinococcus granulosus* (WHO/OIE, 2002).

2.3.2. Clinical aspects

Hydatid cysts grow slowly, usually takes several years to develop to a size where they may cause disease and symptoms in animals. Fertile cysts may occur with in about 6 months in mice, 10 - 12 months in pigs, but about 2 - 4 years in sheep (but only 50 % of *Echinococcus granulosus* cysts are fertile by 6.65 years). Cysts are rarely fertile in cattle in most countries, except where the cattle strain is present (WHO/OIE, 2002).

The life span of cysts of *Echinococcus granulosus* can be very long, for example 16 years in horses and 53 years in man. Hydatid cysts frequently localize in the liver and lungs (Soulsby, 1982). However, they can also develop in other internal organs including the central nervous system, the skeletal muscles and in the marrow cavity of bones. The cysts of *Echinococcus granulosus* vary greatly in size and shape (typically unilocular, but some times multilobed or multilocular) and may be present in large numbers in one or several organs (Thompson, 1979).

2.3.3. Clinical effects

The clinical effects of hydatidosis disease in intermediate hosts have been reviewed in detail by (Kaufmann, 1996). It is well known that the infection of animals with cysts of *Echinococcus granulosus* may be asymptomatic during the whole life span of the hosts.

On the other hand, it has been postulated that symptoms experienced by humans infected with hydatid cysts may also occur to some degree in infected animals. However, such symptoms may be over looked, especially in the flock or herd situation. The development of pathological changes is related to various factors, such as the organs involved, the intra organ site and size of the cysts, the cysts number and their interaction with adjacent structures, particularly with bile ducts, the vascular system, and the bronchial tree. The metacestode stage of *Echinococcus granulosus* may cause severe forms of not only in human but also in animals (for example in horses). Anaphylaxis has been induced experimentally in sheep with hydatid cysts fluid, but sudden death in sheep or other animals ascribed to *Echinococcus* infection has never been recorded (Homson *et al.,* 1985).

2.3.4. Cystic Echinococcosis in Sheep, Goats and Cattle

Sheep are typically infected with multiple, pleomorphic *Echinococcus granulosus* cysts mainly localized in the liver and lungs, but the spleen, heart, kidney, the omentum and other organs can also be affected. Similarly, in goats, the liver and the lung are the main sites of predilection. In cattle, cysts are often multiple and unilocular, and the liver and lung are the organs most commonly affected (Dalimi *et al.,* 2002; Umur, 2003).

If cattle are infected with the cattle strain, cysts are 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 common in cattle and have repeatedly been misidentified as the metacestode stage of *Echinococcus multilocularis* (Thompson *et al.,* 1983).

2.3.5. Cystic Echinococcosis in Buffaloes

About 90 % of all the hydatid cysts recovered from buffaloes are sterile. Cysts have been recovered most commonly from the lungs, but they have also been reported in the liver, spleen, kidneys, heart, brain, diaphragm and uterus (Thompson, 1979**).**

2.3.6. Cystic Echinococcosis in Horses

In horses, cysts may grow slowly so that fertile cysts do not exceed four centimeters in diameter in horses 11-16 years old and not induce symptoms. However, large cysts in horses may also remain asymptomatic. The liver is the organ most commonly affected, but cysts have also been recovered from the lungs, brain, heart, pericardium, pleura, spleen kidney and uterus. It is uncommon for the lung to be the only organ affected. In one case reported from Switzerland a nine years old Irish horse was heavily infected with hundreds of hepatic and pulmonary cysts (1-8 cms diameter) (Oostburg *et al.,* 2000). It also showed massive enlargement of the liver (about 6.5 times), increased serum concentration of liver enzymes, liver function, disturbances, and hyperbetaglobulinaemia, symptoms of chronic obstructive lung disease intermittent colic, anorexia and emaciation.

2.3.7. Cystic Echinococcosis in Pigs

In pigs, the liver is most commonly affected, but cysts can also be found in the lungs, kidneys, spleen, heart, skeletal muscles and occasionally the testes (Reinecke, 1989).

2.3.8. Cystic Echinococcosis in Wildlife

In naturally infected intermediate wildlife hosts, the site of predilection, for larval *Echinococcus granulosus* may render the hosts more susceptibility to predation. In moose in Canada, hydatid cysts occur commonly in the lungs (Ozcel *et al.,* 1966). It has been shown the moose heavily infected with hydatid cysts in their lungs are caught more frequently by timber wolves and are usually the first to be shot by hunters. Cystic Echinococcosis has been recorded in a large number of wild animals, including aberrant hosts.

2.3.9. Cystic Echinococcosis in human

Echinococcus granulosus and *Echinococcus multilocularis* occur simultaneously in large endemic areas; mixed infections of Cystic Echinococcosis and Alveolar Echinococcosis in human are apparently rare in human with regard to the mode of information the following two entities have to be distinguished (Parija, 2004).

Primary Echinococcosis: metacestode develop in various sites of the human body from onchospheres liberated from ingested eggs of *Echinococcus spp*. In Cystic Echinococcosis, parasite cysts may establish in virtually all-anatomic sites, but the liver and the lung are the most frequently affected organs. In Alveolar Echinococcosis, the liver is involved in 98 % to 100 % of the cases as primary site of metacestode development (WHO/OIE, 2002).

Secondary Echinococcus: metacestode material spreads from the primary site to adjacent or distant organs and proliferates. In CE, this form occurs after release of viable parasite material (protoscolices, small daughter cysts) during invasive treatment procedure or after spontaneous or trauma induced cyst rupture. Secondary Echinococcosis in Cystic Echinococcosis is caused by the tumor like proliferation of the metacestode with direct infiltration of adjacent organ or by metastasis formation in distant organs due to spreading of parasite cells via lymph and blood vessels.

The initial phase of primary infection is always asymptomatic, and small (< 5 cm) well in capsulated cysts located in organ sites, where they do not induce major pathology, may remain a symptomatic for many years or permanently. In two Italian series with 420 and 424 patients, 38 % and 60 % of all CE cases were asymptomatic, but this rate may be lower in other regions (WHO/ OIE, 2002). After an undefined incubation period of several months or years, the infection may become symptomatic if cysts exert pressure on adjacent tissue and induce other pathological events. Sudden symptomatology may be due to spontaneous or traumatic cysts rupture.

It is difficult to present exact data from resent years on the rates of morbidity, mortality and fatality. In the regional hospital of Maldivian Chile, 137 new cases of cystic echinococcosis was registered in1987-1991; the mortality rate was 0.2 % 100,000 populations and the fatality rate 2.2 % (WHO/OIE, 2002). In other regions the highest numbers of cystic echinococcosis cases were recorded in older age groups, Example - between 21 and 30 years (Kenya) or 21 to 40 years (Libya). In Ethiopia, the occurrence of the disease in man has been reported by (Hagos et al., 2006), 137 patients seen with hepatic hydatidosis and (Mesfin et al., 2007) 234 patients operated upon for hydatid disease between September 1995 and August 2005 were analyzed. But information is lacking in most hospitals and health centers due to the absence of diagnostic facilities, asymptomatic and chronic nature of the disease as well as failure to document. The occupational distribution of patients may vary widely from country to country depending on epidemiological and socio- economic circumstances.

2.4. Clinical symptoms

Two clinical forms of echinococcosis are known to occur in animals:

- The Intestinal infection with adult or immature stages of *echinococcus spp* and
- The infection of internal organs of intermediate or aberrant boost animals with the metacestode stages (Chandler *et al.,* 1961).

Intestinal echinococcosis occurs in various species of carnivores as definitive hosts without causing any major ill effects to the host. The method used until now for surveys of the *Echinococcus granulosus* infection in dog population is arecoline purging (average sensitivity of 65 % - 78 %) (Thompson, 1979; WHO/OIE, 2002). Coproantigen detection by ELISA (CA-ELISA), which is easier to perform, may replace this method in the near future (WHO/OIE, 2002). In the small intestine, *Echinococcus* parasites deeply lie between the villi into the crypts of lieberkuhm attachment with the suckers and rostellar hook to the epithelium. This intimate parasite-host relationship normally does not cause significant pathology. Minor changes may occur, such as flattening of epithelial cells slight cellular infiltration of the mucosa and increased mucus production.

Excretory / secretary products are released from the scolex region of the parasite and may induce the production of circulating antibodies. The distribution of *Echinococcus multilocularis* in the small intestine of foxes and dogs differs quite markedly from that of *Echinococcus granulosus*. Mature *E. granulosus* is predominantly found in the anterior quarter of the small intestine; where as the site of predilection for mature *Echinococcus multilocularis* is the posterior region (WHO/OIE, 2002). However, in heavy infections the parasites may be distributed through out all sections of the small intestine.

2.5. Diagnosis

2.5.1. Diagnosis in living animals

- Safety precaution: handling of material containing viable eggs *Echinococcus granulosus* represents risk for humans. Therefore, special safety precautions have to be observed.
- Detection of eggs and proglottids: The *Echinococcus granulosus* infection in candies cannot be diagnosed by microscopic egg detection in faecal samples because these eggs are morphologically indistinguishable from those of *Echinococcus multilocularis* and the *Taenia* species.
- Eggs can be detected in faecal samples using routine flotation technique or on the perineal skin using clear adhesive tape, which is pressed to the skin, transferred to a microscopic slide and examined. Proglottids of *Echinococcus granulosus* spontaneously discharged by dogs and detected mostly on the surface of faecal samples may allow a correct morphological diagnosis, if they are in good condition (Charles, 1998).

2.5.2. Arecoline purging

The standard method currently used for surveys of *Echinococcus granulosus* infection in dog the population is arecoline purging. It involves the application of arecoline to dogs and the examination of faecal material discharged after purging. Arecoline is the chief alkaloid of the areca nut, the seed of areca catechu.

Arecoline hydrobromide is a parasympathomimetic drug with a major action on the smooth muscle of the small intestine, as well as paralyzing the worm itself. The subsequent purgation carries the worms out with the faeces. For this activity, the drug must be given by the oral route or occasionally per rectum (WHO/OIE, 2002). Dose rates have varied between 1.75 mg/kg and 3.5 mg/kg b.w and were suitable for most dogs (Thompson, 1979). Doubling or having the dose rate does not increase efficacy, but the former may cause excessive vomiting. The drug may be given in tablet or liquid form.

2.5.3. Immunodiagnosis

Immunodiagnosis involves the following alternative approaches: Detection of parasite antigens in faeces (Coproantigen) and serum antibody detection. Coproantigen detection by (ELISA): several groups have described ELISA'S for the detection of coproantigens released by cestodes, including *Taenia* species of dogs and humans (WHO/OIE, 2002).

In several studies detection of *Echinococcus granulosus* coproantigens was highly specific, and significant cross-reactions have not been observed in experimental *Taenia* spp. using faecal samples from necropsid stray dogs /with *Taenia* spp or intestinal nematodes or helminth- tree involving 183 animals over all specificity was 97 % (Smith, 1994). When *Echinococcus granulosus* worm burdens are greater than 100, the sensitivity of coproantigen tests approaches 92 % to 100 % when post mortem worm counts or arecoline purge counts are below 100 worms then sensitivity is variable (29 % -70 %) with the current coproantigen ELISA'S. Despite an over all sensitivity for coproantigen tests of 63 % to 77 %, more than 90 % of the biomass of adult *Echinococcus granulosus* present in a target dog population will be detectable (WHO/OIE, 2002).

For coproantigen tests, faecal samples are directly taken from the rectum or the ground and mixed with buffer solution. Such samples can be stored for some days in the refrigerator or they may be deep frozen (- 20 ^{0}C) until use. The coproantigen test can be used for identifying pregnant bitchs, old dogs and young puppies (Smith, 1994).

Serum antibodies (IgG, IgA, Ig E) can be detected in experimental canine echinococcosis using an *Echinococcus granulosus* protoscolex antigen preparation in ELISA and *Echinococcus granulosus* anti body could be detected by 2-3 weeks post infection. However, while sensitivity was reported to be high (73 %) for natural canine *Echinococcus granulosus* infection in southeast Australia, there was no correlation with worm burden. Further application of the *Echinococcus granulosus* protoscolex ELISA in endemic areas of Kenya and Uruguay indicated poor correlation (sensitivity 35 % - 40 %) with positive worm identification at necropsy.

2.5.4. Serum antibody detection

Serum antibodies (IgG, Ig A, IgE) can be detected in experimental canine echinococcosis using an *Echinococcus granulosus* protosecolex antigen preparation in ELISA and *Echinococcus granulosus* antibody could be detected by 2-3 weeks post infection. How ever, while sensitivity was reported to be high (73 %) for natural canine *Echinococcus granulosus* infection in southeast Australia, there was no correlation with worm burden. Further application of the *E.* granulosus protoscolex ELISA in endemic areas of Kenya and Uruguay indicated poor correlation (sensitivity 35 % - 40 %) with positive worm identification at necropsy (WHO/OIE, 2002).

Diagnosis at Necropsy

The following approaches are indicated for the diagnosis of the *Echinococcus granulosus* infection of carnivores at necropsy.

Collection of material:

The small intestine should be removed as soon after death of the definitive host as possible, tied at both ends and placed in a numbered plastic bag or metal container. The material can be deep-frozen until examination at -20 ^{o} C or at -70 ^{o} C to –80 ^{o} C. At the lower temperatures, the eggs of *Echinococcus granulosus* are killed. The injection of a fixative (4 ^{o} C to 10 ^{o} C formalin) into the lumen of the intestine is a further option for material preservation. However, it is not recommended, fresh material should be used when ever possible (WHO/OIE, 2002).

Necropsy procedure:

Several techniques are used for the diagnosis of the *E. granulosus* infection at Necropsy:

Direct examination of the Intestine

The intestine can be divided into several sections, and each is placed on a metal tray, opened with a scissors and immersed in physiological saline solution at 37 ^{o} C. Worms adhering to the intestinal mucosa can then be directly counted with the use of a hand magnifying lens or stereoscopic microscope. An initial washing and transfer to another tray may assist, when the intestinal contents with observations of the intestinal wall. This method has disadvantages, because small numbers of worms may be over looked and, these may escape detection (Soulsby, 1982).

Sedimentation and counting technique

Where accurate worm counts are required, the best method is to divide the fresh and unfixed intestine into three or more sections. Open each section along its length and then immerse each in a large beaker in physiological saline solution at 37 ^{o}C for 30 minutes which facilitates the releases most of the sediments.

Diagnosis (In Humans)

The process of diagnosis of Cystic Echinococcosis in individual patients goes through various steps as follows:

- Suspicion on clinical ground or upon screening.
- Confirmation by imaging and identification of characteristic or suspicious cyst structure.
- Confirmation by detection of specific antibodies with Immunodiagnosis test (ELISA, IFAT, and IMMUNOBLOT).
- In doubtful cases diagnostic punctures may be considered, if it is not contraindicated.
- Material obtained by biopsy puncture or surgery can be examined hydatid fluid for *Echinococcus* protoscolices or hooks, protoscolices for DNA by PCR, antigen from sterile cyst, and wall material for characteristic structures by histology.

In many cases, a diagnosis can be made by detecting the characteristic structure and size of *Echinococcus granulosus* cysts visualized by various imaging techniques, including ultrasonography (US), Computed tomography (CT), standard radiology (X-RAY) and magnetic resonance imaging (MRI) in specialized centers (WHO/OIE, 2002). Introduction of " US" has improved both the diagnosis of *Cystic Echinococcus* and the understanding of the natural history of the disease. Rarely characteristic hooks or protoscolices may be found in sputum, bile, stool, or urine after spontaneous rupture of the cysts in lungs, liver or kidneys (WHO/OIE, 2002).

The direct diagnosis can also be made by macroscopic identification of the structure and size of *Echinococcus granulosus* cysts obtained by surgery and or by histological examination of the parasite tissue, available after surgery or biopsy. More sophisticated techniques in direct diagnosis include finding of specific *Echinococcus granulosus* antigen (antigen 5) in the fluid from sterile cysts or DNA markers in the cysts fluid or parasite tissue (by PCR) (Chandler *et al.*, 1961).

2.6. Chemotherapy

Chemotherapy of animals against infection with larval *Echinococcus* has been comprehensively reviewed. Several groups of drugs including cytostatics, antibiotics, sulphonamides, and antiprotozoal compound and several antihelminthic drugs have been tested for their efficacy against the metacestode stage of *Echinococcus.* The efficacy trials for these drugs have been mostly carried out in rodents, but some have also been tested in domestic livestock species. The most promising results were obtained with antihelminthics of the benzimidazole group. Based on data from animal experiments, benzimidazoles have been routinely used in recent years for chemotherapy of Cystic and Alveolar Echinococcosis in humans. At present, there is no routine treatment of domestic animals against Cystic or Alveolar Echinococcosis. However, the application of benzimidazoles in effective dosages would be too expensive. To date, there is only one report that a benzimidazole compound namely Albendazole has been used for the treatment of dogs with Alveolar Echinococcosis in the liver (WHO/OIE, 2002).

A number of studies conducted in rodents with secondary hydatidosis using benzimidazole derivatives such as Albendazole, Fenbedazole and Flubendazole induced experimentally by intra peritoneal injection of protoscolices of *Echinococcus granulosus*. It was found with dose rates equivalent to 30 mg/kg-50 mg/kg.b.w. Daily, for 60 - 80 days, that severe damage or killing of *Echinococcus granulosus* cysts occurred (Smith, 1994). Extensive trials with benzimidazole have also been carried out in rodents infected with metacestodes of *Echinococcus multilocularis*. In trials using long - term treatments with Albendazole (60 days), Fenbedazole (60 - 200 days), Flubendazole (60 - 200 days) and Mebendazole (60 - 300 days) at 30 mg/kg - 50 mg/kg .b.w there was up to 99 % reduction in metacestode weight, as compared with untreated controls (WHO/OIE, 2002).

Socio-economic consequences in human

According to recent report of WHO/OIE (2002), the various consequences of human cystic echinococcosis include:

- Cost for diagnosis of the infection
- Medical and surgical, foods and costs of hospitalization, nursing and drugs.
- Loss of working days or " production "
- Cost of travel to seek treatment for both patient and family members.
- Mortality (potential years of life lost)
- Suffering and social consequences of disability.
- Abandonment of farming or agricultural activities by affected or at risk persons.

Economic consequences in livestock:

According to Smith (1994) the following consequences of cystic echinococcosis have in livestock to be considered:

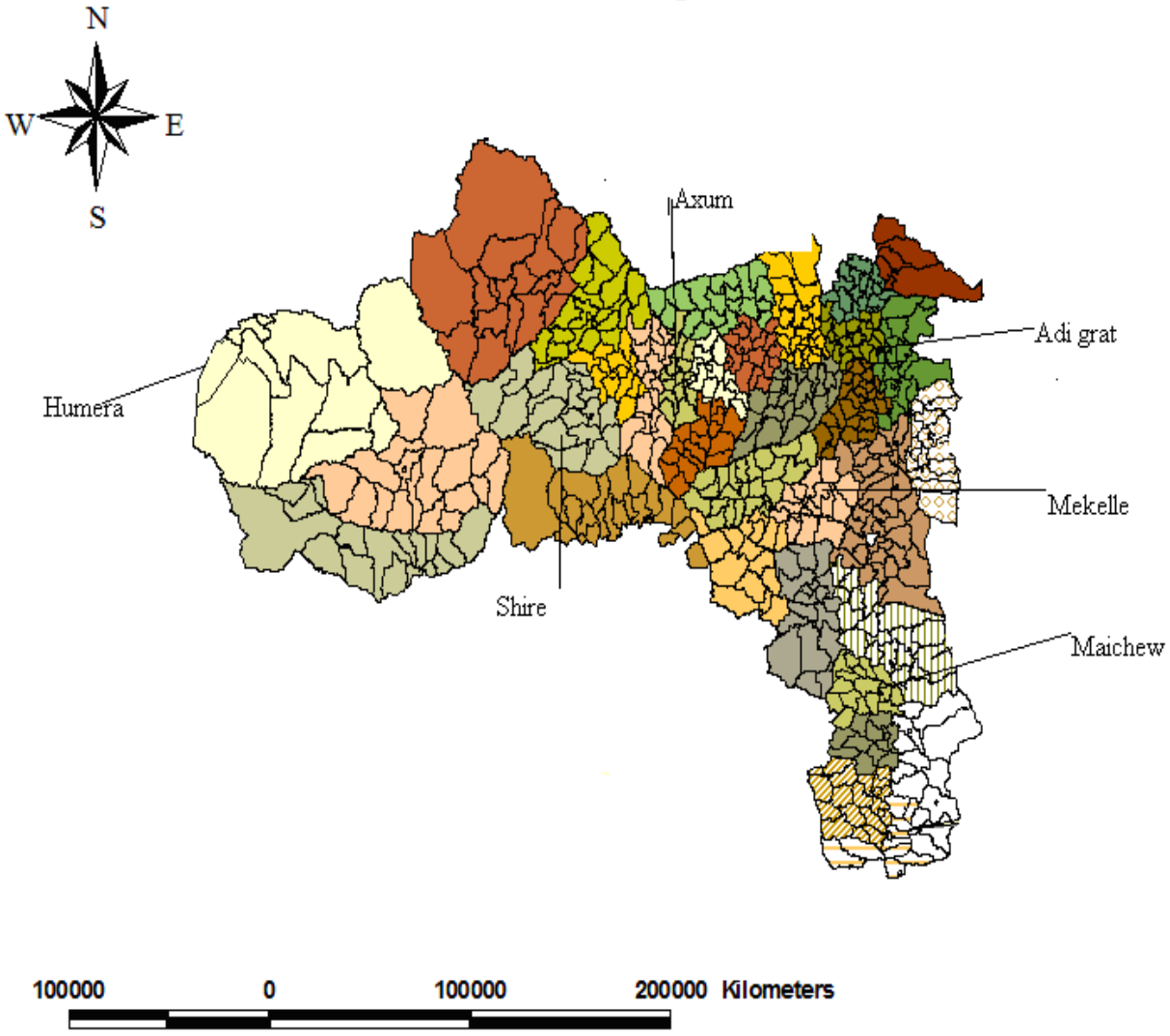
- Reduced yield and quality of meat, milk and wool, reduced birth rate, etc.
- Delayed performance and growth.
- Condemnation of organs, especially of liver and lung.
- Costs for destruction of infected viscera and dead animals.

3. MATERIAL AND METHODS

3.1. Study area

The present study was conducted in Tigray Region State, specifically in all six zones namely: Adigrat, Axum, Humera, Maichew, Mekelle and Shire. The study areas are located with different types of altitude consisting of highland, midland and lowland. The highest altitude is 2500 meters above sea level and the lowest is 1400 meters above sea level. Maximum annual rainfall of the region is 1200 mm (Axum, Humera and Shire zones) and the minimum annual rainfall is 500-600 mm (Adigrat, Maichew and Mekelle zones). Pronounced high rain occurs during the months of July and August and the short rain months are during April and May. Most of the highland areas are found in Adigrat and Axum zones while the lowland areas are located in Humera, Maichew and Shire zones of Tigray Regional State. The human population of the region is 3.5 million. Annual temperature ranges from 20 ^{0}C - 40 ^{0}C (BOARDT, 2003). The Laboratory work has been done at the Mekele Regional Veterinary Laboratory and Mekelle University Faculty of Veterinary Medicine Parasitology Laboratory.

Administrative map of Tigray And Study areas



3.2. Study population

The study population included cattle and human population in all the six zones of Tigray regional State. However, dogs were considered only in Mekelle Zone.

3.3. Study design and sample size determination

3.3.1. Animal Survey:

The study design employed was cross sectional type with the objectives of determining the prevalence and economic loss due to hydatidosis in cattle. The sample size for calculating the total number of visceral organs of cattle to be inspected was determined by using the formula indicated here in below (Thrusfield, 2005).

$$n = \frac{T^2 x Pexp\,[1-Pexp]}{d^2},$$

Where:

n: Sample size to be determined

T: Value at a given confidence level;

P: Expected prevalence of hydatidosis in the study area and

D: Accepted absolute error/level of precision

Taking in to account 50 % expected prevalence of hydatidosis and 5 % accepted absolute error a total of 384 animals were supposed to be inspected and examined. How ever, in order to increase the representative ness and randomness of the study animals, the sample size was inflated about 13.5 times. Therefore, a total of 5,194 were inspected and examined by proportional allocation of the sample size to each of the study zones on basis of the cattle population in the area and the number of daily slaughtering animals. Accordingly, from Adigrat 959, Axum 248, Humera 463, Maichew 403, Mekelle 2389 and Shire 732 cattle heads were inspected and examined.

The animals considered in the present abattoir based cystic Echinococcosis survey belonged both sexes, local breed type and above 5 years of age. The age was determined based on visual observation of teeth and owner's information. It was difficult to precisely trace back the geographical origins of all animals' slaughtered, but 90 % of the cattle were from the Tigray Region.

3.3.1.1. Postmortem examination

During post mortem examination different visceral organs mainly liver, lung, kidney, heart, and spleen were inspected by observation, palpation and incision for the presence of Hydatid cysts.

Examination of the definitive (final) host:

In close collaboration with Mekelle Agricultural Office, field survey was proposed and undertaken to euthanize definitive hosts namely stray dogs in Mekelle town.

The objective of such survey was to assess the epizootological significance of canids especially dogs due to their free access to the abattoir places and disposal pits and also due to their close relation ship with humans and domestic animals. A total of 18 stray dogs from Mekelle town were examined for the presence of the adult parasites. Those 18 stray dogs were examined by the following procedures: first Strychnine baits were given to the stray dogs early in the morning between 4:30 A.M and 7:00 A.M. Euthanized stray dogs were then immediately transported to Mekelle Regional Veterinary Laboratory for detail post mortem examination of the small intestine. Accordingly, after taking out the first half meters of small intestine both end were tied and then longitudinal incision was made to open it. Then the part of the small intestine was washed and scrapping of the mucosa was undertaken in a tray containing 1% saline solution. The suspension was transferred to conical flask to allow gravitational sedimentation. The supernatant was discarded and replaced with 1 % saline solution and this procedure was repeated until getting clear sediment. Then the sediment was examined against a black-back gain for contrast and easy identification of the adult parasites namely *Echinococcus granulosus* (Reddy *et al.,* 1958).

Fertility and viability study:

The content of the cyst was poured in to a Petri dish and small amount of fluid (drop of fluid) was transferred to a glass slide and covered with a cover slip. Examination was made under X40 objective magnification for the assessment of the condition of the cyst. If the protoscolics were present, seen as white dots on the germinal epithelium or brood capsule or hydatid sands with in the suspension, the cyst is categorized as fertile and further was examined for viability. Representative specimens were randomly selected and were subjected to cyst fertility study. Individual cysts were carefully incised and opened, the content poured into clean glass Petri dish, and examined under a microscope (X 40) for the presence of hydatid protoscolices. During viability test were used eosin 1 % (1gm per 99 ml of distilled water), disposable syringe, test tub, slide, cover slip and microscope (Dalimi *et al*., 2002).

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Those samples that were collected from Mekelle slaughterhouse has tested for there viability in Mekelle Regional Veterinary Laboratory and in Mekelle University Faculty of Veterinary Medicine Parasitology Laboratory.

3.3.2. Human survey

The significance of Hydatidosis among human populations in all the six zones of Tigray Regional State was studied using questionnaire survey conducted to generate baseline information on various important issues. Retrospective study (analyzing secondary data), active disease searching and follow up. In the questionnaire survey a total of 138 randomly selected professionals from Zonal Hospitals were interviewed. The following focal points were emphasized and addressed in the questionnaire survey such as: major human health problems, the status of hydatidosis by interviewing physicians, technicians, nurses and other medical staffs of the six zonal hospitals in Tigray Regional State.

3.3.3. Data management and analysis

The data was entered and managed in MS Excel spread sheets and software programs. Using version SPSS 12.0 for windows statistical soft ware was used for data analysis. Analysis of the economical losses of organs due to organ condemnation was estimated. Descriptive statistics such as percentages and frequency distribution was used to describe the nature and the characteristics of the data.

Annual economic losses of condemned organs in selected study areas was made by taking in to consideration the following current estimate price of the organs at Mekelle town in Tigray Regional State as follows: Liver (42 birr), Kidney (4 birr), Lung (8 birr), Spleen (2 birr) and Heart (16 birr).

Other relevant information was collected such as: Average animal slaughtering rate of ruminants from Abattoir records and average price of zebu cattle, liver, lung, kidney, spleen, heart. Similarly, the cost of 1 kg of beef was obtained from butchery. A cost of condemned edible offal and carcass weight loss has been estimated.

A 5 % carcass weight loss due to cystic echinococcosis as described by (Polydrous, 1981) has been used to determine the carcass weight loss. Annual loss due to liver, lung, kidney, kidney and spleen condemnation and carcass weight loss due to cystic echinococcosis has been estimated by using the formula recommended (Ogunrinade, 1980):

[P3*P1*C1*AS1] + [P3*P2*C2*2AS1] + [P3C*3AS1*AS2]

Where:

P3: the mean prevalence of hydatidosis
P1: percent involvement of lung
C1: the mean retail price of a bovine lung
C2: the mean retail price of a bovine liver
AS1: estimated annual cattle slaughter rate
AS2: carcass weight loss due to hydatidosis
P2C: percent involvement of liver

4. RESULTS

4.1. Animal Survey: definitive Host

The present echinococcosis survey in the definitive host (dogs) conducted mainly in different sites of Mekelle; the capital of the Tigray Regional State revealed the occurrence of the adult *Echinococcus spp* parasites in small intestine of 3 dogs out of 18 (16.66 %)euthanized animals. The number of encountered adult *Echinococcus spp*, parasites in small intestine ranged from 3-7 (Table 4).

Table 4: Echinococcosis survey in definitive host in Mekelle zone of Tigray Regional State.

No. of Dogs euthanized	Survey site	Result	Number of adult parasites encountered
1	Mekelle (Enkodo)	Negative	-
1	Mekelle (Enkodo)	Positive	3
1	Mekelle (Jubruk)	Positive	5
2	Mekelle (Industry)	Negative	-
3	Mekelle (Endamariam)	Negative	-
2	Mekelle (Hawelti)	Negative	-
2	Mekelle (around hospital)	Negative	-
3	Mekelle (Elala)	Negative	-
2	Mekelle (Elala)	Negative	-
1	Mekelle (Enkodo)	Positive	7
Total 18			15

Abattoir survey: Intermediate host.

Abattoir based cystic echinococcosis survey in the intermediate host namely cattle were conducted between October 2007 and February 2008 in all six zones of Tigray Regional State. A total of 5,194 cattle in six different zonal abattoirs were considered for the post mortem inspection. The majority of infected cattle had hydatid cyst in both liver and lungs. The lung was more frequently infected than liver in Mekelle 761 (31.85 %) and Adigrat 195 (20.33 %) zones while liver was more frequently infected than lung in Axum 41 (16.53 %), Maichew 40 (9.93 %) and Mekelle 253 (33.24 %) (Table 5).

Table 5. Economic impact of organ condemnation in all six zones of Tigray Regional State.

Name of Abattoirs	Number of Animals slaughtered	Number of animals positive for hydatidosis	No. of organs positive for hydatidosis				
			Liver	Lung	Heart	Spleen	Kidney
Adigrat	959	195 (20.33 %)	42 (21.54 %)	147 (75.38 %)	6 (3.08 %)	-	-
Axum	248	41 (16.53 %)	31 (75.61 %)	10 (24.39 %)	-	-	-
Humera	463	54 (11.66 %)	35 (64.81 %)	17 (31.48 %)	2 (3.7 %)	-	-
Maichew	403	40 (9.92 %)	40 (100 %)	-	-	-	-
Mekelle	2389	761 (31.85 %)	253 (33.25 %)	471 (61.89 %)	6 (0.79 %)	4 (0.53 %)	27 (3.55 %)
Shire	732	55 (7.51 %)	18 (32.72 %)	30 (54.55 %)	7 (12.72 %)	-	-
Total	5,194	1146 (22.06 %)	419 (36.56 %)	675 (58.90 %)	21 (1.83 %)	4 (0.35 %)	27 (2.35 %)

In this abattoir based cystic echinococcosis survey more than 90 % of cattle were males except for Maichew zone where females were dominant.

Organ condemnation:

All affected organs were totally condemned and no partial condemnation at all practiced in the six zonal abattoirs. The average retail market price of organs in the region at the time of survey was liver (42.00 birr), lung (8.00 birr), heart (16.00 birr), kidney (4.00 birr), spleen (2.00 birr) and one kilo gram of beef (45 birr). Accordingly, the economical loss due to hydatidosis was calculated using the formula set by Ogunrinade (1980). A 5 % carcass weight loss due to bovine hydatidosis was already established according to Yugoslavian investigator (Polydorous, 1981) (Table, 6).

The total annual loss from bovine hydatidosis due to offal condemnation (lung, liver, heart, kidney and spleen) and carcass weight loss in the respective study zones was estimated using the following formula; $[P_3. P_1.C_1. AS_1] + [P_3.P_2.C_2.AS_1] + [P_3.P_4.C_3.AS_1] + [P_3.P_5.C4.AS1] + [P_3.P_6.C_5.AS_1] + [P_3.C_{11}.AS_1.AS_2]$

Where:

P_1 = percent involvement of lung
P_2 = percent involvement of liver
P_4 = percent involvement of kidney
P_5 = percent involvement of heart
P_6 = percent involvement of spleen
P_3 = the mean prevalence of hydatidosis
C_1 = the mean retail price of a bovine lung
C_2 = the mean retail price of a bovine liver
C_3 = the mean retail price of a bovine kidney
C_4 = the mean retail price of a bovine heart
C_5 = the mean retail price of a bovine spleen
C_{11} = the mean retail price of kilo of beef
AS_1 = estimated annual cattle slaughter rate
AS_2 = carcass weight loss due to hydatidosis

Table 6: The Direct and indirect economical loss per annum due to hydatidosis in cattle in all six zonal abattoirs of Tigray Regional State.

Study zone	Direct economic loss per annum (in Birr)	Indirect economic loss per annum (in Birr)	Total economic loss per annum (in Birr)
Adigrat	4803.04	924.90	5,727.94
Axum	864.01	418.25	1,282.26
Humera	1112.06	475.69	1,587.75
Maichew	501.48	268.65	770.13
Mekelle	11,508.59	4,237.20	15,745.79
Shire	196.18	297.84	494.02
Overall economic loss			**25,607.89**

N.B: Current foreign currency 1 USD = 9.52 Birr (National Bank of Ethiopia)

From the total of 3895 Hydatid cysts encountered in all six zonal abattoirs of Tigray Regional state, 883 (22.67 %), 847 (21.75 %), 2165 (55.58 %), were found large, medium and small (Table 7).

Table 7: Description of the encountered hydatid cysts in all six zonal Abattoirs of Tigray Regional State.

Cyst size	Liver	Lung	kidney	Heart	Spleen	Total
Large size(>10ml)	141	718	16	6	2	883
	(14.29 %)	(25.24 %)	(59.23 %)	(18.75 %)	(50 %)	(22.67 %)
Medium(5-10ml)	185	637	11	14	-	847
	(18.74 %)	(22.39 %)	(40.74 %)	(43.75 %)		(21.75 %)
Small (<5ml)	661	1490	-	12	2	2165
	(66.97 %)	(53.37 %)		(37.5 %)	(50 %)	(53.58 %)
Total	987	2845	27	32	4	3895

From a total of 509 selected hydatid cyst samples which were tested in Mekelle Regional Veterinary Laboratory and Mekelle University Faculty of Veterinary Medicine Parasitology Laboratory 243 (47.74 %), 141 (27.70 %), 125 (24.56 %) were sterile, fertile and calcified cysts, respectively (Table 8).

Table 8: Type of hydatid cyst (sterile, fertile and calcified) in different organs infected cattle in Mekelle Abattoir Tigray Regional State.

Organs	Cyst condition					
	Sterile	Fertile			Calcified	Total
	No.	Motile	Non motile	Total	No.	
Lung	200	74	26	100	92	372
Liver	40	23	17	40	33	133
Kidney	2		1	1	-	3
Heart	1	-	-	-	-	1
Spleen	-	-	-	-	-	-
Total	**243 (47.74 %)**			**141 (27.70 %)**	**125 (24.56 %)**	**509**

4.2. Human survey

The present human hydatidosis survey conducted in all zonal Hospitals of Tigray Regional State disclosed for the first time the occurrence of one active clinical case in Mekelle Hospital. This active clinical case was encountered on 28/02/2008 in the liver 0f a 67 years old woman (Figures 3, 4). The origin of this patient was from Astibi district about 38 Kms away from the capital town Mekelle.

Figure 3: Ultrasound of film indicating the occurrence hydatid cyst mass in the right lobe of the liver.

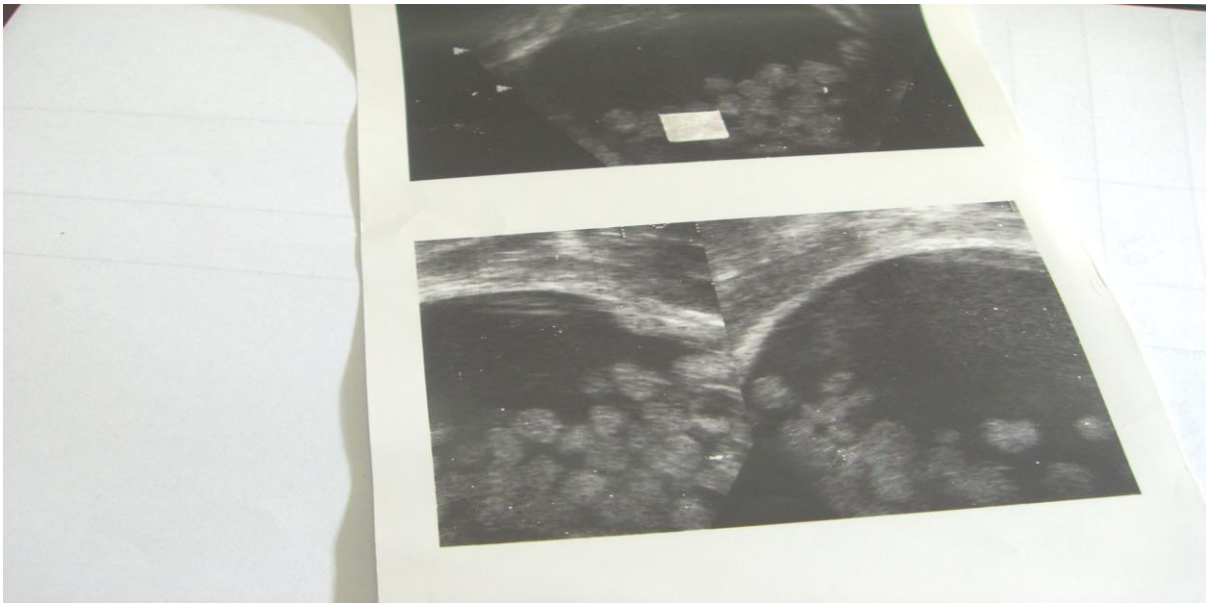

Figure 4: Hydatid cyst collected after surgery from the right lobe of the liver.

An attempt was made to trace back the origin of those patients diagnosed at Mekelle Hospital by looking at their address in the patient card and thorough discussion with physicians in the respective zonal hospitals. Accordingly, most of the human hydatid cyst cases were from Astibi district (Astibi town) about 38 Kms from Mekelle town capital of Tigray Regional State. Based on the above information, rapid questionnaire survey was carried out in Astibi district mainly to veterinary professionals, butchers and other residences of the town. The questionnaire survey disclosed that the district is highly populated with sheep roughly 94,000. Most of the population in Astibi district was observed to keep dogs and sheep living together. The dogs and sheep were seen in a close proximity even at grazing, watering and shelter places. In Astibi town where there is a small scale slaughter house, most people and even butchers rarely used to kill rarely their animals. It is a common practice to see sheep and cattle slaughtered in backyard system in residential houses and at the grazing field. Moreover, there was no proper disposal of infected organs where such organs were left to dogs.

Similarly, eight passive cases of human hydatidosis were encountered in Axum, Maichew and Mekelle zonal Hospitals. This information was generated based on retrospective data analysis of respective zonal Hospitals. The age range of those nine human cases of hydatidosis diagnosed were between 33 and 67 in both sexes five in females and four in males (Table 9 and 10).

Table 9: Details of encountered active and passive human cases of hydatidosis in Tigray Regional State.

Card No.	Date	Age	Sex	Diagnosis	Treatment	Hospital
003897	2004	45	M	Hydatid cyst in the liver	Surgical removal	Axum
076897	2005	51	F	Hydatid cyst in the liver	Alebendazole treatment	Axum
58694	30/11/2000	50	M	Hydatid cyst in the liver	Surgery, drainage, marsuphinizals and antihelmentics	Maichew
020338	23/07/2000	48	F	Hydatid cyst in liver	Operation	Mekelle
018356	2/9/2001	33	F	Haydatid cyst in liver	Excision	Mekelle
048095	14/04/2007	53	M	Hydatid cyst in liver	Excision	Mekelle
049267	28/02/2008	67	F	Hydatid cyst in the liver	Drainage and implication	Mekelle
049361	23/03/2000	58	F	Ultra sound result	Albendazole treatment	Mekelle
049478	25/03/2000	45	M	Ultra sound result	Albendazole treatment	Mekelle

During the questionnaire survey it was interestingly noted that most physicians working in zonal hospitals did not recognize hydatidosis as a zoonotic disease problem because lack of knowledge. In addition to this, the recording system was poor in some zonal hospitals visited where card number, age, sex and even patient name were not filled.

Table 10: Result of Questionnaire survey used to assess human hydatidosis on all six zonal Hospitals of Tigray Regional State.

Points of focus	Mekelle	Axum	Maichew	Shire	Adigrat	Humera
Number of questioner distributed to the professionals	35	30	30	30	30	30
Number of professionals Hydatid cyst recognized as a disease	11	2	2	-	-	-
Diagnostic Method	Ultrasound	Ultrasound	Ultrasound	-	-	-
Location of the cyst	liver	liver	liver	-	-	-
Recording system	Good	poor	Good	-	-	-
Number of specialist / surgeon/	6	1	1	-	1	-
Treatment recommended by the specialist	albendazole	albendazole	albendazole	-	-	-
Number of patient	6	2	1			
Mortality after surgery and treatment	None	None	None	-	-	-

5. DISCUSSION

The present cross sectional study conducted to assess the extent and distribution of bovine hydatidosis in Tigray Regional State indicated the prevalence to be 31.85 % in Mekelle, 20.33 % in Adigrat, 16.53 % in Axum, 11.66 % in Humera, 9.9 % in Maichew and 7.5 % in Shire. Comparable findings of bovine hydatidosis were reported in other African countries where a higher prevalence of 32 % in Niger delta (Arene, 1985) and lower prevalence of 5.6 % in Libya were recorded (Mohammed, 1985).

Generally such variation (7.5 % to 31.85 %) in prevalence of bovine hydatidosis recorded in all six zones of Tigray Regional State might be due to the fact that difference in agro climatic locations of the study sites and livestock management. In the present study, the overall prevalence was found to be relatively higher. The main reason for this could be the age of the slaughtered animals. Most of the slaughtered animals were old with high chance of exposure to the disease (parasitic ova) over a long period of time with an increased possibility of acquiring the infections. Previous studies conducted strongly suggest prevalence is heavily influenced by age (Torgerson *et al.*, 2002; Lahmar *et al.*, 1999). In almost all parts of Tigray Regional State there is an evident cultural and religious (Christian) taboos which favor the keeping of dogs in close association with their family and farm animals. Apart from this, the higher number of stray dogs and practice of back yard slaughtering are the main incriminated factors for the area wide occurrence of hydatidosis/echinococcosis in Tigray Regional State.

The underlying reasons why back yard slaughtering is common in Tigray Regional State include: The existing abattoirs were totally under capacity where there is lack of basic equipment and insufficient water and electricity supply. As a result of this, most of the butcheries were noted to slaughter their animals in back yards and roadsides. The wide spread tradition of offering uncooked infected offal's to dogs and cats (pet animals) around homestead, poor public awareness about the disease including professionals from study zonal hospitals and the habit of improper disposing dead wild or domestic animals, unburied and left open for scavenging carnivores creates favorable condition for environmental contamination by maintaining the life cycle of echinococcosis in stray dogs.

In the present study animals with poor body condition were found to have higher hydatid cyst counts. The poor condition in such animals is probably a reflection of the effect of relatively high cyst burden. Battli (1997) explained that in moderate to severe infection the parasite may cause retarded performance and growth, reduced quality of meat and milk as well as live weight.

More than 90 % of cattle presented to the abattoirs were males except in Maichew abattoir where females were dominant. However, it was difficult to precisely trace back the geographical origins of all animals' slaughtered, but 90 % of them were from the region.

The present study also disclosed that hydatid cysts occur predominantly in the lung and liver and rarely in heart, kidney and spleen. For instance 36.56 % and 58.9 % of all the hydatid cysts encountered were in liver and lung, where as a relatively lower proportion were obtained from heart (1.83 %), spleen (0.35 %) and kidney (2.36 %). Most of the infected cattle (95.46 %) had hydatid cysts both in the liver and in the lungs as reported also by Giannetto *et al.* (2004) in Sicily and by Azlaf *et al*. (2006) in Morocco. This is explained by the fact that lungs and livers posses the first great capillaries sites encountered by the migrating *Echinococcus* oncosphere (hexacanth embryo) which adopt the portal vein route and primarily negotiate hepatic and pulmonary filtering system sequentially before any other peripheral organ is involved. In addition, the lungs were mostly infected than any other organ this might be due to the fact that ruminants are slaughtered at older age. In addition, hydatid cysts were mainly unilocular (78.8 %) as also found by Dalimi *et al.* (2002) in Iran.

From the total of 3895 hydatid cysts counts 883 (22.67 %), 847 (21.67 %), 2165 (53.02 %) were found large, medium and small cysts respectively. From 509 samples were tested in Mekelle Regional Veterinary Laboratory and Mekelle University Faculty of Veterinary Medicine 243 (47.74 %), 141 (27.70 %), 125 (24.56 %) were sterile, fertile and calcified cysts, respectively. Similar findings were reported by Dalimi *et al.* (2002), where 56 % sterile, 18.9 % fertile and 25 % calcified cysts found to occur in cattle indicating that most of the cysts in cattle are infertile (Khan, 2001).

However, the present study indicated a relatively higher proportion of fertile cysts 27.70 % as compared to previous studies. Conversely in Britain up to 90 % total Hydatid cysts from cattle are said to be sterile. Lower fertile cysts were reported from different studies such as 0.7 % in Australia (Banks *et al.,* 2006), 2.6 % in Sardinia (Scala *et al.,* 2004) and 4.0 % in Sicily (Giannetto *et al.,* 2004). Even in most cases fertile hydatid cysts were not totally encountered in any of the cystic echinococcosis positive cattle.

In comparison of the fertility rate among the organs, it was higher in lungs than liver. It has been stated that the relatively softer consistency of lung tissue allows the easier development of the cyst and the fertility rate of hydatid cyst may show a tendency to increase with advancing age of the hosts (Himonas, 1987 and Radfar, 2004). This may be attributed probably due to reduced immunological compatibility of animals at their older age of infection.

The variation between tissue resistances of the infected organs may also influence the fertility rate of cysts, in the liver, host reaction may limit fertility rate of hydatid cysts. The variation in fertility rate among different species and in different geographical zone could be due to the difference in strain of *Echinococcus granulosus* (McManus, 2006). Exceptionally in Mekelle abattoir, one large cyst was found in the lung containing about 1.2 liters of fluid.

Most of the hydatid cyst human cases were from Atsibi district specially admitted and treated in the Mekelle hospital. The main factors that attribute for occurrence of hydatidosis in human in Astibi district include: Most of the residences of Astibi district keep dogs and sheep together. The dogs and sheep are much closed even at the place of grazing, watering and shelter. In Atsibi there is only one municipality small scale slaughter house. Rarely, butchers are using this small scale slaughter house. It is also a common practice to see sheep slaughtered in residential houses and at the grazing field. Moreover, there is no proper disposal of affected organs or offal's, where most of the time routinely left to dogs. Interestingly, in Italy the dogs or other canids may have the opportunity to feed on cattle carcasses (Cringoli *et al.,* 2007). In nutshell, the close association observed between dogs, sheep and human favours the life cycle of the parasite and its cyclical transmission.

The questionnaire survey conducted to assess the public health significance of hydatidosis in human indicated that the disease is not well known by most of the physicians working in zonal hospitals. This is mainly because of lack of knowledge. In some of the zonal hospitals there was poor recording system lacking card no, patient name, age, sex and Ultra sound films. Medical professionals from Mekelle zonal Hospital were found to be very much interested in Hydatid cyst survey in humans. The finding of one active hydatidosis human patient motivated and encouraged them as a step forward for studying other zoonotic diseases in close collaboration with Bureau of Health and Bureau of Agriculture and Rural development of Tigray Regional State.

The number of active hydatidosis patients would have been more that one had there not been hesitation to undertake surgery. What was observed in some of the patients was hesitated to surgery especially in Mekelle, Maichew and Axum zones of Tigray Regional State. Instead physicians were prescribing antihelmintic drugs most commonly albendazole.

During the study period especially in Mekelle zone two human hydatid cyst patients were diagnosed by Ultrasound and treated by albendazole. According to the collected base line information from the recorded secondary data (retrospective survey), misdiagnosis of clinical cases seems to be very common. This mis diagnosis can be justified as follows. In the active hydatidosis case found from Mekelle hospital in Tigray Regional state, at first the physicians suspected pulmonary tuberculosis and treated the patient with Streptomycin for 60 days but after the treatment resulted no change.

Generally in Tigray Regional State hydatidosis was found to be one of the major zoonotic and economically importance disease. Among the six zonal hospitals found in Tigray Regional State few professionally skilled man powers mainly of specialists (surgeon) were found in Mekelle zonal Hospital having the knowledge about hydatidosis. Quite interestingly, even after performing operation the hydatid cysts were simply discarded with out the affected organ proper handling (preserving) the surgically removed organ. Moreover, it was noted that there was no experience sharing between professionals. Due to this effect, the knowledge about hydatidosis remains only in hands of very few specialists (surgeon).

Other studies suggested that ethnic and cultural taboos have been reported as responsible for the high transmission rates for hydatidosis among Eskimos, Basques in California and Turkana in Kenya.

Coupled with the results of the present study, the previous conducted fragment studies in different parts of the country strongly suggest that echinococcosis/hydatidosis is one of the highly prevalent diseases of ruminants incurring huge economic loss and acting as serious public health threat in Ethiopia. Jambyl Oblast has reported the highest human incidence in Kazakhstan, although Almaty and South Kazakhstan Oblasts had comparable figures for the year 2000 (Torgerson *et al*., 2002).

Among the 18 dogs examined in Mekelle town 3 (16.66 %) were found infected with *Echinococcus granulosus*. A relatively similar finding was observed in other studies (5-15 % prevalence) at necropsy in endemic areas of Sichuan, Qinghai and Gansu Provinces of China (Craig et al., 2007). The infection pressure and the intensity of *Echinococcus granulosus* in dog were studied in several areas in Morocco and the results reported by Dakkak (1992), showed high prevalence ranging from 22 to 58 % worms per infected dog. Similarly, in Tunisia Lahmar *et al.* (2001) found 21 % of dogs infected and a mean of 2534 parasites per infected dog. According to Gemmelle *et al.* (2001), 8470 eggs were shed from average infected dog per day. Thus the high prevalence of echinococcosis in dogs either in rural or in peri-urban areas and the high proportion of stray and free roaming dogs lead to very high pollution of the environment by *Echinococcus granulosus* eggs (Dakkak, 1992). Therefore, the dissemination of eggs, the contamination of water and food and the risk to contaminate farm animals and human are very high.

High economical losses due to total organ condemnation were observed in Mekelle zone (15,745.79 Ethiopian Birr), Adigrat (5,727.00 Ethiopian Birr), Humera (1,567.75 Ethiopian Birr), Axum (1,282.26 Ethiopian Birr), Maichew (770.13 Ethiopian Birr) and Shire (494.02 Ethiopian Birr). Similar economic loss analysis was conducted in several studies to identify the financial losses due to cystic echinococcosis in cattle caused by condemnation of organs and decrease in production (Umur, 2003).

The economic loss assessment made in the present study indicated that about 22.35 Ethiopian Birr (2.5 USD) was lost per every slaughtered animal.

Bovine hydatidosis is one of the major parasitic infections in Tigray Regional State warranting for serious attention. The various indirect effects of the disease, for instance the reduction in working capacity of oxen, are not included in this economical loss assessment. Although precise evaluations of economic loss due to hydatidosis in animals are difficult to estimate, there is no doubt that it has got adverse effects on productivity. Polydorous 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. Hydatidosis causes considerable economic loss in livestock due to condemnation of organs. In Tigray Regional State at least in the six zonal abattoirs, meat inspection service was very inefficient and moreover livestock disease information gathering was poor. This makes very difficult to obtain a baseline and reliable data for having picture of epidemiology diseases.

It is well known that an efficient meat inspection service should function as an important monitoring agent in the control of animal diseases with considerable economic and public health significance mainly in cases of chronic and ill-defined conditions which are not apparent either to the stockowner or veterinary surgeon (Blamier *et al.,* 1980). More importantly a feedback from the slaughterhouses to the individual farm is of great value in the field of preventive medicine.

6. CONCLUSIONS AND RECOMMENDATIONS

Hydatidosis a prevalence disease of considerable economic and public health significance in Tigray Regional State. Hydatidosis is distributing in all over the region. with high variation between the different administrative zones. The high prevalence is due to poor husbandry systm, absence of awareness among the public about the presence of slaughter houses, contamination of pasture with dogs feces, unhygienic disposal of condemned organs, presence of stray dogs, close relationship between cattle, dog and man, lack of cooperation between the veterinary and public health professionals.

Hydatidosis in human occurs in some areas of Tigray Regional State. In most of the cases, infections in human are misdiagnosed due to lack of facilities and knowledge. Based on the above conclusion, the following recommendations are forwarded.

- Standardized abattoirs should be established of being well equipped and having routinely meat inspection by the qualified and experienced.

- Awareness should be created in terms of knowledge of zoonotic diseases namely echinococcosis/hydatidosis among veterinary as well as human health professionals through refreshment on job training.

- Stray dogs should be controlled in close collaboration with Health Bureau, Bureau of Agriculture and Rural Development and City Municipalities in order to address the issue of public health problems namely hydatidosis and Rabies.

- There should be routine experience sharing between Bureau of Agriculture and Rural Development and Bureau of Health about major zoonotic diseases of Tigray Regional State and develop guide line.

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8. ANNEXES

Annex 1: Case history of the hydatid cyst diagnosed patient in Mekelle Zonal Hospital Tigray Regional State.

Name of the patient: Miss Brehan Hadera

Clinical Notes:

- Date 13/06/99 (free)
- Diagnosis - cystic abdominal mass
- Pulmonary - tuberculosis
- Chest X-Ray -lung mass
- Hydatidosis- cyst
- No evidence of Tuberculosis
- Age - 67

Diagnosis: Hydatid cyst in liver right lob

Drainage and implication

Procedure - Under general anesthesia (GA) abdomen clean dramped and entered via mid line laparatomy. These were a tense cystic mass in the right lob of the liver. Aspirate was clear fluid formalin injected. Contents aspirated 1kg of brood capsules, perenal layer, pecules, per cyst indicated.

Draw left laparatomy closed in layers.

Gauze and pack count correct.

Treatment:

Post operational order

Cephtroxon 1gm IV - PID (two times per day)

Hydrocortisone 100 mg IV- TID (three times per day)

Annex 2: Viability test data (Laboratory analysis result).

Date collected sample	Type of sample	Number of sample	Viable		Non viable	Calcification
			Fertile		Sterile	
			Motile	Non motile		
23/11/2007	liver	12	4	2	6	
"	lung	22	6	10	3	4
26/11/2007	lung	14	3	2	5	4
"	liver	3	1	2		
"	heart	1	1			
28/11/2007	lung	6	1			
"	liver	1		1		
30/11/2007	lung	17	2	-	10	5
"	liver	5			3	2
03/12/2007	liver	3		1	2	
05/12/2007	lung	18	8	2	4	4
"	liver	4	2	2		
07/12/2007	lung	23	5	1	12	5
,,	liver	1	1			
,,	kidney	1			1	
10/12/2007	lung	9	1		5	3
14/12/2007	lung	20			11	9
,,	liver	4				4
17/12/2007	lung	2			2	
,,	kidney	1			1	
19/12/2007	lung	12	1	6	5	
,,	liver	3			3	

,,	kidney	1		1			
21/12/2007	lung	16			7	9	
,,	liver	3	1		2		
24/12/2007	lung	2				2	
,,	liver	1			1		
26/12/2007	lung	6			1	5	
28/12/2007	lung	12	4			8	
31/12/2007	lung	6				6	
,,	liver	2				2	
03/01/2008	lung	19	12	2	5		
,,	liver	4	2	2			
09/01/2008	lung	4			3	1	
,,	liver	6			4	2	
11/01/2008	lung	16			11	5	
,,	liver	6			4	2	
14/01/2008	lung	12	2		5	5	
,,	liver	7			7		
16/01/2008	lung	11				11	
,,	liver	6			6		
18/01/2008	lung	6			6		
,,	liver	4			4		
19/01/2008	lung	16	5		5	6	
,,	liver	4				4	
21/01/2008	lung	11			11		
,,	liver	6			3	3	
23/01/2008	lung	20	1	1	18		
,,	liver	2		2			
25/01/2008	lung	7	4		3		
28/01/2008	lung	6	2		2	2	
,,	liver	11	2		2	7	

06/02/2008	lung	33	8			10	15
,,	liver	1	1				
08/02/2008	lung	8	1	2		5	
,,	liver	11	2	4		3	2
11/02/2008	lung	5	3			2	
13/02/2007	lung	9	5			4	
,,	liver	1	1				
18/02/2008	lung	10				5	5
,,	liver	1				1	
19/02/2008	lung	25	9			5	11
,,	liver	2	2				
21/02/2008	lung	13				11	2
,,	liver	6	1			5	
23/02/2008	lung	10				8	2
,,	liver	2	1	1			
25/02/2008	lung	4				3	
28/02/2008	lung	6				6	
,,	liver	11	2			4	5

Annex 3: Rapid human questionnaire survey format used in Atsibi district of Tigray Regional State.

During the retrospective survey of human cases in six zonal hospitals most of the human cases from Mekelle hospital were admitted from Atsibi district (Atsibi town). Because of this reason a rapid questionnaire survey was conducted to Veterinary professional, Human health center personnel, Butchers and selected residences in Atsibi district.

- Name of the Vet or human professional, butchers or from other occupation ……
- Sex: Male ……..Female …….
- Age …….
- Animal population in Atsibi district:
    - Cattle ……..
    - Sheep ……..
    - Goat …….
    - Equines ……
    - Pet animals ……
- Major animal diseases of Asibi district:

  A/ Scientific name…….. Local name ……

  B/ Scientific name…….. Local name…….

  C/ Scientific name…….. Local name ……..

  D/ Scientific name…….. Local name……
- Importance of zoonotic disease :

  Major zoonotic diseases of Atsibi district
    - Scientific name …….. Local name ……
    - Scientific name …….. Local name……
    - Scientific name …….. Local name ……
    - Scientific name …….. Local name……
- If you have any zoonotic diseases how do you challenge?

  A. Prevention method ……

B. controlling method……

- Do you have small scale slaughter house?

  Yes …….. No... …….

- If the answer is (yes) please clearly explain the status of small scale slaughter house

……

……

- Do you have assistant meat inspector?

  Yes…….. No ……

- If the answer is yes please indicate the major lesion in countered from visceral organs

  Lung …….. Liver ……. heart …… spleen ……Kidney……

- Type of condemnation?

  A / Total condemnation …….. B/ partial condemnation……

- Knowledge about hydatidosis disease by the human health center and Veterinary Professionals and the basic major have taken?

  ……

  ……..

. ……

- Did you suspect hydatidosis?

  Yes……. No……..

- If the answer is yes explain clinical symptoms and control major

  ……

  ……

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Annex 4: Questionnaire survey format to assess zoonotic importance of echinococcosis/hydatidosis for selected zonal hospitals of Tigray Regional State.

- Name of Zonal Hospital……
- Number of physicians……

  Specialists……..

  Nurses……

  Others ……
- Number of patients for any medical service visiting the Hospital for the last 5 years:

  1999 ……

  1998…….

  1997…….

  1996…….

  1995…….
- Do you suspect echinococcosis?

  Yes…… No…….
- If the answer is yes describe the signs and symptoms of echinococcosis

  ……

  ……

  ……

  ……
- Patient ID ……..
- Origin ……
- Location of cysts ……..
- Age …….
- Sex …….
- Diagnosis method …….
- Any prurience …….

- Number of patients regarding echinococcosis/hydatidosis for the last 5 years:

  1999 ……

  - Age group: Child Male…… Female…….
  - Young: Male……Female…….
  - Adults: Male……Female…….

  1998…….

  - Age group: Child Male…… Female…….
  - Young: Male……Female…….
  - Adults: Male……Female…….

  1997…….

  - Age group: Child Male…… Female…….
  - Young: Male……Female…….
  - Adults: Male……Female…….

  1996…….

  - Age group: Child Male…… Female…….
  - Young: Male……Female…….
  - Adults: Male……Female…….

  1995…….

  - Age group: Child Male…… Female…….
  - Young: Male……Female…….
  - Adults: Male……Female…….

- Diagnostic tools:

  …….

  …….

- X-Ray film ……
- Other additional information…….
- Treatment……..

Annex 5: Meat Inspection daily recording format

Serial Number ……

Date ……

- Name of abattoir …….
- Number of slaughterer animals ……**.....**
    - Sex: Male ……. Female ……
    - Age: Young …… Adult ……
- Number of inspected animals …….
- Number of animals positive for hydatidosis……
- Lesion descriptions: (size of cyst)
    - Liver: Large…… Medium …… Small ……
    - Lung: Large …… Medium ……Small……
    - Kidney: Large …… Medium …… Small ……..
    - Heart: Large…… Medium ……. .Small ……
    - Spleen: Large…… Medium…….. Small……

9. CURRICULUM VITAE

Personal Data:

- Name - Kebede W/Giorgis.
- Date of birth - June 14/06/58
- Place of birth - Tigray region in Adwa Awraja.
- Marital status - married with three children.
- Nationality - Ethiopian.
- Profession - Veterinarian.
- Occupation - Regional Animal health team leader in Tigray Regional state.

Educational background:

- 19667 - 1970: Wezero kelemework Elementary School (1-6 Grade)
- 1971 -1972: Arbegnoch Junior Secondary School Addis Ababa (7 - 8 Grade)
- 1973 - 1976: Medehane Alem Sc.school Addis Ababa (9 - 12 Grade)
- 1978 -1985: Previous USSR in Moldavia republic (DVM Degree)
- January/1997: Training on Skin disease of small ruminants (Certificate)
- February/2002: Training on Veterinary Privatization in Zambia (Certificate)
- April/2004: Training on disease free zone and Quarantine in Namibia (Certificate)
- August/2008: Addis Ababa University Faculty of Veterinary Medicine (MSc fellow)

Work experience:

- 1986: Eastern Harerge Region (Garamuleta Awraja): Veterinarian
- 1988: Eastern Hareregе (Web era Awraja): Livestock team leader
- 1988 -1993: Eastern Hareregе region. Regional Animal Health team leader
- 1994: In Tigray Regional State Southern zone: Zonal Veterinarian
- 1995: In Tigray Regional State Central zone: Zonal Veterinarian
- 1996-2002: Bureau of Agriculture and Rural Development Regional Senior Veterinarian: Tigray Regional State.
- 2002-2004: Bureau of Agriculture and Rural Development Regional Animal Health Team Leader: Tigray Regional State.
- 2005: Bureau of Agriculture and Rural Development acting livestock department head: Tigray Regional State.
- 2006-2008: Bureau of Agriculture and Rural Development Regional Animal Health Team Leader: Tigray Regional State.

Special skills:

- Computer skills in MS DOS, MS Words, MS Excel, MS Access, MS power point and SPSS.

Languages:

- Tigrigna: speaking and writing.
- Amharic: speaking and writing.
- English: speaking and writing.
- Russian: speaking and writing.

Publications:

- Current status of slaughter house and identifying solutions in Tigray Regional State.
- Zoonotic Importance of Hydatidosis in Cattle and Humans in selected areas of Tigray Regional State (MSc Thesis).

Reference:

Dr. Germa Zewde (DVM, PhD, Associate Professor)

Dr. Hagos Ashenafi (DVM, MSc, Assistant Professor)

10. SIGNED DECLARATION SHEET

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any university and that all source of materials used for the thesis have been duly acknowledge.

Name: _____

Signature: _____

Date of submission: _____

This thesis has been submitted for examination with our approval as University advisors.

Academic Advisors:

Dr. Girma Zewede (DVM, PhD, Associate Professor) _____

Dr. Hagos Ashenafi (DVM, MSc, Assistant Professor) _____