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Prevalence of Bovine Cysticercosis and Human Taeniasis in Jigjiga, Babile and Dire Dawa Towns, Eastern Ethiopia

MSc. Thesis

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As thesis research advisor, I hereby certify that I have read and evaluated in title **Prevalence of bovine cysticercosis and human taeniasis in Jigjiga, Babile and Dire Dawa towns of eastern Ethiopia**, prepared under my guidance by Akalu Abera. I recommend that it has to be submitted as fulfilling the thesis requirement.

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BIOGRAPHICAL SKETCH

Akalu Abera was born in June, 1987 in Babile woreda, east Hararghe zone. He attended his elementary and high school in Babile Karl Heinz Boehm primary and secondary school and preparatory in Harar senior secondary school, east Hararghe zone. He then joined Haramaya University in 2008 and graduated in doctor of veterinary medicine in 2012.

After graduation, he was employed by Gode Polytechnic college, Ethiopian Somali region as instructor II since 2012. During his stay, he has been department head of animal health occupation and instructors' representative of the college. He developed different training manual for short and long term trainees. He had taken training methodology, kaizen, entrepreneurship and skill gap training in Maichew and Wukro towns of Tigray region.

In 2015 he was granted a scholarship by ministry of agriculture and joined Haramaya University to attend MSc. program in veterinary public health.

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Lastly, I offer my regards and blessings to my wife, family and all my friends of those who supported me by idea and moral in any respect during the working of this research and the writing of this thesis.

ACRONYMS AND ABBREVIATIONS

BDLDHA	Babile District Livestock Development and Health Agency
CDC	Center for Disease Control
CI	Confidence Interval
CS	Civil Servant
CSA	Central Statistics Authority
DDCA	Dire Dawa City Administration
EARO	Ethiopian Agricultural Research Organization
ELISA	Enzyme Linked Immunosorbent Assay
ESRSLPDB	Ethiopian Somali Regional State Livestock and Pastoralist Development Bureau
FAO	Food and Agricultural Organization
FRM	Food Related Merchant
GPS	Global Positioning System
IHAT	Indirect Hemagglutination Test
MoA	Minister of Agriculture
NFRM	Non Food Related Merchants
OIE	Office International des Epizooties
OR	Odd Ratio
PCR	Polymerase Chain Reaction
ROC	Receiver Operating Curve
UVLRA	Univariable Logistic Regression Analysis
WHO	World Health Organization

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ABSTRACT

A cross-sectional study was conducted from September 2017 to July 2018 on randomly selected carcasses and human population of the towns to estimate the prevalence of bovine cysticercosis and human taeniasis respectively at Jigjiga, Babile and Dire Dawa towns and their corresponding municipal abattoirs, eastern Ethiopia. Active abattoir survey from local zebu and cross (HF x zebu) cattle presented to Jigjiga, Babile and Dire Dawa abattoirs and questionnaire surveys data collected were analyzed using STATA release 14.0 software. Out of 1108 inspected animals, 302 animals had varying number of Cysticercus bovis with prevalence of 27.3%. Jigjiga had the highest prevalence 33.5% as compared to Babile 31% and Dire Dawa 18%. Among the examined predilection sites, C. bovis distribution was the highest in liver 9.6%, followed by tongue 8.5%, masseter 5.1%, shoulder 4.3%, arm muscle 2.5%, heart 2.3%, thigh muscle 1.8% and diaphragm 0.4%. From the total of 686 C. bovis cysts collected during the study period 289 (42.0%) were found to be viable while the other 397 (58.0%) were non-viable. Three predictors namely site, age and body condition were found to be significantly associated with C. bovis detection ($p < 0.05$). For human taeniasis, among the total of 900 respondents interviewed in Jigjiga, Babile and Dire Dawa towns 432, 48.0% (95%CI, 44.7-51.3) had contracted Taenia saginata infestation. From 300 interviewed respondents from each town Babile town 51.6% (n=155/300) had the highest infestation of T. saginata than Jigjiga 48% (n=144/300) and Dire Dawa town 44.3% (n=133/300). Risk factors namely occupation, sex, marital status, educational status and raw beef consumption were found to be significantly associated with T. saginata infestation ($p < 0.05$). The findings of this study indicated the importance of bovine cysticercosis and taeniasis in the study area. Therefore, attention should be given to the public awareness and detailed meat inspection to be safe to public health and promote meat industry in the country.

Key words: cysticercosis, taeniasis, Jigjiga, Babile, Dire Dawa, Prevalence

1. INTRODUCTION

The total livestock population in Ethiopia according to 2014 estimation was 56.71 million cattle, 29.33 million sheep and 29.11 million goats, which places Ethiopia first in Africa and ninth in the world in terms of total stock populations (CSA, 2015). Despite the reported high livestock population of the country, livestock diseases negatively affect the public health and impede economic growth by incurring direct (morbidity and mortality) and indirect economic losses (EARO, 2006).

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. 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 is a zoonotic infestation of cattle caused by the larval stage, *Cysticercus bovi*s (*C. bovis*), of the human intestinal cestode, *Taenia saginata (T. saginata)* (Garcia *et al.*, 2007). This parasite is universally distributed in developing as well as in developed countries (Oladele, 2009). In humans, the disease is called as taeniasis (WHO, 2013). Taeniasis is food-borne caused by the consumption of meat containing viable *Cysticercus* (Gracey *et al*., 2015). This develops to a tapeworm and patients are frequently asymptomatic. However, they may present mild symptoms of nausea, abdominal discomfort, flatulence, epigastric pain, diarrhea, vitamin deficiency, excessive loss of appetite, weakness and loss of weight, digestive disturbances, and intestinal blockage may occur (CDC, 2017). Variably adult tapeworms release motile distal segments containing eggs and their independent motility is the reason for various disorders such as appendicitis, biliary tract obstruction, anal pruritis, peritonitis, jejunal perforation (Asaava, 2009; Bekraki and Hanna, 2016).

Bovine cysticercosis is responsible for considerable amount of economic losses which can approach 30% of price of cattle when allowance is made for the loss in the carcass weight and the cost of freezing for the infested meat (Chomel, 2008). Live cattle having *C. bovis* shows no symptoms however, heavy infestation by the larvae may cause myocarditis or heart failure (Cabaret *et al.*, 2002). The problem caused by the adult worms in human gives rise to high

medical costs (Calvo *et al.,* 2013). Generally, the loss is determined by disease prevalence, grade of the animals infested, potential markets, prices of cattle and treatment costs for detained carcass (Torgerson and Macpherson, 2011) and medical costs for infested human beings (Calvo *et al.,* 2013). The average annual loss due to taenicidal drugs for treatment in Ethiopia was estimated to be 4,937,583.21 Ethiopian Birr (Abunna *et al.,* 2008).

Cysticercus can remain alive in cattle anytime from weeks to years and such infestation in cattle is a public health problem as the infested raw or undercooked beef consumption causes taeniasis in human (Mcmanus, 2006). The life cycle of the parasite, *T. saginata*, involves humans as final host and cattle as intermediate host (Pam *et al.,* 2015). Ingested eggs develop into *cysticerci*, which can often be detected during meat inspection at the routinely inspected localization sites of the parasite, including tongue, heart, skeletal muscle, liver and diaphragm (WHO and FAO, 2005). 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 (Murrell, 2013). Human beings are the obligate final host and become infested by ingesting beef having the parasite that has been inadequately cooked or frozen. *T. saginata* occurs in the small intestine of human and the metacestode (*C. bovis*) is found in tongue, masseter, liver, diaghrem and skeletal muscles of cattle (Pawlowski and Murell, 2001, Cabaret *et al*., 2002).

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 (Cabaret *et al*., 2002). *C. bovis*/ *T. saginata* highly distributed almost all over the world, with very low prevalence in developed countries, where under cooked beef steak is consumed rarely (Oladele, 2009). 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 infested carcasses (Wayne *et al*., 2002). Various studies have been conducted on the prevalence of taeniasis in Ethiopia. The prevalence of taeniasis in Halaba Kulito 19% (Hirpha *et al*., 2016), 30.4% in Bahirdar (Tamirat *et al.,* 2018), 60.7% in Harar (Terefe *et al.*, 2014), 64.44% in Jimma (Taresa *et al*., 2011) and 69.5% in Debre Zeit (Tesfaye, 2016) were recorded based on questionnaire surveys. On the other hand the prevalence of

Cysticercosis reported 30% from different abattoirs in the country (Solomon, 2012), 6.5% in Dale Wabera district western Ethiopia (Bayou and Taddesse, 2018), 4.7% in Kombolcha (Kassaw *et al*., 2017), 19.7% in Harar (Terefe *et al.,* 2014), 5.6% in Bishoftu (Emiru *et al.*, 2015), 3.6% in Addis Ababa (Ibrahim and Zerihun, 2012), 5.2% in Shire (Belay and Mekelle, 2014) based on Abattoir survey. However the studies conducted was limited to certain parts of the country and there was no information on prevalence of bovine cysticercosis in Babile and Dire Dawa towns. In addition, no reported results were found on the prevalence of human taeniasis in Jigjiga, Babile and Dire Dawa towns.

The general objective of this study was to estimate the prevalence of bovine cysticercosis and human taeniasis in Jigjiga, Babile and Dire Dawa towns of eastern Ethiopia.

The specific objectives of the current study were:

- To estimate prevalence of bovine cysticercosis and associated risk factors.
- To assess the prevalence of human taeniasis (*T. saginata*) and factors associated with its occurrence.

2. LITERATURE REVIEW

2.1. Taxonomy and Morphology of *T. saginata* and *C. bovis*

T. saginata and its metacestode *C. bovis* belong to the class Cestoda; order *Cyclophyllidea;* Family *Taeniidae* and Genus *Taenia* (Lefevre *et al.*, 2010). *T. saginata*, the beef tapeworm, is a large worm measuring 3-10 meters in length rarely the adult measures up to 15m (Dorny *et al.*, 2009). 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 head (scolex), neck and strobila (Garcia *et al.*, 2007). The scolex, measuring 1 millimeter to 2 millimeter in diameter, has four strong hemispherical suckers. There is no rostellum and hooks and the predilection site in the intestinal mucosa on the proximal part of the jejunum (WHO and FAO, 2005; OIE, 2012). The neck is short unsegmented with a germinal structure immediately behind the scolex, which continuously produces proglottids (Acha and Szyfres, 2003). The strobila is a chain of segments made up of sexually immature, mature and gravid segments in linear sequence. Each segment is called proglottids, strobilization occurs at the distal part of the neck (Gracey *et al.*, 2015). 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 margins of the segment (Lefevre *et al.*, 2010).

Figure 1: Adult *T.saginata* (ghoeloh, 2015)

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 and leave the host via anus (Jenkins *et al.,* 2013). This implies that coproscopic examination has a limited value in the diagnosis of *T. saginata* infestation (Dorny, 2009). The graved segments, each containing 11-32 branched uteri, are filled with thousands of eggs. The number of segments increase constantly as the tapeworm grows, forming long chains. The segments, which are formed first, are pushed towards the end leaving space for the new ones. The segments, which are found at the rear, are the oldest. These old segments periodically detached from the worms and discharged from the host's body with feces or independent of defecations (Mcmanus, 2006). Each segment has a complete set of male and female reproductive organs in which eggs mature and develop (OIE, 2000). The ova from small number of carriers of the tapeworm can be widely distributed and infest large number of cattle (Oladele, 2009). Once the mature eggs are excreted with the feces, they are capable of infesting the intermediate host, bovine (Gracey *et al*., 2015).

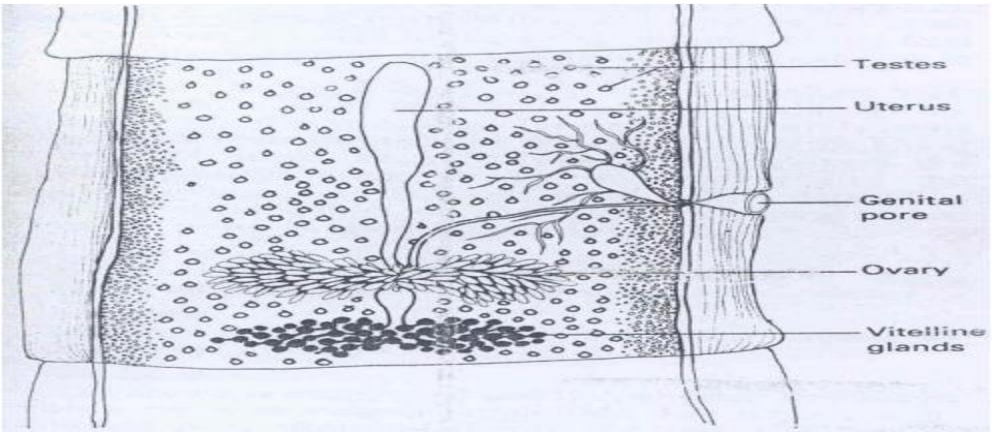

Figure 2: Mature segment showing reproductive organs (Lefevre *et al*., 2010)

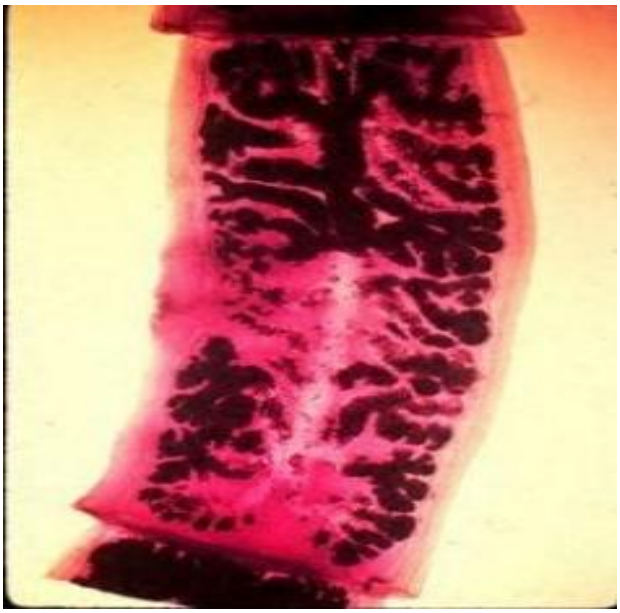

Figure 3: Gravid proglottid of *T. saginata* (Minozzo *et al.*, 2002).

Eggs passed in feces or discharged from ruptured gravid segments are sub spherical 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 (Oladele, 2009). It measures 30-41 micrometers in diameter and 46 to 50 micrometers in length (OIE, 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^{o}C (Garcia *et al.*, 2007).

Figure 4: The egg of *T. saginata* (Minozzo *et al*., 2002)

The larval stage, *C. bovis* is round or oval, and when fully developed, consists of a scolex, invaginated into a fluid-filled vesicle (tail bladder), which is surrounded by connective tissue capsule formed by the reaction of the tissue of the host (Pawlowski and Murrell, 2001). The cyst, measure up to 10mm in diameter, is seen as a small whitish vesicle and is found between muscle fibers (Figure 5) (Ortega, 2006). It is transparent and contains translucent fluid (Mcmanus, 2006). The invaginated scolex is visible in the form of whitish spot at one end of the pole of the cyst (Scandrett *et al.*, 2009). As in the adult tapeworm, it has neither rostellum nor hooks (Murrell, 2013).

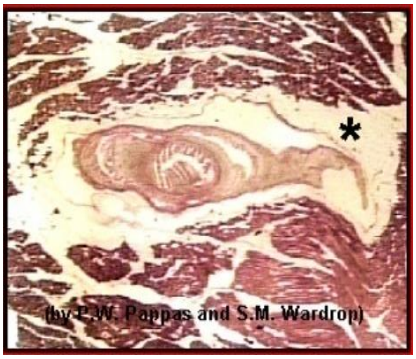

Figure 5: *C. bovis* in muscle (histology) (Pawlowski and Murrell, 2001).

2.2. Epidemiology

T. saginata taeniasis occurs throughout the world with variable degree of prevalence (Oladele, 2009). Its prevalence could be classified into three groups: high prevalence with taeniasis exceeding 10%, moderate infestation rates (0.1-10%) and low infestation rate of less than 0.1% (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 (Cabaret *et al*., 2002).

Cattle are intermediate and humans are the final hosts of *T. saginata*. In cattle all ages are susceptible for this parasite; whereas, young age groups are more susceptible than the others. Sometimes parasitism is observed in other ruminants like sheep, goats, antelopes, gazelles and buffaloes, but the development of *C. bovis* is unlikely to the others (Lefevre *et al.*, 2010). The geographic distribution and status of taeniasis is more serious and less recognized for public

health problems in the developing countries (Minozzo *et al*., 2002). Whereas, the distribution of bovine cysticercosis is an international and it is very common in Africa. It is highly endemic in areas of Central and East African countries like Ethiopia, Kenya and Zaire (Acha and Szyfres, 2003). In Ethiopia the custom of eating undercooked beef dishes such as *kurt, lebleb* and, *kitfo* and the habit of defecating in open fields used for cattle grazing made taeniasis of human and cysticercosis for cattle common (Abunna *et al.,* 2008). A high prevalence of human infestation in different agro-climatic zones of the country has been reported (Solomon, 2012). Estimates made by different investigators on prevalence of taeniasis in Ethiopia is vary widely from16% to over 70% (Alemneh *et al*., 2017). Bovine cysticercosis has been reported from different parts of the country (Table 1).

Table 1. Bovine cysticercosis in different parts of Ethiopia

Place	Percent prevalence	Reference
Harar	19.7%	Terefe *et al.,* 2014
Jigjiga	2.25%	Biruk, 2017
Bishoftu	5.6%	Emiru *et al.*, 2015
Central Ethiopia	3.1%	Megersa *et al.,* 2009
Jimma	4.9%	Taresa *et al*., 2011
Gonder ELFORA abattoir	2.0%	Adem and Alemneh, 2016
Hawassa	26.3%	Abunna *et al.,* 2008

2.2.1. Risk factors of human taeniasis

The prevalence of taeniasis is associated with different risk factors. The potential risk factors of taeniasis are the habit of raw beef consumption, age, sex, educational level, presence and usage of sanitary facilities especially toilets (Calvo *et al*., 2013). Metacestode is distributed in different organs and found throughout the edible parts of the carcass like masseter muscles, cardiac muscles, triceps muscles, thigh muscles, shoulder muscles, diaphragm, intercostals muscles, liver, heart, tongue, lung and kidney (Allepuz *et al.,* 2012).

Figure 6: *C. bovis* cyst distribution in different organs (Assefa, 2015).

2.3. Life Cycle

These tapeworms have an indirect life cycle and are relatively host specific for both larval and adult stages. Humans are the only natural definitive hosts of the adult tapeworm. The adult tapeworm is fully developed and reproductively mature as early as 10-12 weeks after infestation of the host (Murrell, 2013). Once mature, the tapeworm regularly sheds its most posterior segments, called gravid proglottids, which are discharged from infested humans spontaneously or with defecation. These proglottids contain thousands of immediately infective eggs that can remain in the proglottid or be expelled free into the surrounding fecal matrix or environment (WHO and FAO, 2005). On average, a single *T. saginata* tapeworm releases six to nine proglottids daily each proglottid contains 80,000-100,000 eggs, so an infected person may shed about 240,000-900,000 eggs daily (Pawlowski and Murrel, 2001). Although multiple and mixed species infestation can occur, most taeniasis involve a single tapeworm. Upon ingestion by a suitable intermediate host, a hexacanth embryo, or oncosphere, hatches from the egg and uses its six hooklets to penetrate the intestinal mucosal within a few hours to enter the circulatory or lymphatic system. It eventually reaches the tissue site (such as the lymphatic space in skeletal

muscle) where it eventually develops into a *cysticercus* which is infective to a human final host after about 7-10 weeks and remains viable for 4-12months (Jenkins *et al.*, 2013). The intermediate hosts for *T. saginata* is domestic cattle. Reindeer (*Rangifer tarandus tarandus*) have also proven suitable intermediate hosts for *C. bovis* (Scandrett *et al*., 2009). In cattle, *cysticerci* are found predominantly in cardiac and skeletal musculature, liver and occasionally in other sites including lung, kidneys and lymph nodes (Scandrett *et al*., 2009). There is evidence that pre-natal infestation of calves can occur (Mcmanus, 2006).

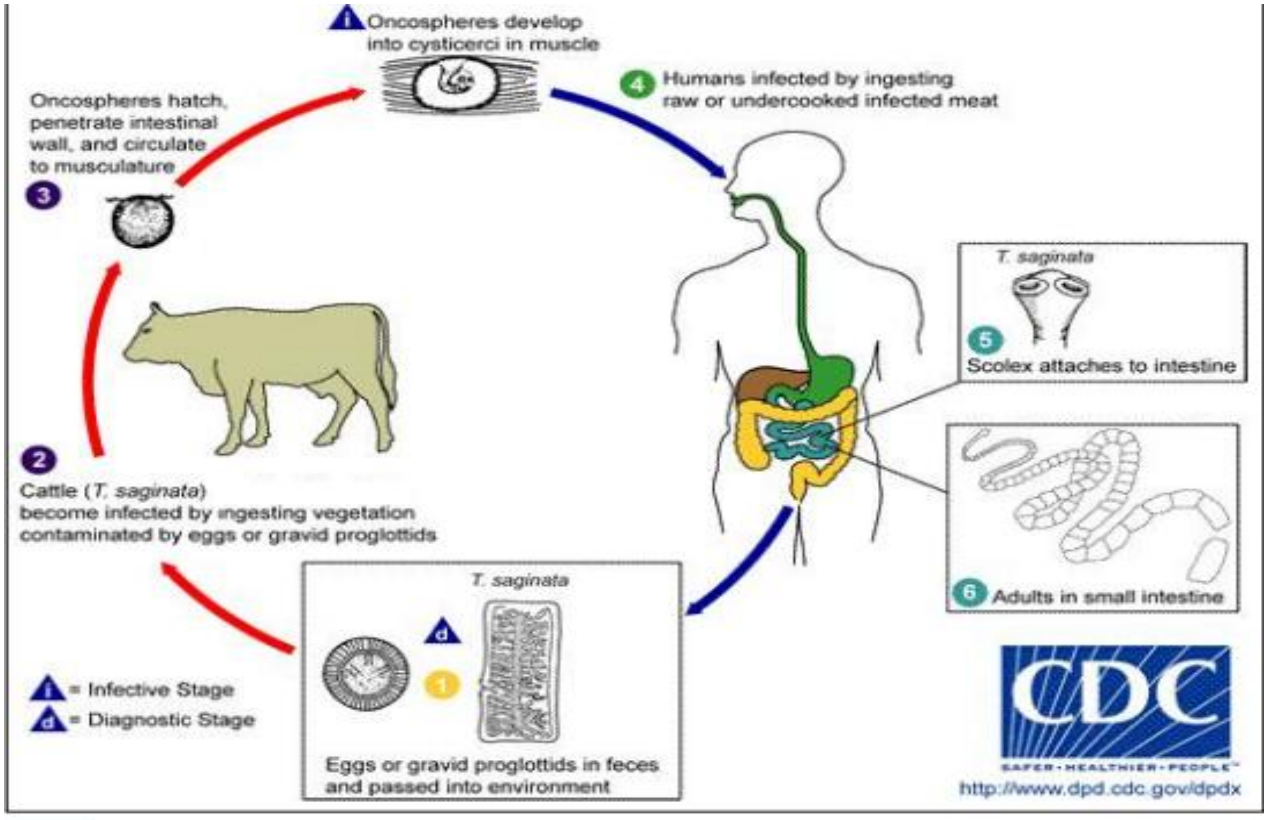

Figure 7: Life cycle of *T. saginata* (CDC, 2017)

2.4. Clinical Manifestations

The clinical manifestations in humans include abdominal pain, nausea, debility, weight loss and flatulence diarrhea or constipation (CDC, 2017). A patient may have one or several of these symptoms and a high percentage of patients experience gastric hypo secretion (Pawlowski and Murrell, 2001). Individual reactions to the infestation differ and may be influenced by psychogenic factors, since patients often notice symptoms only after they see proglottids (Calvo *et al.*, 2013). Signs like those of epigastric discomfort, hunger sensations and irritability were also observed in infested individuals (Oladele, 2009). Light or moderate cysticercosis in cattle is not usually associated with any defined clinical picture. Heavy infestations, 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 (Cabaret *et al.*, 2002).

2.5. Diagnosis

2.5.1. In human

Adult cestodes can be expelled from human using anthelmentics followed by a saline purgative and identified based on the scolex and proglottid morphology (WHO, 2013). The diagnosis is established by examination of the eggs in the stools or gross examination of the proglottids or segments passed in the stool (Ortega, 2006). Diagnosis is based on symptoms although it is difficult to discover the disease during the first three months (Onyango *et al*., 2012). A person should not be considered uninfected before having three negative test completed over a 2-3 days interval (OIE, 2000). *T. saginata* egg cannot be distinguished from *T. solium* by their morphology (Gracey *et al*., 2015). However ELISA and PCR can differentiate the eggs of *T. saginata* from *T. solium* and morphology can be used to distinguish these proglottids (OIE, 2005).

2.5.2. In animals

Live cattle show no symptoms. However, serological tests are available to detect disease in live animals (Allepuz *et al*., 2012). The IHAT with 100% sensitivity and 91-100% specificity can be used as a diagnostic test for epidemiological survey, to map infested and disease free areas and to estimate the natural prevalence of the disease (Abuseir *et al.,* 2013). A previous history of infestation on the animal premises also acts as available diagnostic tool (Acha and Szyfres, 2003). Diagnosis at post mortem examinations by direct observation of *C. bovis* in the muscle (WHO and FAO, 2005).

2.6. Treatment

Live cattle show no symptoms. However, praziquantel and albendazole are the two anti *Cysticercal* drugs used to treat patients diagnosed with Cysticercosis in Serological tests (Gracey *et al*., 2015). Treatment with praziquantel and albendazole has been shown to eliminate cysts in 80% of treated patients with an additional 10% of patients experiencing a significant reduction in the number of cysts present (Chomel, 2008).

For the treatment of the taeniasis there are a number of taenicidal drugs available in the market (Abuseir *et al*., 2013). However, the drugs of choice in treating taeniasis are niclosamide (Elizandro and Maria, 2016). Adult dose rate of 200 mg is effective in damaging the worm (Allepuz *et al.*, 2012). Albendazole is a broad spectrum anthelmentic of the benzimadazole carbanate class, which is effective against larva and adult stage of cestodes and treamtode (OIE, 2012). In Ethiopia, the majority of the rural inhabitants use traditional herbal drugs in routine self-deworming practices as a taenicidal herb (Assefa, 2015).

Table 2. Traditional herbal drugs (Assefa, 2015)

No	Local name	Scientific name	Parts of plants used
1	Bisana	*Croton macrustachys*	Bark
2	Duba ferie	*Cucurbita pepo*	Seed
3	Enkoko	*Embelia skimpier*	Fruit
4	Kosso	*Hygeia Abyssinica*	Flower
5	Wogert	*Silen macrosclen*	Root

2.7. 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 infestation in cattle (Cabaret *et al*., 2002). Adequate meat inspection, abstinence from eating raw or inadequately cooked beef (thorough cooking of meat at a temperature of 56 – 60^{o}c) and freezing the infested carcass at -10°C for 10 days prevents human infestation. Chemotherapy in humans reduces the spread of eggs and infestation in cattle (Calvo *et al*., 2013). Recombinant vaccines have been developed using non-living antigens of the parasite and host. Protective responses that can be induced readily in the intermediate hosts may be used to control the infestation in cattle (Oladele, 2009). 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).

2.8. Public Health Importance

T. saginata has been known to live for 20 years within a single individual (Garcia *et al*., 2007). It is found globally and most prevalent where cattle are raised and beef is consumed (Kyvsgaard and Murrell, 2005). *T. saginata* is found in small intestine of humans which computed through the absorption of the digested food and its proglottids migrate to different organs causing different signs (FAO, 2004). *T. saginata* infestation is usually asymptomatic. However, heavy infestation often results in weight loss, dizziness, abdominal pain, diarrhea, headaches, nausea, constipation or chronic indigestion and loss of appetite (CDC, 2017). There can be intestinal obstruction in humans and this can be alleviated by surgery (Bekraki and Hanna, 2016). The tapeworm can also expel antigens that can cause an allergic reaction in the individual (Murrell, 2013). It is also rare cause of pancreatitis, cholecystitis, cholangitis (WHO, 2013). Migrating proglottids cause inflammation of the appendix, inflammation of the bile duct (FAO, 2004).

2.9. Economic Importance

Economic losses from bovine cysticercosis are determined by disease prevalence, grade of animal's infested, potential market price of cattle and treatment cost for detained carcasses (Chomel, 2008). For example, in Botswana and Kenya, the incidence of *C. bovis* at export abattoirs is about 8% and 12%, respectively. Annual losses in Botswana now approaches to 0.5 million pounds; while in Kenya it is about 1 million pounds (WHO and FAO, 2005). The economic significance of adult parasite *T. saginata* and the proportion of carriers requiring hospital treatment was over 20% in Poland and 10% in France it is also assumed that each carrier misses one day work on average in France (OIE, 2000). The average annual loss due to taenicidal drugs for treatment in Ethiopia was estimated to be 4,937,583.21 Ethiopian Birr (Abunna *et al.,* 2008).The economic impact of the disease in the cost implication can be broken down in to those involved in treating human taeniasis and cattle carcass (cost of freezing) or condemned as well costs involved in the inspection procedures amount to a million of birr (Nigatu, 2008).

3. MATERIALS AND METHODS

3.1. Study Area

The study was conducted in eastern Ethiopia, specifically in Jigjiga, Babile and Dire Dawa towns from September 2017 to July 2018 on randomly selected carcasses and human population of the towns.

Jigjiga town is the capital city of Ethiopia Somali region, found eastern part of Ethiopia 630 km away from Addis Ababa and 105 km from east of Harar city. Jigjiga is situated at altitude of 1660 meters above sea level, 9° 20° north latitude and 45° 56° east longitude. The climate of Jigjiga is semi-arid type which is characterized by high temperature and low rain fall. The mean annual rain falls is about 543 mm and mean annual temperature is about 22°C (CSA, 2015). Livestock population of Jigjiga was 270,662 cattle, 462,725 sheep, 180,250 goats, 12116 equine and 934,906 camels (ESRSLPDB, 2014). Total population of Jigjiga was 277, 560 among this 149,292 are male and 128,268 are female, from the total population 125,876 populations dwell in city (CSA, 2015).

Babile district is located at 90° 8° north latitude and 42°21° east longitude at the distance of about 557 km east of Addis Ababa. The altitude of the district ranges from 950 to 2000 meter above sea level. It has mean annual minimum and maximum temperatures of 18 and 28 ^{o}C respectively. The mean annual rainfall and humidity of the area ranges from 700 to 900 mm and 33 to 38%, respectively (CSA, 2015). Cattle are the most dominant in population size (56,355 heads) followed by goat (23,020), sheep (12,216) and camel (9,704) (BDLDHA, 2015). The total human population of the district is estimated 115,229 among this 58767 are male and 56462 are female, from the total population 49,585 live in town (CSA, 2015).

Dire Dawa city is located in the eastern part of Ethiopia at 9°36′ north latitude and 41°52′ east longitude. The town is situated at the distance of 515 km east of Addis Ababa and 86 km west of Babile district. The altitude of the town is about 1200 meters above sea level. The mean annual rainfall and humidity are 594 mm and 41.82%, respectively. The town has mean annual maximum and minimum temperatures of 31.4 ^{0}C and 18.41 ^{0}C, respectively. Livestock populations in Dire Dawa town are cattle (61,420), sheep (37,570), goats (79,880) and camel

(11,910) (DDCA, 2017). The total human population of the Dire Dawa town was estimated 440,000 among these 224400 are male and 215600 are female, from the total population 277,000 lives in the city (CSA, 2015).

3.1.1. Jigjiga, Babile and Dire Dawa municipal abattoirs

Jigjiga and Dire Dawa abattoirs are owned by cities agricultural livestock and environmental protection office while Babile abattoir was owned by woreda municipality, which aims to provide officially inspected and safe meat (beef, camel, goat and mutton) for consumers. The abattoirs have separate compartments to slaughter animals for Christian and Muslim residents. On average 41, 4 and 50 cattle's for Christian and 20, 2 and 22 cattle's for Muslim were slaughtered per day in Jigjiga, Babile and Dire Dawa municipal abattoir respectively. The numbers of slaughtered animals were much larger than the capacity of slaughtering rooms. The routine meat inspection service is provided by one animal health assistant in Babile and Jigjiga that shift every two other day and one veterinarian in Dire Dawa that shift every other day employed by agricultural office. Seven *C. bovis* per organ were set for condemnation of organ in Jigjiga and Babile abattoirs while five cysts per organ were allowed to be condemned in Dire Dawa abattoir. However, only the cysts were trimmed and allowed to pass for consumption when cyst was identified in heavy muscles. Letters of confirmation for condemned organs were written by abattoir manager when the organ was judged to be condemned by inspectors.

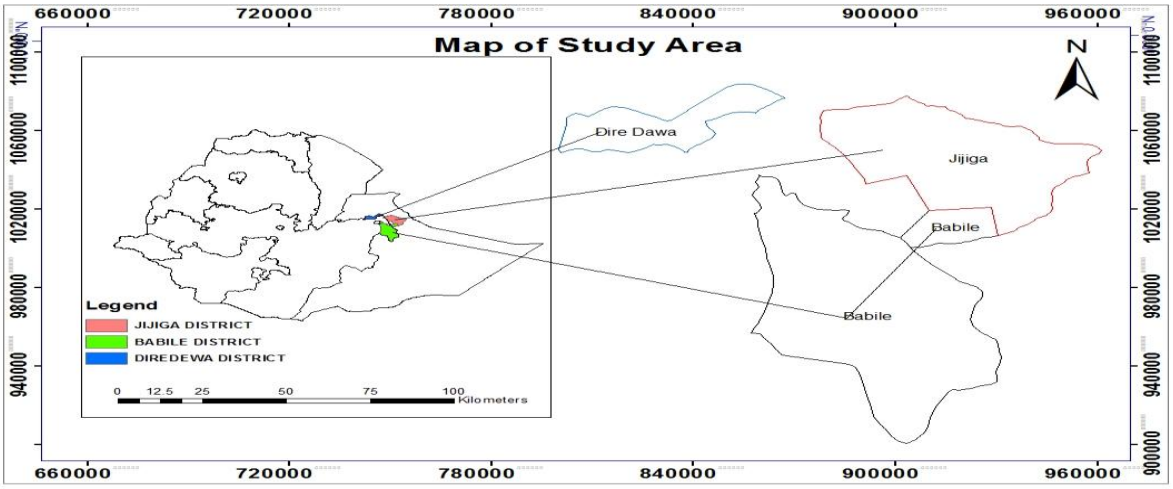

Figure 8: maps of Study area (GPS, 2017)

3.2. Study Design

Cross sectional study was employed by using a structured questionnaire survey and active abattoir survey.

3.3. Study Population

Study populations are all cattle slaughtered between September to November 2017 in Jigjiga, from December 2017 to April 2018 in Babile and between May and July 2018 in Dire Dawa municipal abattoirs. Cattle slaughtered at Jigjiga abattoir were sourced from Jigjiga area and neighboring districts of Babile and Gursum. Cattle presented for slaughter at Babile were sourced from Babile district, while cattle slaughtered at Dire Dawa municipal abattoir were sourced from Dire Dawa area, nearby cattle markets of Shinile (Ethiopian Somali Regional State), Kersa, Burka, Bedeno, Chelenko, Fedis, Dawe, Kulubi, Girawa and Water (Oromia Regional State). The average numbers of slaughtered animal per day were 61, 6 and 72 in Jigjiga, Babile and Dire Dawa respectively. On the other hand, respondents for questionnaire survey where randomly selected population of Jigjiga, Babile and Dire Dawa towns who started dwelling before 2008. The population of respondents consists of different age, sex, marital status, habit of raw meat consumption and education.

3.4. Sample Size Determination

The sample size calculated by using the standard formula described by Thrusfield (Thrusfield, 2007) for random sampling method.

$$N = \frac{(1.96)^2 P_{exp}(1-P_{exp})}{d^2}$$

Where: N=Sample size, P*exp* = Expected prevalence and d = desired level of precision.

Since there was no similar previous study in Babile and Dire Dawa towns, 50% expected prevalence, 5% desired absolute precision and 95% confidence level used to calculate the minimal sample size. Therefore, 384 carcasses were inspected during the study period for the presence of *C. bovis* in different organs in each town. While in Jigjiga there was one study with the expected prevalence of 2.25% (Biruk, 2017) so the sample size required based on above

formula was 34 carcasses. But to increase the precision of the study the sample size was increased to 340 carcasses.

For an outcome scored 0/1 for no/yes, the standard deviation of the outcome scores is given by $SD = [p (1-p)/N]^{1/2}$ where p is the proportion obtaining a score of 1, and N is the sample size. The standard error of estimate SE (the standard deviation of the range of possible p values based on the pilot sample estimate) is given by $SE= SD/N^{½}$. Thus, SE is at a maximum when p = 0.5. Thus the worst case scenario occurs when 50% agree, 50% disagree. Therefore, the questionnaire survey sample size was calculated by using the formula $N = 0.25/SE^2$ (Arsham, 2015).

Where: N= sample size, SE (standard error) =5%

The sample size required for the questionnaire survey as per the above formula was 100 for each town. However, to include different risk factors and increase the precision of the result the total number was increased to 900 individuals. Therefore, 300 individuals were interviewed from each of the three towns.

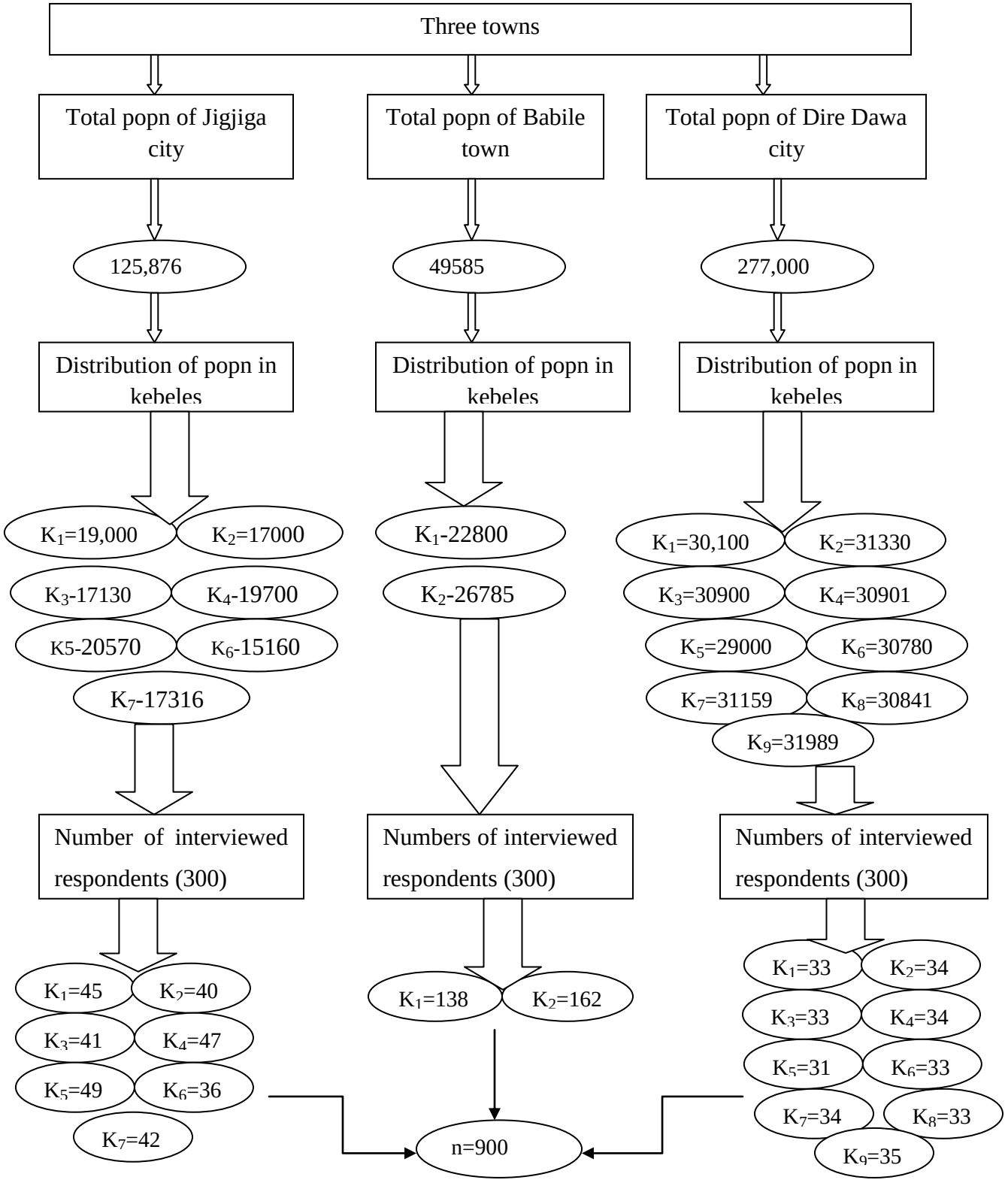

Figure 9: Schematic presentation of sampling procedure

3.5. Study Methodology

3.5.1. Questionnaire survey

The sampling frame was prepared based on information collected from environment protection authority, the education, health, housing, and capacity building bureaus. 55510, 30567 and 12050 residence houses and four family units per house were estimated in Dire Dawa, Jigjiga and Babile urban towns respectively based on collected information. Respondent randomly selected from every 500 meter distances from the first residence houses. Next residence houses were used for unwilling household members. However, butchers and food related merchants (FRM) were purposively interviewed. Interview was done every Saturday and Sunday for three months in each town. Twelve-fifteen respondents were interviewed per a day.

The respondents were interviewed on their habit of raw beef consumption (yes or no), frequency of consumption (daily, once per week, once per month and occasionally), preference of raw beef type (*kurt, kitfo, dulet* and 2or/and all), exposure of taeniasis infestation (yes or no) infestation rate (once per life time, twice per life time and three and above) and finding of proglottids in their stool and underwear, year of infestation (before 2008, after 2008 and both), solution for the infestation (sought treatment from health professional at hospitals/health stations/clinics, self-prescribed drug purchase from pharmacy and used local herbal), educational status (elementary, high school, diploma and above graduated and no formal education), age (12-17 years and 18 years and above), sex (Male and female), marital status (married and single), occupation (civil servant, laborer, FRM, non-food related merchants (NFRM), butchers, driver and students), income (less than 500birr, between 500-1000 birr and greater than 1000 birr), keeping livestock (yes or no), use latrine (yes or no), meat source (butchers, other than butchers and both), awareness (yes or no) of the respondents was registered to assess the prevalence and possible risk factors of *T. saginata* (Annex 1).

3.5.2. Active abattoir survey

A systematic random sampling technique was applied on those animals that came to the municipal abattoir. Antemortem was done at dawn (5:00AM-8:00AM) in Babile and at night (8:00PM-1:00AM) in Jigjiga and Dire Dawa during which the cattle were slaughtered. The first

animal was randomly selected and then every 10^{th} animal in Jigjiga and Dire Dawa were thoroughly inspected. In Babile, however, every 2^{nd} animal entering the slaughter house after ante mortem inspection was considered and marked. Five to seven animals were examined on each slaughter day in Jigjiga and Dire Dawa while three animals in Babile. The abattoir were visited six days per week in Jigjiga and Dire Dawa while all days of the week in Babile. Age (adult for less than 5 years and old for 5 years and above), breed (local and cross), body condition was categorized as good if ribs and hindquarters are fully covered and poor for the ribs, backbone and spine process are highly visible and identified by touch, sex (male and female) of each study animals was recorded on prepared format paper at ante-mortem. Body condition scoring of the cattle was made based on the guideline provide by (Frederick, 2016). Age determination was carried out by means of their dentition as described by (De-lahunta and Habel, 1989). Prior to sampling, each selected animal was given an identification number by writing a code on its head by using permanent marker.

3.5.3. Laboratory examination

Meat inspection was made in accordance with the procedures of Ethiopian Ministry of Agriculture Meat Inspection Regulation (MOA, 1972) for the detection of *C. bovis*. For thorough inspection multiple incisions were made on the masseter muscle, tongue, heart, liver, kidney, lung, diaphragm, biceps and triceps on thigh and arm muscle to expose the cysts in the carcass. Careful examination on the carcass of study unit was made through palpation of the organs followed by incision as follows: the surface and substance of tongue was examined visually, followed by longitudinal ventral incision from the tip of the root. Extensive deep incision was made into external and internal muscles of masseters parallel to the plane of the jaw (parallel to the jaw bone from the lower jaw). Visual inspection and longitudinal incision of the myocardium from base to apex was made. Examination of kidney, liver, biceps and triceps of thigh and arm, intercostals muscle, diaphragm and the lung also was conducted accordingly by visualization, palpation and incision.

At the end of the examination, the cysts were collected properly, labeled and brought after seven hours to Jigjiga regional veterinary laboratory, after 30 minutes to Babile veterinary clinic laboratory and after seven hours to Dire Dawa regional veterinary laboratories in respect of the

cyst sourced for further investigations. The viability of cysts was examined by placing them in a normal saline solution with 30% ox bile and incubated at 32^{o}C. Evagination of the unarmed scolex in viable cysts normally takes place within 1-2 hours (Gracey *et al.*, 2015). The cysts then identified as *C. bovis* if they lack hooks and rostellum on the evaginated scolex with four suckers (Opara *et al.,* 2006).

3.6. Data Analysis

The data collected was entered, recorded and stored in Microsoft excel spread sheets program version 2010. The data was cleaned, coded and imported to STATA release 14.0 software (Stata Corp., College Station, Texas) for further statistical analyses. Associations of *C. bovis* and *T. saginata* with risk factors were assessed using univariable logistic regression. All predictors were checked for multi-collinearity in a cross-tabulation using Goodman and Kruskal's Gamma Statistic. Statistical significance level was set at $P < 0.05$ at 95% confidence level to determine whether there are statistical significant differences between the parameters measured. Based on Wald's test backward elimination technique and likelihood ratio test statistics ($p > 0.05$) were dropped from the model. All the remaining non-collinear variables were used to build the final model. The final model was assessed using the Hosmer and Lemeshow method for goodness of fit and the receiver operating curve (ROC) for reliability (Dohoo *et al.*, 2009).

4. RESULT

Large numbers of animals were inspected with one meat inspectors due to this Poor meat inspection procedures have been applied in Jigjiga and Dire Dawa municipal abattoir. Also due to small slaughter rooms and weak enforcements of government, backyard slaughtering were practiced. Among 1108 slaughtered cattle 302 carcasses were infested with *C. bovis* with prevalence of 27.3% (95% CI, 24.6-29.9). About geographical site, Jigjiga had the highest prevalence followed by Babile, while Dire Dawa had the least level of carcass infestation. The differences are statistically significant ($p < 0.05$) (Table 3).

Table 3. Prevalence of *C. bovis* in Jigjiga, Babile and Dire Dawa Municipal abattoirs

Site	**No sampled carcasses**	**No of +ve carcasses**	**Prevalence (95%CI)***
Dire Dawa	384	69	18(14-22)[a]
Babile	384	119	31(26-35.6)[b]
Jigjiga	340	114	33.5(28.5-38.6)[b]
Overall	1108	302	27.3(24.6-29.9)

*different superscripts within the same column are significantly different ($p < 0.05$)

4.1. Risk Factors for *C. Bovis*

Univariable logistic regression analysis indicated that *C. bovis* significantly associated with age, site and body condition ($p < 0.05$). In the present study; adult, male, cattle with good body condition and local cattle had significant association with the occurrence of bovine cysticercosis than old, female, poor body conditioned and cross breed cattle (Table 4).

Table 4. Univariable logistic regression analysis of risk factors for *C. bovis*

Variable	Categories	No. samp.	Prevalence (95%CI)	OR(95%CI)	p-value
Age	Old	576	22.4(19.0-25.8)	Ref.	-
	Adult	532	32.5(28.5-36.5)	1.70(1.3-2.2)	0.000
Sex[a]	Male	611	31.7(28.0-35.4)	Ref.	
	Female	497	21.7(18.1-25.4)	0.59(0.4-0.8)	0.000
BCS	Good	873	31.6(28.5-34.7)	Ref.	-
	Poor	235	11.06(7.0-15.0)	0.27(0.2-0.4)	0.000
Breed[b]	Local	1064	28.3(25.6-31.0)	Ref.	-
	Cross	44	2.3(0.05-12.0)	0.1(0.01-0.4)	0.005
Site[a b]	Dire Dawa	384	18.0(14.0-22.0)	Ref.	-
	Babile	384	31.0(26.0-35.6)	2.0(1.5-2.9)	0.000
	Jigjiga	340	33.5(28.5-38.6)	2.3(1.6-3.2)	

OR=odd ratio, no samp = number of sampled animal, variable with **a**, **b** superscript are collinear, ref = reference

For multivariable logistic regression analysis, collinear predictors, namely, sex and breed category were dropped from the model. Cows are not slaughtered in Babile and crossbreeds are only slaughtered in Dire Dawa so 'sex' and 'breed' were found to be collinear with 'site'. All the remaining non-collinear variables were used to build the final model, and three predictors namely site, age and body condition were found to be significantly associated with *C. bovis* ($p < 0.05$). Accordingly, cattle slaughtered in Jigjiga municipal abattoir were more likely to harbor *C. bovis* in their carcasses as compared to Babile and Dire Dawa municipal abattoirs. Adult and good body condition cattle were noted to have higher prevalence than old and poor body condition (Table 5).

Table 5. Multivariable logistic regression model for potential predictors

Variable	Categories	OR(95%CI)	p-value
Site	Dire Dawa	Ref.	-
	Babile	1.9(1.3-2.8)	0.000
	Jigjiga	2.5(1.7-3.6)	0.000
Age	Old	Ref.	-
	Adult	2.7(2.0-3.7)	0.000
Body condition	Good	Ref.	-
	Poor	0.3(0.2-0.4)	0.000

Hosmer-LemeshowX^2=4.49, p-value= 0.7224, ROC=0.6803

Analysis of the active abattoir survey showed that there was a variation with regard to the anatomical distribution of *Cysticercus* in the organs inspected. As indicated in Table 6, the highest proportions of *C. bovis* were observed in liver, followed by tongue, masseter, shoulder, arm muscle, heart, thigh muscle and diaphragm in decreasing order. Of the total 686 *C. bovis* collected during the study period 289 (42.0%) were found to be a viable while the remaining were not. Heart, shoulder and thigh muscle had the highest proportions of viable cysts while, masseter, liver and diaphragm had the lowest number of viable cysts (Table 6).

Table 6. Frequency distribution of *C. bovis* in different organs (n=1108)

Organ inspected	No. of +ve organ	Prevalence	Total no of cyst on organ	No. of viability	No. of non-viability	Cyst viability per organ %
Tongue	94	8.5(6.8-10.1)	162	72	90	44.4
Shoulder	48	4.3(3.1-5.5)	93	54	39	58.0
Masseter	56	5.0(3.8-6.3)	89	26	63	29.0
Heart	26	2.3(1.4-3.2)	52	31	21	60.0
Liver	106	9.6(7.8-11.3)	194	50	144	26.0
Diaphragm	4	0.4(0.1-0.7)	5	1	4	20.0
Thigh muscles	20	1.8(1.0-2.6)	40	21	19	52.0
Arm muscles	28	2.5(1.6-3.4)	51	34	17	67.0
Total	382	34.5(25.5-43.1)	686	289	397	42.0

For questioner survey 900 respondents were interviewed in Jigjiga, Babile and Dire Dawa towns. Babile town had the highest infestation of *T. saginata* than Jigjiga and Dire Dawa. From 432 infested respondents' more than half observed *T. saginata* proglottids in their stool, followed by observation of proglottids on their underwear and only small minority were laboratory diagnosed. From positive respondents 246 infested once per life time either before or after 2008, 89 twice per life time and 97 more than three times. Out of those who experienced taeniasis majority bought drug from pharmacies without prescription (self-prescription), while others used local herbal drugs and only smaller proportion of the respondents visited health care institutions for treatment (Table 7).

Table 7. Prevalence of *T. saginata* in Babile, Jigjiga and Dire Dawa towns.

Variable	No respondants	Yes	Prevalence (95%CI)
Dire Dawa	300	133	44.3(38.7-50.0)
Babile	300	155	51.6(46.0-57.3)
Jigjiga	300	144	48.0(42.4-53.7)
Recognized on under wear	432	174	40.3(35.6-45.1)
Recognized in stool	432	228	52.8(48.0-57.6)
Recognized on laboratory	432	30	6.9(4.7-9.8)
Infestation once per life time	432	246	56.9(52.0-61.7)
Infestation twice per life time	432	89	20.6(16.9-24.7)
Infestation more than three times	432	97	22.4(18.6-26.7)
Infestation before 2008	432	179	41.4(36.7-46.2)
Infestation after 2008	432	67	15.5(12.2-19.3)
Infestation before and after 2008	432	186	43.1(38.3-47.9)
Health centers/hospital/clinic	432	66	15.3(12.0-19.0)
Pharmacy	432	222	51.4(46.6-56.2)
Local herbal	432	144	33.3(28.9-38.0)
Overall	900	432	48.0(44.7-51.3)

4.2. Risk Factors of *T. saginata* in Human

Univariable logistic regression analysis indicated that *T. saginata* significantly associated with occupation (civil servant, FRM, student and butchers), sex, marital status, educational status (elementary, high school and college), age, income, raw beef consumption, habit of raw beef consumption and form of raw beef ($p < 0.05$). Age is collinear with occupation, marital status, income, educational status and meat sources. In the present study butchers and food related merchants, male, Married, elementary, greater than 18years age, greater than 1000 birr income, raw beef consumer as Kurt, respondents that bought beef other than butchers and those that had no awareness about *T. saginata* have been positively correlated with the exposure of *T. saginata* relatively to civil servants and drivers, female, single, other categories of educational status (high school and college graduates), less than 18 years age, other categories of income (500-1000 birr and less than 500 birr), raw beef non consumer, respondents had awareness about *T. saginata* and bought raw beef from butchers (Table 8 and 9).

Table 8. UVLRA of city, occupation, sex, marital status, education, age, income, raw beef consumption in relation to *T. saginata*.

Variable	Categories	no of resp	Ni	Pre(95% CI)	OR(95%CI)	p-V
Town	Dire Dawa	300	133	44.3 (38.7-50.0)	Ref.	
	Babile	300	155	51.6 (46.0-57.3)	1.3 (1.0-1.8)	0.072
	Jigjiga	300	144	48.0 (42.4-53.7)	1.2 (0.8-1.6)	0.368
Occupation[a]	Civil servant	283	110	38.9 (33.1-44.6)	Ref.	
	Laborer	124	66	53.2 (44.4-62.0)	0.6 (0.2-2.0)	0.444
	FRM	169	137	81.1 (75.1-87.0)	2.3 (0.9-5.8)	0.069
	Students	124	19	15.3 (9.0-21.7)	2.0 (0.6-7.0)	0.280
	Butchers	42	38	90.5 (81.5-99.5)	5.8 (1.0-33.0)	0.047
	NFRM	101	53	52.5 (42.7-62.3)	0.3 (0.1-1.1)	0.068
	Driver	57	9	15.8 (6.2-25.3)	0.01 (0.01-0.04)	0.000
Sex	Female	391	147	37.6(32.8-42.4)	Ref.	
	Male	509	285	56.0(51.7-60.3)	2.1(1.6-2.8)	0.000
Marital status[b]	Married	548	318	58.0(53.9-62.2)	Ref.	
	Single	352	114	32.4(27.5-37.3)	0.3(0.3-0.5)	0.000
Education[c]	Elementary	264	164	62.1(56.2-68.0)	Ref.	
	High school	179	76	42.5(35.2-49.7)	0.4(0.3-0.7)	0.000
	College	359	123	34.3(29.3-39.2)	0.3(0.2-0.4)	0.000
	Non-Educated	98	69	70.4(61.3-79.5)	1.4(0.9-2.4)	0.145
Age[abcde]	$\leq$ 18	68	4	5.9(0.2-11.5)	Ref.	
	> 18	832	428	51.4(48.0-54.8)	16.9(6.1-47.0)	0.000
Income[d]	< 500 birr	118	24	20.3(13.0-27.6)	Ref.	
	500-1000 birr	154	64	41.5(33.7-49.4)	2.8(1.6-4.8)	0.000
	>1000 birr	628	344	54.8(50.9-58.7)	4.7(2.9-7.6)	0.000
Raw beef consumption habit	Yes	463	382	82.5(79.0-86.0)	Ref.	
	No	437	50	11.4(8.4-14.4)	0.03(0.02-0.04)	0.000

Table 9. Continued UVLRA for meat source, awareness, habit and form of raw beef in relation to *T. saginata*.

Variable	Categories	No of resp	Ni	Pre(95% CI)	OR(95%CI)	p-value
Meat source[e]	Butchers	648	280	43.2(39.4-47.0)	Ref.	
	Other than butchers	131	59	45.0(36.5-53.6)	1.1(0.7-1.6)	0.700
	Both	121	93	76.9(69.3-84.4)	4.4(2.8-6.8)	0.000
Awareness	Yes	510	238	46.7(42.3-51.0)	Ref.	
	No	390	194	49.7(44.7-54.7)	1.1(0.9-1.5)	0.360
Habit of raw beef consumption period	None	437	50	11.4(8.4-14.4)	Ref.	
	Daily	44	37	84.1(73.1-95.0)	41.0(17.3-96.7)	0.000
	1s/weekly	123	105	85.4(79.1-91.6)	45.15(25.3-80.7)	0.000
	1s/monthly	96	79	82.3(74.6-90.0)	36.0(19.7-65.6)	0.000
	Occasionally	200	161	80.5(75.0-86.0)	32.0(20.2-50.5)	0.000
Form of raw beef	None	437	50	11.4(8.4-14.4)	Ref.	
	Kurt	217	189	87.1(82.6-91.6)	52.2(31.9-85.6)	0.000
	Kitfo	93	65	70.0(60.5-79.3)	18.0(10.5-30.6)	0.000
	Dulet	48	38	79.2(67.5-90.8)	29.4(13.8-62.6)	0.000
	2 or/and all	105	90	85.7(79.0-92.4)	46.4(25.0-86.4)	0.000

No of resp= number of respondent, Ni= number of infested, Pre. =prevalence, OR=odd ratio, p-V= P value, variable with **a, b, c, d, e** superscript are collinear, < = less than, > = greater than, 1s = once.

For multivariable logistic regression analysis, risk factors namely butchers, FRM, civil servants and driver from the occupation, sex, marital status, educational status and raw beef consumption were found to be significantly associated with *T. saginata* ($p < 0.05$). Accordingly, butchers, non-educated, male, married and raw beef consumer are highly exposed (Table 10).

Table 10. Multivariable logistic regression model for potential predictors of *T. saginata*

Variable	Categories	No of infested	OR(95%CI)	p-value
Occupation	Civil servant	110	Ref.	
	Laborer	66	0.9 (0.4-2.2)	0.075
	Food related merchant	137	2.6 (1.2-5.9)	0.015
	Student	19	1.0 (0.4-2.3)	0.089
	Butcher	38	5.9 (1.3-27.4)	0.022
	Non-food related merchants	53	0.4 (0.2-1.1)	0.091
	Driver	9	0.02(0.01-0.05)	0.000
Sex	Female	147	Ref.	
	Male	285	3.4 (2.1-5.8)	0.000
Marital status	Married	318	Ref.	
	Single	114	0.1 (0.07-0.2)	0.000
Education	Elementary	164	Ref.	
	High school	76	0.2 (0.1-0.5)	0.000
	College	123	0.4 (0.2-0.8)	0.016
	Non-Educated	69	2.7 (1.2-6.4)	0.021
Habit of eating raw	Yes	382	Ref.	
beef	No	50	0.01 (0.01-0.02)	0.000

Hosmer-LemeshowX^2=393.68, p-value= 0.6103, ROC=0.9499

5. DISCUSSION

In the present study the overall prevalence of *C. bovis* was 27.3% (95% CI, 24.6-29.9). Which is comparable with the findings at Hawassa 26.3% (Abunna *et al.,* 2008), 30% from different abattoirs in the country (Solomon, 2012) and Tanzania 27% (Over *et al*., 2012). The finding of the current study was less than 38% finding in Kenya (Over *et al.,* 2012). This could be low number of inspected carcasses than study at Kenya. Low number of inspected carcasses and Limited number of incision may decrease the prevalence of *C. bovis* (Pam *et al.,* 2015).

The prevalence of *C. bovis* in the current study was higher than most of the recent and old finding in different areas of the country; 15.5% at Ambo (Bekele *et al.,* 2017), 6.5% at Dale Wabera district western Ethiopia (Bayou and Taddesse, 2018), 4.94% in Kofale (Mekonnen, 2017). Much higher than the findings at Asella 1.2%, (Edao *et al*., 2016) and Jigjiga 2.25% (Biruk, 2017) and Kombolcha ELFORA Meat Processing Factory 4.7% (Kassaw *et al*., 2017). This could be due to strict application of detailed meat inspection in the current study. Experimental studies showed a 5-50 times higher prevalence could be achieved by complete slicing of the predilection sites (Geysen, 2007).

Multivariable logistic regression analysis indicated that *C. bovis* significantly associated with site, age and body condition ($p < 0.05$). Jigjiga had the highest prevalence as compared to Babile and Dire Dawa. High prevalence of *C. bovis* in Jigjiga may be related to access of cattle to contaminated water and/or pastures for the cattle that come from Jigjiga area, Babile and Gursum to be slaughtered in Jigjiga abattoir. Poor environmental hygiene, particularly the presence of open field defecation increases the prevalence of the diseases in the environment (Laranjo *et al*., 2016). The present study was much higher than the prevalence reports of Biruk 2.25 % (Biruk, 2017) from the same study area Jigjiga this variation may be variation in the method and quality of meat inspection, experience and diligence of inspector. It may also due to changes in levels of environmental contamination associated with increasing human population and expansion of urban areas into grazing areas over the last 10 years after the study was conducted in 2008. Low prevalence of cyst at Dire Dawa may be high temperature kills proglottids from faces of infested human agreed with finding at Nyagatare that justify high temperature in Nyagatare which kills proglottids from infested human (Habarugira *et al.,* 2015).

In the present study the carcass of adult cattle had higher prevalence than that of older ones. The finding agrees with the previously reported trends such as 16.9% in adult and 14.8% in old reported from Ambo (Bekele *et al*., 2017), and 3.38% in adult and 1.56% in older cattle from Kofale district (Mekonnen, 2017). This could be due to subsequent development of active immunity that negatively affects cyst survival at older age. Majority of cysticerci from initial calf hood infestation may degenerate or disappear (Gracey *et al*. 2015). In countries where *T. saginata* is common cattle frequency increases ingesting tapeworm ova. However, the survival of the parasite population is dependent up on the intrinsic regulatory mechanisms of the intermediate host population. An active immunity develops and the prevalence of *C. bovis* decreases progressively with age (Abuseir *et al.,* 2013).

High prevalence of cyst was observed in cattle with good body condition than poor body condition. This agreed with finding at Yirgalem 26.6% on good body condition and 6.3% poor body condition (Abunna, 2013), 22.3% good and 12.7% poor body condition at Adama municipal abattoir (Birhanu and Abda, 2014). An increased risk on good body condition than poor body condition has been associated with the number of slaughtered animals.

In the study area the commonly inspected organs for presence of *C. bovis* were liver, heart, shoulder muscle, thigh muscle, arm muscle, lung, tongue, kidney, masseter, diaghrem and intercostal muscles. Analysis of the active abattoir survey showed that there was a variation with regard to the anatomical distribution of *cysticercus* in the organs inspected. The highest proportions of *C. bovis* were observed in liver 9.57%, followed by tongue 8.48%, masseter 5.05%, shoulder 4.33%, arm muscle 2.53%, heart 2.35%, thigh muscle 1.81% and diaphragm 0.36%. The trends in the findings of this study are in line with findings at Mekelle municipal abattoir that stated liver to be the most frequent site for the cyst 6.74% on liver, 0.39% on tongue, 0.29% triceps muscles, 0.39% heart, 0.29% lung and 0.097% masseter muscles (Abay and Kumar, 2013) and findings at Asella municipal abattoir with distribution of cyst 43.8% in liver, 31.3% in heart, 12.5% in tongue and 12.5% in masseter muscle (Edao *et al*., 2016) and 4.3%, in liver, 0.5% in heart and 0.0% tongue at Shire municipal abattoir (Belay and Mekelle, 2014). More number of *C. bovis* was observed in the liver than other organs inspected. Experimental study indicates that absence of specific predilection site for *C. bovis* (Calvo *et al*., 2013), so more number of larvae collected through mesenteric and portal veins residing in the

liver could be the large volume of blood that reaches the organ from the intestines. Other workers reported that any geographical and environmental factors affecting blood kinetics in the animal may also affect the distribution of oncospheres as well and hence the predilection sites during meat inspection (Scandrett *et al.,* 2009).

During the study period high numbers of non-viable cyst were collected than viable cysts. This could be due to the age of animals slaughtered in the study area. The majority of the animals slaughtered were old with subsequent development of active immunity; the majority of cysticerci from initial calf hood infestation might have degenerated. An active immunity develops and the viability and prevalence of *C. bovis* decreases progressively with age (Abuseir *et al.,* 2013).

Among the total of 900 respondents interviewed in Jigjiga, Babile and Dire Dawa towns 432, 48.0% (95% CI, 44.7-51.3) had contracted *T. saginata* infestation. This result agreed with the finding at Asella town and Tiyo woreda 44.3% (Edao *et al*., 2016), 44% in Hawassa town (Belachew and Ibrahim, 2012) and 44.4% in Shire Indasilassie district (Gebremichael and Mohammed, 2013). But less than the finding at Debre Zeit town 69.5% (Tesfaye, 2016), at Yirgalem70% (Abunna, 2013), at Harar 60.7% (Terefe *et al.*, 2014), at Batu 59% (Demeke and Debash, 2015). Even though there is consumption of raw and undercooked beef, in this area there is high consumption of camel meat than beef particularly, by Muslim community. This may contribute the prevalence *T. saginata* to decrease compared to above listed areas. Raw beef consumer had higher chance to contribute for *T. saginata* infestation (Gracey *et al*., 2015).

But our findings were higher than 19% at Halaba Kulito Town (Hirpha *et al*., 2016), 18% at Adama town (Birhanu and Abda, 2014), 31.8% at Kombolcha town (Tegegne *et al.,* 2018), 30.4% at Bahirdar (Tamirat *et al.,* 2018). Socioeconomic and cultural practices such as backyard slaughters, consuming "Wosla" is common and daily habit in the population of the study area this may expose society for *T. saginata*. Wosla is the traditional food by Somali and eastern Oromo populations, by which the whole muscles where allowed to be cooked without cutting or chopping. Sometimes deep rooted cyst in the muscle may pass under cooked. The prevalence of cyst also contributed the prevalence *T. saginata* to increase. In France, it was estimated that one undetected carcass could potentially infest between eight and 20 humans (Dupuy *et al.,* 2014).

Multivariable logistic regression analysis indicated that *T. saginata* significantly associated with occupation (Butchers, FRM, civil servant and Driver), sex, marital status, educational status, age, raw beef consumption ($p < 0.05$).

In the present study butchers had 6 times higher odds of exposure and FRM had 2.6 times higher odds of infestation for *T. saginata* than civil servants. The findings of the current study are in line with the findings at Debreberhan 50.0% butchers and 37.5% FRM as the highest exposed occupations (Wondimagegnei and Belete, 2015). This might be these occupations have strong relationship with raw beef. Exposed groups have higher access to eat raw beef; there could be a possibility of getting infestation with *T. saginata* (Alemneh *et al*., 2017).

Based on the current study non-educated have 2.7 times higher odds of exposure than educated groups with the prevalence of 70.4% non-educated, 62.1% elementary, 42.5% high school, 34.3% college/university. The highest prevalence of non-educated followed by elementary and high school and college agreed with finding at Hawassa (Belachew and Ibrahim, 2012) and Bishoftu (Emiru *et al.,* 2015). Education can be considered as one of the key factor influencing continued involvement in programs of prevention and control of cysticercosis (Elizandro and Maria, 2013).

With regards to sex males had 3.4 higher odds of exposure than females. This result agrees with different reports in various parts of our country, at Ambo 68.25% male were more affected than 26.9% female (Bekele *et al.,* 2017), at Bishoftu 73.44% male and 47.22% female (Emeru *et al.,* 2015) and at Zeway 67.7% male and 44.8% female (Bedu *et al*., 2011). This due to the cultural and social factors in which the males are usually involved in slaughter houses and butchery as well has having access to the hotels meals (Deressa *et al*., 2012).

In the present study married had 10 higher odds of exposure than singles. The current finding in line with finding at Debreberhan city 43.48% married and 21.05% single (Wondimagegnei and Belete, 2015), at Bahirdar 35.7% married and 29.7% single (Tamirat *et al.,* 2018). These due to married people had strong economic power to visit the butchers and restaurants mostly than single (Bekele *et al*., 2017). And also since the studies are cross sectional married people had double chance to be infested with *T. saginata* while they are single and married.

Raw beef consumers had 77% higher odds of exposure than raw beef non-consumer. Previous reports from Ethiopia also indicated that consumption of raw beef was strongly associated with *T. saginata* infestation. For example 81.6% raw beef consumer and 28.3% non-consumer at Bishoftu (Emiru *et al.,* 2015), 59.1% raw beef consumers and 24% not consume raw beef at Shire Indasilassie district (Gebremichael and Mohammed, 2013) and 22.1% raw beef consumer and 8.7% non-raw beef consumer at Halaba Kulito town (Hirpha *et al.,* 2016) reported experience of taeniasis.

Most of the positive respondents witnessed infestation once per life time in their stool, followed by underwear. Respondent were confirmed that they don't consume pork meat due to religious purposes; so the proglottids observed were surely to be of *T. saginata*. *T. saginata* is known by its more frequent anal expulsion than *T. solium* (WHO and FAO, 2005). In present study self-medication was higher than consulting health professionals for treatment. The study showed that half of positive respondents had awareness about human taeniasis and its modes of transmission. However, due to deep rooted tradition or custom even most of conscious professionals (medical professional and veterinarians) often consume *kurt* or *kitfo* in Ethiopia (Belachew and Ibrahim, 2012). As a limitation majority of cattle are sourced from neighbor woreda of the study area so risk of latrine or sewage disposal of the population to cattle was not magnified.

6. CONCLUSION AND RECOMMENDATION

The current study assessed the prevalence of *C. bovis* and *T. saginata*. The prevalence of both *C. bovis* in cattle and *T. saginata* infestation in humans were high. The prevalence of *C. bovis* was associated with age, body condition and site while the prevalence of *T. saginata* in people was affected by occupation, educational status, marital status and raw beef consumption. Poor meat inspection procedures, consumption of raw and undercooked meat were common in the study area. Slaughter rooms are small, government enforcements is weak and backyard slaughtering were practiced. Large numbers of animals inspected with one meat inspectors. Self-medications were high in positive respondents than consulting health professionals for treatment. Based on the above conclusion increase awareness for the community to eat adequately cooked meat, Backyard cattle slaughter should be discouraged, detailed meat inspection procedure should be applied, further studies on the prevalence of taeniasis and cysticercosis in the rural part of the study area, study that relate effect of latrine and sewage disposal of human for prevalence of cysticercosis and also experimental studies should be encouraged.

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8. ANNEX

Questionnaire set to study risk factors related to taeniasis infestation in humans

Code_____ Date_____

District/town_____ Kebele_____

1. Occupation of the respondents: _____
2. Sex of the respondent

   A. Female B. Male
3. Marital status of the respondent

   A. Married B. Single
4. Educational level of the respondent

   A. Elementary B. High school C. College D. Non-educated
5. Age of the respondent

   A. Less than 18yrs B. Greater than or equal to 18yrs
6. Income:

   A. Less than 500 birr ETB B. 500-1000 ETB C. Greater than 1000 ETB
7. Do you have livestock?

   A. Yes B. No
8. If yes on Q7 Reasons for keeping cattle:

   A. Source for food B. Source of income C. Others (specify?)_____
9. Are there any latrines in the areas where cattle are grazed?

   A. Yes B. No
10. Sewage disposal system:

    A. Latrine in house where cattle are not grazed

    B. Defections in open area
11. Did you eat raw beef /uncooked meat (raw beef consumer/ not consumer).

    A. Yes B. No

12. Where do you buy meat? (Meat source)

A. Butcher shop (Assumed to be officially inspected)

B. Other than butcher shop (Backyard, street vendor, from slaughter men)

C. Both

13. If your answer to **Q11** is '**No**', what was your reason not to eat raw meat?

_____

14. Have you ever been advised in the past not to eat raw beef? (awareness of *Taenia saginata*)

A. Yes B. No

15. Habit of raw beef consumption

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

16. In which form do you like to eat raw beef most commonly?

A. As "Kurt"

B. As"Kitffo"

C. As"Dulet

D. 2 or/and all

17. Have you ever experienced tapeworm infestation?

A. Yes B. No

18. If your answer to **Q18** is yes, how did you found out it was a tapeworm?

A. Noticed/found the proglottids in my underwear

B. Noticed/observed the proglottids in my stool

C. Recognized by health professionals during my illness (laboratory)

19. Infestation rate with *Taenia saginata* in your life time

A. Once per year B. Twice per year C. other

20. If your answer to Q20 is **a** and/or **b**, what are you done next

A. Went to health station/clinic/hospital to get drugs

B. Went to pharmacy to by drugs by myself

C. Used local herbal drugs for treatment

21. Year of Infestation

A. Before 2008 B. After 2008 C. Both