ADDIS ABABA UNIVERISTY

COLLEGE OF VETERINARY MEDICINE AND AGRICULTURE

STUDY ON THE RISK OF HUMAN TAENIASIS AND PREVALENC OF BOVINE CYSTICERCOSIS IN JIMMA TOWN, SOUTHWESTERN OROMIA

BY

MERON TALU

June, 2012
Debre- Zeit, Ethiopia

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A thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfilment of the Requirement for the Degree of Masters of Veterinary Science in Tropical Veterinary Public Health

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LIST OF ABBREVIATIONS

CSA	Central Statistic Authority
FAO	Food and Agricultural Organization
MoA	Ministry of Agriculture
OIE	Office International des Epizootics
P-value	Probability value
WHO	World Health Organization

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ABSTRACT

A cross-sectional study was conducted from December 2011-March 2012 to estimate the prevalence of *Cysticercosis* in cattle slaughter at Jimma abattoir and risk of human infection through raw meat consumption at butcheries of Jimma town. Interview was conducted on 120 residents to know the risk of infection through raw meat consumption. Active abattoir survey and questionnaire survey were performed to accomplish the study. Of the total 600 inspected animals, 15 animals had varying number of *C. bovis* giving a prevalence 2.5% (15/600), a total of 41 cysts were collected and anatomical distribution of cysticerci were; 12 (29.3%) in shoulder muscle, 9 (21.9%) in neck muscle, 5 (12.2%) in tongue, 5 (12.2%) in heart, 4 (9.8%) in masseter muscle, 4 (9.8%) in liver and 2 (4.9%) in kidney. Of the total 120 interviewed respondents/ consumers, 66.6% (80/120) had contracted the disease at least once in the last two years and maximum infestation was three times per year. The majority of the respondent had an experience of raw meat consumption as a result of traditional and cultural practice. The infestation varied significantly ($p< 0.05$) with age group, sexes, habit of raw meat consumption and religion of the respondents. However, there was no significance ($p>0.05$) difference between educational level and martial status of the respondents. The findings of this study indicated the importance of cysticercosis and taeniasis in public health aspects in the area. Therefore, due attention should be given to the public awareness and strict routine meat inspection in order to safe guard the public health and promote beef industry in the country.

Keywords: Abattoir, *C.bovis*/Taeniasis, Cattle, Prevalence, Public Health.

1. INTRODUCTION

Many emerging and re-emerging diseases of humans are caused by pathogens which originate from animals or products of animal origin. There are a number of zoonotic diseases that can be transmitted from animal to humans in various ways. Wide variety of animal species, both domestic and wild, acts as reservoirs for these pathogens, which may be viruses, bacteria or parasites. Given the extensive distribution of the animal species affected and the ineffective surveillance, prevention and control of zoonotic diseases pose a significant challenge (Meslin *et al*. 2000).

In the past zoonotic diseases were limited to populations living in low- and middle-income countries, but the geographical limits and populations at risk are expanding and changing because of increasing international markets, improved transportation systems, and demographic changes. Most parasitic zoonoses are neglected diseases despite causing a considerable global burden of ill health in humans and having a substantial financial burden on livestock industries. Although the global burden for most parasitic zoonoses is not yet known, the major contributors to the global burden of parasitic zoonoses are toxoplasmosis, food borne trematode infections, cysticercosis, echinococcosis, leishmaniasis and zoonotic schistosomasis (Torgerson and Macpherson, 2011).

Bovine cysticercosis refers to the infection of cattle with metacestodes of the human tapeworm (Oladele, 2004). Ingested eggs develop into cysticerci, which can often be detected during meat inspection at the routinely inspected localization sites of the parasite, including heart, skeletal muscle and diaphragm (Gracey *et al*., 1999). Most incidents in cattle arise as a result of direct exposure to proglottids shed from farm workers, but there have been some reports of large scale outbreaks resulting from sewage-contaminated feed or forage (Gracey *et al*., 1999).

Human beings are the obligate final host and become infected by ingesting beef having the parasite that has been inadequately cooked or frozen. *Taenia saginata* occurs in the small intestine of human and the metacestode (*Cysticercus bovis*) is found in cattle (Pawlowski and Murell, 2001, Caparet *et al*., 2002). The life cycle and transmission of *T. saginata* occurs most commonly in environments characterized by poor hygiene, poor sanitation, poor livestock husbandry practices and inadequate meat inspection and control and also where inhabitants

traditionally eat raw or insufficiently sun cured or cooked meat (Caparet *et al*., 2002, Minozzo *et al*., 2002).

Cysticercus bovis/ *Taenia saginata* highly distributed almost all over the world, with very low prevalence in developed countries, where under cooked beef steak is consumed rarely. Moderate prevalence levels are seen in southern Asia. High prevalence rates occur in Sub-Saharan Africa, where it causes an important economic loss due to partial or total condemnation of infected carcasses (Wayne *et al*., 2002). In Ethiopia, there are different reports regarding the prevalence of taeniasis. Examples are 89.41% reported by Tembo (2001), 64.2% by Abunna *et al*. (2008), 51.1% by Regassa *et al*. (2008), 56.7% by Megersa *et al.* (2009) and 64.44% by Taresa *et al*. (2011) based on questionnaire surveys.

On the other hand the prevalence of cysticercosis reported was between 3.1 and 4.9% in Central Ethiopia, Jimma and Gondar (Tembo, 2001; Dawit, 2004; Megersa *et al*., 2009; Taresa *et al*. 2011), and 13.3-26.3% in Hawassa and Wolita Sodo (Abunna *et al*., 2008; Regassa *et al*., 2008), based on Abattoir survey. However, none of the reports addresses the direct risk of human to *Taenia saginata* through consumption of infected carcasses and the associated factors for exposure. Assessing the magnitude of risks associated with consumption of raw meat from known infected carcases is essential to estimate the possible infection prevalence of *T. saginata* and design acceptable control strategy.

Therefore, the objectives of this study were:

- To assess the direct risk of human infection by *Taenia saginata* through consumption of raw meat from known infected carcasses at Jimma.
- To estimate the prevalence of C. *bovis* in cattle slaughtered at Jimma municipal abattoir.
- To estimate the prevalence of human taeniasis /*Taenia saginata* in the area through questionnaire survey.

2. LITERATURE REVIEW

2.1. Taxonomy and morphology

Taenia saginata and its metacestode *Cysticercus bovis*, belong to the class Cestoda order Cyclophyllidea Family Taeniidae and Genus Taenia. *Taenia saginata*, the human tapeworm, is a large worm measuring 3-10 meters in length and rarely the adult measures up to 15 meters (Urquhart *et al*., 1996). It resides in the small intestine of humans where it attaches using its scolex and can survive for many years.

The adult is ribbon-shaped, multi-segmented and hermaphroditic flatworm its body divided into three distinct parts consisting of scolex (head), neck and strobila (Gracey, 1981; Soulsby, 1982). The scolex, measuring 1mm to 2mm in diameter, has four strong hemispherical suckers. There is no rostellum and hooks and the predilection site in the intestinal mucosa is in the proximal part of the jejunum (O.I.E., 2000). The neck is short unsegmented with a germinal structure immediately behind the scolex, which continuously produces proglottids (Urquhart *et al*., 1996). The strobila is a chain of segments made up of sexually immature and mature gravid segments in linear sequence. Each segment is called progllotid and strobilization occurs at the distal part of the neck (Soulsby, 1982). An adult *T. saginata* tapeworm has 600 to 2000 segments each of which is hermaphroditic with one set of reproductive organs and genital pores which open on the lateral margin(s) of the segment (Doyle *et al.,* 1997). Self and cross fertilization between and among proglottids is possible. The gravid proglottids are 15 to 35mm long and 5 to 7mm wide and filled with eggs which detach from the strobila singly. This implies that coproscopic examination has a limited value in the diagnosis of Taenia saginata infection (Doyle *et al.,* 1997). It is estimated that each graved segment can contain as many as 80,000 to 100,000 eggs and an infected person may shed about 24 - 50 million eggs daily (Gracey, 1981; Teka, 1997).

Eggs passed in feces or discharged from ruptured gravid segments are subspherical to spherical in shape. The egg consists of the hexacanth (6-hooked) embryo (oncosphere), thick dark brown to yellow in color. There is an outer oval membranous coat, the true egg shell, which is lost in fecal eggs (Harrison and Sewell, 1991; Brown and Neva, 1983). It measures 30-41 micrometers in diameter and 46 to 50 micrometers in length (O.I.E., 2000). The eggs survive up to 200 days in moist manure, 33 days in river water, 154 days on pasture and are resistant to moderate desiccation, disinfectants and low temperature (4-5°C) (Doyle *et al*., 1997).

The larval stages (*C. bovis*), or metacestodes also referred to as "beef measles", are found in all striated muscles of the intermediate host. *C. bovis* is a small (pea-sized) oval in shape (O.I.E., 2000), semi-translucent cyst filled with dense white fluid containing an invaginated scolex. The metacestode is morphologically similar to the future adult tapeworm. It measures about 10 mm in diameter and 6 mm in length (Doyle *et al*., 1997). When incised, the cyst may be viable containing a thin fibrinous capsule or degenerate showing cream or green colored calcification (O.I.E., 2000). The cysticerci are formed over a period of 3-4 months after the egg is ingested. This form may remain viable in the intermediate host for up to 9 months or even up to the entire life of the host. In the carcass, *C. bovis* can survive for about 15 day's at-5°C, 9 days at 10°C and 6 days at-15°C to -30°C (Harrison and Sewell, 1991). If a carcass is found to contain cysts, it is required to be frozen at -10^{o}c for 10 days, however if the lesions are extensive, the entire carcass is condemned (Yoder *et al*., 1994).

2.2. Epidemiology

Taenia saginata, Taeniasis occurs throughout the world with variable degree of prevalence (Harrison and Sewell, 1991). Its prevalence could be classified into three groups: High prevalence with Taeniasis exceeding 10%, Moderate infection rates (0.1-10%) and Low infection rate less than 0.1% (Doyle *et al.*, 1997; Minozzo et al., 2002). Poor hygiene, poor sanitation, poor livestock husbandry practices and inadequate meat inspection and control and also eating raw or insufficiently cooked meat can be risk factors for the spread of the disease (Caparet *et al*., 2002, Minozzo *et al*., 2002).

In developing countries, cattle are reared on extensive scale, human sanitation is of comparatively lower standards and the inhabitants traditionally eat raw or inadequately cooked beef. Based on routine carcass inspection, the infection rate of bovine cysticercosis is often around 30-60% in developing countries although the real prevalence could be considerably high (Tembo, 2001). *T. saginata* infections also occur in developed countries, where standards of sanitation are high and meat is carefully inspected and generally thoroughly cooked. Taeniasis/cysticercosis spreads in developed areas of the world through tourists enjoying the consumption of lightly grilled meat, mass migration of labor and the export of meat unreliably

passed by ‘’eye or knife’’ inspection or from live animals imported from endemic areas (Mann, 1984).

Human feeding habits and modes of life are responsible for the spread of *T. saginata* infections. Man’s customs and traditions of consuming raw meat and inadequately cooked beef dishes like steak tartar in Europe and Kurt and Kitfo in Ethiopia containing viable bladder worms perpetuate human infection. Cattle are infected by ingestion of pasture and drinking water contaminated with *T. saginata* eggs (Teka, 1997).

Cattle are the preferred intermediate hosts and humans are the only final hosts of *T. saginata*. Cattle of all ages are susceptible; however young age groups are more susceptible. Parasitism is sometimes observed in other ruminants (sheep, goats, antelopes, gazelles, buffaloes) but Cysticercus development is unlikely. Management of animals in their natural environment predisposes them to infection. Cattle grazing communally have a higher risk of picking up *T. saginata* eggs since they are frequently in contact with human feces compared to commercial herds (Harrison and Sewell, 1991). In developing countries cattle are reared on extensive scale, human sanitation is poorly developed which makes the incidence of *T. saginata* infection in humans very high. Calves are infected usually in early life, often with in the first few days after birth from infected stockmen whose hands are contaminated with Taenia eggs (Maedia *et al*., 1996). In Africa, inadequate education of population and low accessibility to safe taenicides has favored the spread of *Taenia saginata* (Pawlowski, 1996).

Reports have demonstrated very high but varied prevalence rates of human infection/Taeniasis in different agro-climatic zones of the country suggesting that the problem is widespread and contributes for the maintenance of infection in the intermediate host, cattle. On the other hand the prevalence of bovine cysticercosis was reported to be lower in Central Ethiopia, Jima, Gondar and Addis Ababa, and significant at Hawassa, Wolaita Sodo and Debre Zeit (Table 1). While this could be a possibility, it may also be attributed to the ineffectiveness of the routine meat inspection technique and the varied skills of meat inspectors to demonstrate the parasite.

Table 1: Prevalence of Cysticercosis and Taeniasis in different parts of Ethiopia.

Study area	Prevalence in %		References
	C.*bovis*	T.*saginata*	
Central Ethiopia	3.1	89.41	Tembo (2001)
Hawassa	26.3	64.2	Abunna *et al*., (2008)
Jimma	4.4	56.7	Megersa *et al*., (2009)
Jimma	3.65	64.4	Taressa et al., (2011)
Wolita Sodo	13.3	51.1	Regassa *et al*., (2008)
Gondar	4.9		Dawit (2004)
Addis Ababa	2.2%		Teka (1997)

2.3. Life cycle

After the eggs are deposited in the soil or vegetation they are ingested by cattle or other herbivores. In ruminants, the thick embryophore of the ova remains un- affected in its passage through the first three compartments of the stomach. On reaching the abomasum it is exposed to the action of pepsin, which destroys the cementing substance (Symth, 1994). In the duodenum it is further affected by the pancreatic secretion and disintegrates releasing the onchosphere still contained within its ellipsoidal onchospheral membrane (Harrison and Sewell, 1991). Histolytic secretion released by the onchosphere assists in invading the intestinal epithelium and is carried by vascular channels to the striated muscles in the hind limb, diaphragm and tongue. Here, it is filtered out and transformed into an ovoid bladder warm or cysticercus over a period of 3-4 months (Teka, 1997; O.I.E, 2000). Man ingests the cyst in raw or under-cooked beef where the parasite develops to adult stage in the small intestine and completes its life cycle (Hancock *et al*., 1989). After ingestion of the cyst, about two months is required for the adult worm to develop in the intestine (Symth, 1994).

2.4. Clinical manifestations

The clinical manifestations in humans include abdominal pain, nausea, debility, weight loss, flatulence and diarrhea or constipation. A patient may have one or several of these symptoms and a high percentage of patients experience gastric hyposecretion. Individual reactions to the infection differ and may be influenced by psychogenic factors, since patients often notice symptoms only after they see proglottids (Symth, 1994). Signs like those of epigastric discomfort, hunger sensations and irritability were also observed in infested individuals (Harrison and Sewell, 1991).

Light or moderate cysticercosis in cattle is not usually associated with any defined clinical picture. Heavy infections, those induced experimentally by 200,000 to 1,000,000 *T. saginata* eggs, may give rise to fever, weakness, profuse salivation, anorexia, increase heart and respiratory rates and a dose of one million or more eggs may cause death between 14 to 16 days due to a degenerative myocarditis (Oryan *et al*., 1998).

2.5. Diagnosis

Definitive diagnosis is based on identifying the proglottids, since the eggs of *Taenia saginata* cannot be distinguished from those of other species of Taenia. The gravid proglottid of *T. saginata* has 15 to 35 lateral branches of the uterus on each side of the main uterine stem (Harrison and Sewell, 1991; Teka, 1997). If the gravid proglottids is treated with 10% formaldehyde and injected with india ink the uterine branches are very prominent. Uterine branches also can be seen by gentle pressing the proglottid between two microscope slides and holding them in front of a bright light (O.I.E., 2000). If the scolex is present, the four characteristic hookless suckers can be used as a distinguishing feature for identification (Symth, 1994).

The development of DNA probes has made it possible to distinguish *T. saginata* from *T. solium*. Sensitivity of serological tests varies depending on the particular method and the clinical form of infection (Doyle *et al*., 1997). A “dip stick” technique based on an antigen capture ELISA, to detect coproantigens in feces has been developed for Taenia species in humans (Zarlenga and Rhoods, 1999). The metacestodes are readily visible in the organs or musculature at autopsy and

therefore; diagnosis of bovine cysticercosis is usually made during post mortem examination in abattoirs and packing plants (Moreira *et al*., 2001; Kumba *et al*., 2001). Individual countries have different regulations regarding the inspection of carcasses, which usually attempts to reconcile the interests of owners and those of the consumers (Harrison and Sewell 1991). Meat inspection relies exclusively on visual examination of the intact and cut surfaces of the carcass (eye-and-knife method) in the slaughterhouse by meat inspectors who follow officially laid-down procedures (Yoder *et al*., 1994). Individual countries have different regulations regarding the inspection of carcasses, but invariably the masseter muscle, tongue, and heart are incised and examined. Diaphragm, muscles of the hind limb, liver, esophagus, lungs, kidneys, spleen and intercostals muscles are also potential sites for cyst location (Maeda *et al*., 1996; Dorny *et al*., 2000). However, the classical meat inspection techniques cannot detect all of the carcasses infected with cysticerci (Harrison *et al.,* 1997; Dorny *et al*., 2000).

The effectiveness of meat inspection in the detection of *C. bovis* depends on the procedure used. The following are laid as normal routine inspection of carcasses by the Ministry of Agriculture in Ethiopian Meat Inspection Regulation Notice Number 428 of 1972 and the Meat Control Act of Kenya (MOA, 1972).

- Visual inspection and palpation of the surfaces and a longitudinal ventral incision of the tongue from the tip of the root
- One deep incision into the triceps muscles of both sides of the shoulder
- Extensive deep incision into external and internal muscles of the masseter parallel to the plane of the jaw
- Visual inspection and longitudinal incision of the myocardium from base to apex, but more incision are also allowed when necessary
- Visual inspection and 3 parallel incisions into the long axes of the neck muscles on both sides
- Two parallel incisions on the thigh muscles of both hind legs
- Careful inspection, palpation and two parallel incisions into the diaphragmatic lobes of the lung through the lung substances
- Visual examination of intercostal muscles and incisions when necessary
- One extensive incision into the fleshy part of diaphragm; visual examination, palpation and incision of kidneys, liver, oesophagus and associated lymph nodes

In spite of this, minor infections are difficult to detect irrespective of laws and the skill of the inspector. If a Cysticercus is found in any of these sites and organs, thorough inspection of the whole carcass and offal should be done. The location, nature and number of cysts should be recorded (MOA, 1972).

2.6. Prevention and Control

Lack of and improper use of latrine or open field defecation leads to contamination of grazing lands. The use of latrine reduces spread of *T. saginata* eggs. Controlled grazing, avoiding use of sewage effluent to fertilize pasture, prevents infection in cattle (Symth, 1994). Adequate meat inspection, abstinence from eating raw or inadequately cooked beef (thorough cooking of meat at a temperature of 56 - 60^0c) and freezing the infected carcass at -10°C for 10 days prevents human infection. Chemotherapy in humans reduces the spread of eggs and infection in cattle (Solusby, 1982).

There are a number of taenicidal drugs available in the market. However the drug of choice in treating Taeniasis is niclosamide (Niclocide, Yomesan). Adult dose rate of 2000 mg is effective in damaging the worm to such an extent that a purge following therapy often produces the scolex. Praziquantel (Bilitricide) at a dose rate of 5 to 10 mg per kg also has been reported highly effective (Doyle *et al*., 1997) but the scolex is partially digested and often not recovered (Symth, 1994). Other drugs used in the treatment of *T. saginata* are mebendazole (Doyle *et al*., 1997) followed by purgatives such as magnesium sulphate to expel the dead worms. In animals treatment with 50mg/kg of compounds such as albendazole, praziquatel or mebendazole can be given but they are considered not fully effective (Symth, 1994; Soulsby, 1982). Praziquantel at this dose for four days is reported effective but this is proved impractical because of high cost (Reinecke, 1983).

Recombinant vaccines have been developed using non-living antigens of the parasite, host. Protective responses that can be induced readily in the intermediate hosts may be used to control the infection in cattle (Lightowlers *et al*., 1996).

A number of traditionally used medicinal plants are also found effective against taeniasis in humans. This include those commonly utilized in different parts of Ethiopia such as the flowers

of *Hagenia abyssinica* (*Kosso*), the fruit of *Embelia schimperi* (*Enkoko*) and seeds of *Glinus lottoides* (*Metere/Amkint*) (Kloos *et al*., 1978; Tembo, 2000).

Improvement of an effective control programme has to include actions intervening at various points of the *T. saginata* life cycle. It will require a coordinated approach among all stakeholders: consumers, medical doctors and pharmacists, directors of sewage treatment plants, meat inspectors, veterinary practitioners and farmers (Kyvsgaard and Murrell, 2005; Cheruiyot and Onyango-Abuje, 1984; WHO, 1983).

2.7. Zoonotic importance

Man is the only final host where the adult *Taenia saginata* resides in the small intestine. The size reached by the adult worm is related to the number of worms present (Maeda *et al*., 1996). In a single worm infection, a worm can develop longer and produce large number of proglottids (Symth, 1994). Multiple infections up to 20 tapeworms in one host have often been reported in developing countries (Mann, 1984). The effect on human health is generally slight and symptoms may be vague or absent. However, taeniasis has a debilitating effect on people who live on protein deficient diets and those who suffer from iron deficiency and infected by hookworm (Mann, 1984).

Taeniasis causes various symptoms, which probably depend very much on the psychological and physical characteristics of the host. Some patients lose their appetite and thus lose weight while others tolerate the infection. Sometimes the gravid proglottids of *T. saginata* migrate to different organs appendix, pancreatic duct, nasopharyngeal pathways and bile ducts producing obstruction and inflammation of the affected organs (Florova, 1982). Tapeworms can also cause intestinal obstruction (Doyle *et al*., 1997). *T. saginata* in the small intestine of man absorbs digested food. From the day the Cysticercus is ingested it may take 2-3 months for the parasite to produce ripe segments. As long as the scolices are attached to the intestinal mucosa of the victim new segments will continually grow to replace those, which are being detached from the worm (Teka, 1997).

2.8. Economic Importance

Attempts to reduce the prevalence of *T. solium* and *T. saginata* in humans and their cysticerci in animals (pigs, cattle) may have a considerable impact on the economics of meat production industries. Cysticercosis in domestic animals is a significant food safety problem and causes economic loss in food production. This will be particularly important where export industries are involved, since most importing countries have stringent regulation designed to prevent the importation of infected meat (Harrison and Sewell, 1991). The cost implication can be broken down into those involved in treating human taeniasis and cattle carcasses (costs of freezing, boiling) or condemned, as well as the costs involved in the inspection procedures that amounts to millions of dollars (Mann, 1984).

An annual loss due to treatment in USA was USD 100, 000 (Robert, 1985). Similarly, different reports have shown that losses due to treatment of human taeniasis are significant, Megersa *et al*., (2009), reported 4,913,346 adult taeniacidal drugs doses worthing 72,190,21 Eth, Birr (820,343 USD) in Jimma. Carcasses shall be considered excessively infested and totally condemned if incision in various parts of the musculature exposes on most of the cut surfaces (Hubert, 1974). In this regard, findings so far reported in Ethiopia have demonstrated losses due to partial condemnation of carcasses and edible internal organs. Examples are: - liver, kidney, heart.

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted from December 2011-March 2012 at Jimma town in Oromia National Regional State. The town is located 352 km Southwest of Addis Ababa at latitude of about $7^0$13'-$8^0$56' North and longitude of about $35^0$52'-$37^0$37' East, and at an elevation ranging from 880 m to 3360 meter above sea level (Figure 1). The study area receives a mean annual rainfall of about 1530 millimetres that comes from the long and short rainy seasons. The mean annual minimum and maximum temperatures are 14.4 and 26.7°C respectively with dominant warm and humid weather condition (MoA, 2008). The town has total population of 159,009 of which 80,897 were males and 78,112 were females (CSA, 2008). According to reports of Jimma agricultural office (2008) the livestock population in Jimma zone is composed of 2,016,823 bovine, 942,908 ovine, 288,411 caprine, 74,574 horse, 49,489 donkey, 28,371 mules and 1,488,848 chickens.

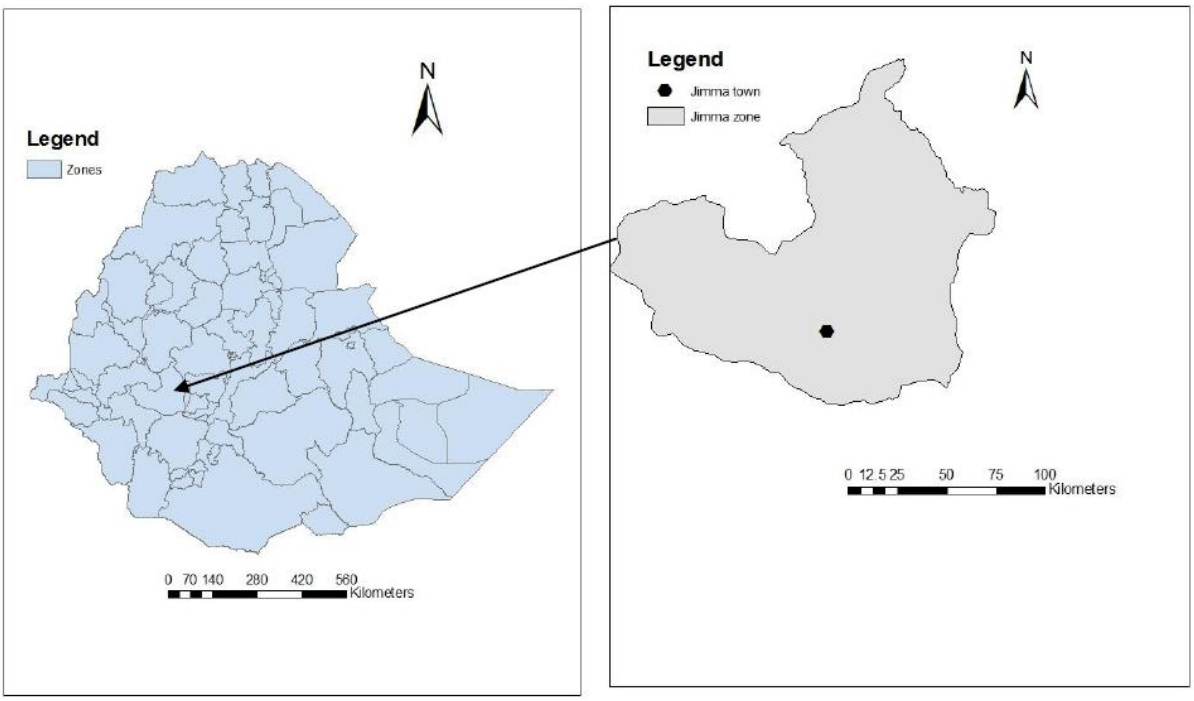

Figure 1. Map of the study area

3.2. Study population and design

The study is a cross - sectional type in which a structured questionnaire survey, and active abattoir survey supported by follow up of *C. bovis* infected carcasses to destinations of butcheries and consumers of the study area. Animal study population were cattle presented to Jimma municipal abattoir for slaughtering. On the other hand, identification of respondents for questionnaire survey was based on selection of volunteer individuals getting services at butcheries of Jimma town. On the days where cyst-positive carcasses were detected, those carcasses were followed to their destinations to butcheries. Daily, until all the meat was sold, customers/consumers who visited the butcher house were systematically (every other customer ordering any service) selected for the interview. The population of customers had different age, sex, martial status, habit of raw meat consumption, education and religion.

3.3. Sample size determination

A systematic random sampling technique was applied on those animals that came to the municipal abattoir. Starting from the first one, every other animal entering the slaughter house after ante mortem inspection was considered and marked. Ten animals were examined each slaughter day. By considering 3.65% expected prevalence, the desired sample size (n) for the study was calculated using the formula given by Thrusfield (1995) with z-95% confidence interval (1.96) and 5% absolute precision/ margin error (d). Accordingly, 26 animals were desired. However, to minimize sampling error and maximize accuracy, 600 carcasses were inspected during the study period for the presence of *Cysticercus bovis* cyst in different organs. Almost all cattle brought to the abattoir were oxen of local zebu (*Bos indicus*). For the questionnaire survey, 120 volunteers were selected and interviewed individually using semi-structured questionnaire.

3.4. Study Methodology

3.4.1. Questionnaire survey

Questionnaire survey respondents identified for this study were questioned on their habit of raw meat consumption, frequency of consumption, experience of taeniasis infection and finding of proglottids in their faeces, underwear. Religion (Christian/ Muslim), educational status (educated/ non educated), age (less than 18 years/ greater than 18 years old), sex (Male/ female), marital status (married / single) of the respondents was also registered as possible risk factors.

3.4.2. Active abattoir survey

According to the guideline by Ministry of Agriculture (1972), routine meat inspection technique was employed for detecting *C. bovis* cysts, the meat was inspected visually, followed by a longitudinal ventral incision of the tongue from the tip of the root, one deep incision into the triceps muscles of both sides of the shoulder, deep incision into external and internal muscles of the masseter parallel to the plane of the jaw, longitudinal incision of the heart from base to apex, 3 parallel incisions into the long axes of the neck muscles on both sides as well as one extensive incisions on the diaphragm; visual examination, palpation and incision of liver and kidneys. Findings were registered according to the organs inspected.

3.4.3. Follow up survey

Once *C.bovis*-positive carcass was identified at the slaughter house, it was followed up to its destination at the butchery. Here, the amount of meat consumed raw at the butchery and sold for take away but still to be consumed raw in the form of *Kurt* (meat cubes) and *Kitfo* (minced beef) was registered until the major part of the carcass was finished.

3.5. Data Analysis

Abattoir and questionnaire data collected were entered and coded and preliminary analysis was done using Microsoft Excel work sheet (Microsoft Corporation). The abattoir data were summarized and prevalence was calculated for the area using Microsoft Excel work sheet.

Anatomical distribution of *C.bovis* tabulated. The questionnaire data were also summarized and analysed to assess the association of potential risk factors for taeniasis among different respondents using univariate logistic regression Stata version 9 special Edition USA. The odds ratio (OR) and 95% confidence interval (CI) was calculated to assess strength of association of different factors to the occurrence of the disease in humans. P- Value less than 0.05 considered significance ($p< 0.05$).

4. RESULTS

4.1. Questionnaire survey

Of the 120 interviewed respondents who participated in this study, 66.6 % (80/120) had contracted *T. saginata* infection at least once in their life. The majority of the respondents had an experience of raw meat consumption as result of traditional and cultural practice. The logistic regression analysis of the risk factors showed (Table 2) that the prevalence was reported to be significantly higher in respondents above 18 years of age than in people younger than 18 years old, in male than in female respondents, in Christian than Muslim respondents and in frequent consumers of raw meat consumers than in occasional consumers ($p< 0.05$).

Table 2: Univarible logistic regression result of potential risk factors for Taeniasis prevalence among the interviewed respondents in Jimma.

Variables	No respondents	No Infected	Prevalence (%)	P-value	OR (95%CI)
Age					
< 18yrs	36	20	55.5		
> 18yrs	84	60	71.4	0.002	2.08 (2.16-30.1)
Sex					
Female	30	10	33.3		
Male	90	70	77.7	0.004	3.11 (2.67-189.3)
Religion					
Muslim	52	23	44.2		
Christian	68	57	83.8	0.002	1.65 (1.85-14.8)
Education					
Educated	61	40	65.6		
Non educated	59	40	67.8	0.247	0.54 (0.23-1.45)
Martial status					
Married	50	25	50		
Single	70	55	78.6	0.144	0.72 (0.18-1.28)
Raw meat consumption					
Occasional	52	24	46.2		
Once per week	56	45	80.4		
Almost daily	12	11	91.7	0.001	1.8 (2.3-31.3)

4.2. Abattoir survey

Of the total 600 inspected animals in Jimma municipal abattoir, 15 animals had varying number of *C.bovis* with an over all prevalence of 2.5% (15/600). Analysis of the active abattoir survey showed that there was a significant variation with regard to the anatomical distribution of Cysticercus cysts in the organs inspected. As indicated in Table 3, the highest proportion of *C.bovis* cyst were observed in shoulder muscle (29.26%) followed by neck muscle (21.95%).

Table 3: Bovine cysticercosis in different organs of cattle found positive at Jimma abattoir

Organs	Frequency of cyst recorded	Prevalence (%)
Shoulder muscle	12	29.3
Neck muscle	9	21.9
Tongue	5	12.2
Heart	5	12.2
Masseter muscle	4	9.8
Liver	4	9.8
Kidney	2	4.9
Total	41	

4.3. Follow up survey

After identification of the 15 infected carcasses in the abattoir, the destinations were tracked and butcheries receiving the carcasses located all in Jimma town. According to butcheries information on average, 30 kg/carcass of meat was sold for Kurt while 6 kg/carcass was sold for Kitfo. Hence, the total amount of meat sold for Kurt was 450 kg (15 carcasses) whereas, according to the customers information (restaurants) and butchers, half of the meat sold for Kitfo was consumed raw and therefore, 45kg (15 carcasses) of meat was consumed as raw Kitfo while the rest was consumed undercooked. Butchers and restaurant owners as well as personal

observations suggest that a kilo of Kurt was consumed by an average of 2 persons while a kilo of raw beef for Kitfo was served for 5 persons. Accordingly, the estimated risk of exposure to taeniasis infection in Jimma town was calculated by considering the number of animals slaughtered and the amount of raw meat consumed from infected carcasses (Table 4). During the study time an average of 20 cattle per day were presented for slaughter. This estimate did not take into account the remaining part of the carcass which could be consumed raw, products of backyard slaughter that may make significant part of beef supply and consumption of undercooked beef. The hump (*shagna*), neck muscle (*shint*), fore limbs (*worch/ nebero*), hind limbs (*talaq*) and ribs (*godin/ dabit*) were the preferred parts for raw beef consumption in study area.

Table 4: Estimated infection exposure of people to taeniasis through Kurt (meat cubes) and Kitfo (minced beef) per year at Jimma town.

Yearly estimate	**Consumption**
Animals slaughtered/year (average 20/day)	7300
KURT consumption/year (600 kg/day)	219000 kg
Raw KITFO/year (60 kg/day)	21900 kg
No of infected carcasses/year (2.5% prevalence)	183
Infected KURT consumed/year	5490 kg
Infected raw KITFO consumed/year	549 kg
No. of people exposed to infected KURT/year (2 /kg)	10980
No. of people exposed to infected raw KIFO/year (5 /kg)	2745
Total estimate of exposed people to infected raw meat	13725

5. DISCUSSIONS

5.1. Questionnaire survey

The prevalence of *T. saginata* or human taeniasis varies from country to country and even differs within the same country from area to area. This could be due to many factors, such as variation in the habit of raw meat consumption, awareness of patients about the clinical pictures of the disease and variation in personal and environmental hygiene. In the present study, the questionnaire survey respondents disclosed the finding of proglottids in their faeces, underwear, and laboratory diagnosis at health institution which indicates the presence of *T. saginata*. This is based on the WHO (1983) guidelines, which stated that *T.saginata* is known by its more frequent expulsion through anus than *T. solium.* The supporting evidence for the occurrence of *T. saginata* rather than *T. solium* among the respondents was that almost all of the residents of the town do not eat pork due to religious cult which confirms the current finding to be *T. saginata*, ruling out possible differential diagnosis of *T. solium.*

According to the respondents, 66.6% of them had contracted taeniasis at least once in their lifetime. This finding agrees with the observations of Abunna *et al*. (2008) who reported 64.2% in Hawassa, Taresa *et al*. (2011) who reported 64.44% and 56.6% by Megersa *et al*. (2009) in Jimma, 69.2% by Dawit (2004) in Gondar, 79.5% by Hailu (2005) in East Shoa. However, lower than report of Tembo, (2001), 89.41% in Addis Ababa. Assessment of predisposing/risk factors such as age, sex, religion, literacy and marital status showed that literacy level and marital status had no significant impact on the probability of a person being infected by *T. saginata*. The prevalence was higher in respondents older than 18 years of age. Similar reports were documented by Abunna *et al*. (2008) and Hailu (2005). The possible suggestion for this could be adult people had the habit of raw meat consumption than the younger population owing to the fact that children are not allowed to consume raw meat and adult individuals can financially afford consuming raw meat " Kurt or Kitfo" mainly at butcher houses.

The significance association between sex of the respondents and higher prevalence of infection of taeniasis could be due to economic reasons and culture practice in that male do not prepare their dish at home, rather frequently consume at restaurants and butcheries. Similar findings have also been reported previously (Hailu, 2005; Tembo, 2001) in different parts of Ethiopia.

Similar to the reports of Taresa *et al*. (2011), Tembo (2001) and Abunna *et al.* (2008), the present study showed taeniasis occurrence was higher among the Christian community than Muslims. This could be justified by the fact that most Muslim communities prefer small ruminants as a source of meat than beef. Abunna *et al*. (2008) and Tembo (2001) have also reported similar observations in other parts of Ethiopia where the tradition of raw beef consumption is more important in the christian community and the muslim communities prefer mutton and goat meat. The study also showed significantly higher prevalence of Taeniasis among individuals who often consume raw meat than those with occasional/ less frequent raw meat consumption. This is similar to the finding of Abunna *et al*. (2008), who reported higher prevalence of Taeniasis among raw meat consumers. In the present study variation was not observed among the people with different educational backgrounds and marital status although it tends to be higher in single respondents than married respondents.

5.2. Prevalence of *C. bovis*

The prevalence of bovine cysticercosis obtained in this study was 2.5%, which is relatively comparable to the findings of Tolossa *et al*. (2009), Tembo (2001) and Teka (1997) who reported respectively 2.93%, 3.1% and 2.2% in Jimma and Central Ethiopia. However, it is less than the levels observed by Hailu (2005), Abunna *et al*. (2008) and Regassa *et al*. (2008) who noted respectively 17.5% in East Shoa, 26.3% in Hawassa and 13.3% in Wolita Sodo. Similarly, higher prevalence were reported in many parts of Africa including 20% in Senegal, 27% in Tanzania and 38-62% in Kenya (Over *et al*., 1992) where as lower prevalences were reported from developed countries such as 0.26% in Crotia (Zivkovic *et al*., 1996), 0.48-1.08 in Germany (Abusier *et al*., 2006) and 0.9% in Cuba (Sau'rez, 2005). Factors like the method/skill of meat inspection, difference in the management and the number of cuts made on each organ during inspection can contribute for the variation of the prevalence (Wanzala *et al*., 2003). The variation may also be associated with poor sanitary infrastructure, low awareness and improper disposal of sewage particularly in developing countries. Accordingly, the lower prevalence of bovine cysticercosis in this study might be attributed to the variation in the personal and environmental hygiene, religion, culture and feeding habit of the population and their production system. The majority of animal producers (farmers) around Jimma from where slaughtered animals were originated are predominantly muslims who do not consume raw beef as frequent as christians.

Regarding the anatomical distribution of the cysts, in the present study the organs affected in order of the proportion of the cysts were shoulder, neck muscle, tongue, heart and Masseter muscle. These are frequently reported important predilection sites for *C. bovis*; a reason advanced for the frequent involvement of these muscles, being the increased blood supply due to frequent or continuous/rhythmic movement of the body parts (Gracey *et al*., 1999). The proportion of shoulder muscles affected with *C. bovis* in this study was 29.26% , which is in agreement with the reports of Taresa *et al*. (2011) and Regassa *et al*. (2008), 27% and 29.82% respectively. However, the present finding is lower than the findings of Megersa *et al*. (2009) and Hailu (2005), who recoded shoulder cyst proportion of 46.3% and 32% respectively.

5.3. Risk of human exposure to Taeniasis

In the present study, the part of the carcass served to consumer for 'Kurt or Kitfo' were fore limbs (*worch /nebero*), Neck muscle including lion muscles (*shint*), Ribs (*godin/ dabit*), Hind limbs (*talaq*), and hump (*shagna*). Except the hump, most of these sites are commonly preferred residential areas of *C. bovis* (Dorny *et al*., 2000). Hence, consumers' preference of these parts of the carcass due to palatability, look or other factors has a significant contribution for increasing risk of infection by the parasite.

Our observations also showed that abattoirs do not disclose information to butcheries on those carcasses found infected by *C. bovis*. This coupled with the tradition of raw beef consumption exacerbates the magnitude of the problem. Accordingly, by considering only carcasses passing through municipality abattoir at Jimma, it was possible to show that quite a large number of people consume from a single infected carcass suggesting direct exposure to the infection through raw beef. If the amount of raw beef consumed from back yard slaughter is included, no study has ever addressed this part, then the magnitude of the infection becomes much higher than the present estimate. Besides the health or pathological impact of the problem on the exposed population, the coast of treatment to expel the parasite from the body could also be very high. In this regard, Megersa *et al*., 2009) reported that 222,706 Eth, Birr and 72, 190, 21 Eth. Birr, a total of 74, 417, 27 Eth. Birr was lost due to taeniasis treatment expenditure in Jimma.

6. CONCLUSION AND RECCOMENDATIONS

Taenia *saginata* is a medically and economically important cestode parasite in humans, while infection with the Cysticercus larval stage in cattle causes economic loss in the beef / meat industry. This study indicated that taeniasis is a widespread problem with higher prevalence among the resident of Jimma town. Religion, habit of raw meat consumption, Age and Sex were identified to be the most important risk factors for the disease occurrence in the study area. Even if the present study showed the existence of lower prevalence of cysticercosis, there is deep-rooted tradition of raw meat consumption which magnifies the public health hazards of taeniasis in the study area. Based on the above conclusion the following recommendations are forwarded.

Recommendations

- Attention must be given to routine meat inspection. Meat inspectors should be vigilant to detect *C.bovis* in beef carcasses.
- Public should be made aware to use latrines, not to contaminate the environment with proglottids or *Taenia eggs* by defecating on pastures where cattle graze.
- Public education should be given at all levels to increase public awareness and bring cultural changes so as to avoid the consumption of raw beef.
- *Taenia saginata* shall be considered as a notifiable disease and mechanism should be put in place to deworm Taenia carriers.
- Studies on prevalence and public health importance of bovine cysticercosis should be encouraged.
- Study on the risk of *Taenia saginata* due to consumption of infected carcasses should be carried out.
- Further studies on the prevalence of Cysticercosis and Taeniasis should be encouraged.

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ANNEX 1: Questionnaire Format

Risk factors related to Taeniasis infestation rate in humans

1. Religion of the respondent

A. Christian B. Muslim

2. Sex of the respondent

A. Female B. Male

3. Martial status of respondent

A. married B. unmarried/ single

4. Education level of the respondent

A. educated B. non educated

5. Age of the respondent

A. <18yrs B. > 18 yrs

6. Origin of respondent/ consumer

A. Rural B. Town dweller

7. Habit of cattle/ large animal raw meat consumption

A. Daily B. Once per week C. Once per month D. Occasional

8. Infestation rate with *Taenia saginata* in life time

A. Once per year B. Twice per year

9. Experience of raw meat consumption

A. culture B. tradition

10. Have you notice/ find proglottids in your underwear, feces or laboratory diagnosis at health institution

A. Yes B. No

10. Have you consume/ eat pork meat

A. Yes B. No

Annex 2: Parts of carcass served to consumers for ‘Kurt’ or ‘Kitfo’ at Butcheries of Jimma

- fore limbs (*worch/ nebero*)
- neck muscles (*shint*)
- ribs (*godin/ dabit)*
- hind limbs (*talaq*)
- hump (*shagna*)

STATEMENT OF DECLARATION

I declare that this thesis is my original work and this thesis is not submitted to any University for the awards of any academic degree. This thesis is submitted in partial fulfilment of the requirements for an Msc degree in Veterinary Public Health in Addis Ababa University College of Veterinary Medicine and Agriculture and this is deposited at the university library to be made available to borrowers under rules of the library. Permission must be obtained from the Author and advisors.

Name: Meron Talu Zergaw _____

June, 2012

This thesis has been submitted for the examination with our approval as university academic advisors.

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