



# Prevalence of Bovine Cysticercosis in Jigjiga City Municipal Abattoir and Treatment Costs of Human Taeniasis

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Combination of Cross-sectional and retrospective study was conducted from Jan 2021 up to Jun 2021 in Jigjiga city Municipal abattoir and inventory of pharmaceutical drug shops, with the objectives of determining the prevalence of bovine *cysticercosis* and treatment costs of human taeniasis. Systematic random sampling technique was employed for selecting the study animals, while the Sampling methodology was based on Active abattoir survey and Inventory of pharmaceutical drug shops. From the 520 animals examined at abattoir, the overall prevalence of *cysticercus bovis* was 2.69% (14/520) with 95% CI of (1.43, 4.29). There was no statistically significant difference in sex, age, body condition score and origin of the animal with the occurrence of *C. bovis* ( $P>0.05$ ); From 14 infected cattle with *cysticercus bovis*, 7 (50%) of *cysticercus bovis* were in the triceps muscle, 5 (35.71%) in tongue, 1 (7.14%) in biceps muscle and 1 (7.14%) in masseter muscle. Descriptive statistics revealed that a total of 23,063 doses of taenicial drugs concern a 4-year period (2017-2020) were used for the treatment of human taeniasis which worth 56,933 Ethiopian Birr in the town. Albendazole was employed at a rather high dose, followed by Mebendazole, Praziquantel, and Niclosomide, in that order. The most commonly prescribed medicines for the treatment of taeniasis were albendazole and mebendazole. The discovery highlights the importance of cysticercosis and taeniasis in terms of both economics and public health. To reduce the impact of this parasite, special focus should be paid to raising public awareness and conducting thorough routine meat inspections.

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## 1. INTRODUCTION

Human taeniasis is a parasite disease that can be seen in both industrialised and developing countries, particularly in locations where eating raw or undercooked beef is widespread [1]. The larval cyst of the zoonotic tapeworm *T. saginata* causes Bovine cysticercosis [2]. Humans are the final hosts for adult tapeworms, while cattle are the most common intermediate hosts for the larval stage (cyst), which plays a significant role in human taeniasis epidemiology [3]. Ingestion of raw or undercooked meat harbouring the larval cysts causes infection. To kill the cysts and make the beef safe to eat, it must be cooked to a minimum internal temperature of 60°C. Ingested viable larvae develop into segmented, adult tapeworms that can grow to be several metres long and live in the bowels for many years [1]. The majority of infections cause only mild abdominal pain, but serious consequences such as appendicitis, gangrenous cholecystitis, cholangitis, intestinal blockage, and gall bladder perforation can occur [4].

Bovine cysticercosis is difficult to diagnose in live cattle, however following the slaughter inspection process, meat inspectors examine for cysts in beef muscle tissue. Human eating is not permitted on severely afflicted corpses. If cysts are identified in a specific area of the organs or tissues, the afflicted parts can be removed, and the carcass can be returned to the food chain after treatment, which can include freezing at -10°C for at least 10 days or heating the carcass to a minimum internal temperature of 60°C throughout [5].

Bovine cysticercosis is known to be caused by calves being exposed to sewage and effluent polluted with human faeces. Cattle producers can limit the risk of infection by providing appropriate bathrooms and handwashing facilities, as well as requiring all employees and visitors to use them on a regular basis. Human waste pollution of feed bunks, feed storage sites, ditches, and other areas can be avoided using these methods. Open or outside defecation, combined with a lack of access to clean water, is a key risk factor for bovine cysticercosis in underdeveloped nations [6].

National or regional pooled prevalence estimates based on meat inspection are variable. For example, the prevalence was estimated to be varied from 0 to 1.7%. In Eastern Europe [7], in

Western Europe, it varies from 0.0002 to 7.82% [8], 15-20% in the Middle East and North Africa [9], 29% in West and Central Africa [10] and 13% in Vietnam [11]. This disease can pose major obstacles for trade and can cause a substantial financial burden that is linked with carcass condemnation or rejection and an overall reduction in the beef carcass value [7,12].

Human *T. saginata* and bovine cysticercosis are major concerns in Ethiopia, owing to the widespread consumption of raw or undercooked beef [13], widespread defecation in the open fields due to a lack of toilets, an extensive cattle production system, poor hygienic practices, sanitary infrastructures, and a lack of access to clean water [14,15]. In Ethiopia, a recent analysis of the spatiotemporal distribution of bovine cysticercosis and *T. saginata* revealed a high prevalence of bovine cysticercosis, with prevalence estimates ranging from 1.9 percent in Addis Ababa to 26.3 percent in municipal abattoirs in Hawasa.

In contrast to that, human taeniasis prevalence ranges from 7.8% in Modjo to as high as 89.4% in Addis Ababa city [16]. Therefore, this research had been undertaken with the following specific objectives:-

## 2. OBJECTIVE

### 2.1 Specific Objectives

- ✓ To determine the prevalence of bovine cysticercosis in cattle slaughtered at jigjiga city Municipal abattoir
- ✓ To determine the treatment costs of human taeniasis in jigjiga city

## 3. METHODOLOGY

### 3.1 Study Area and Period

The study was conducted at jigjiga city municipal abattoir in Somali Regional State, Ethiopia, from Jan 2021 to June 2021, Its geographical coordinates are 9° 21' 0" North, 42° 48' 0" East; this area is inhabited by pastoral and agro-pastoral communities whose livelihood is based on livestock production. Study area has high livestock population density and is major source of livestock for the domestic and export markets. Furthermore human-animal interaction and habit of consumption is very high. Cross-border movement of pastoral communities and their

livestock to neighboring countries (Djibouti and Somalia) is common, the city is located in the Jigjiga Zone approximately 106 km east of Harar and 628 km from Addis Ababa. This city has an elevation of 1,609 meters above sea level. The climate of Jigjiga is a subtropical highland climate with the influence of mountain climate, with hot and dry summers and cold winters. This is attributed to the fact that Jigjiga is located on a plain surrounded by mountains and to its distance to the sea and its effects. The average temperature and rainfall range are between 25 to 31 °C and 11 to 712 mm respectively. The % humidity was in the range of 45 to 70%. The

Livestock population of the area comprises as follows cattle; 1,413,635 Goats; 2,065,200 Sheep;

2,827,204 [17]. In this abattoir on average 20 cattle are slaughtered every day.

### 3.2 Study Population

The study population for this study was included those cattle brought to jigjig a city municipal abattoir for slaughter and passed for ante mortem examination. These animals were brought from different market places found in and around town majority (99%) of them slaughtered in the abattoir were adult male having good body condition and older than 5 years and local zebu cattle (*Bos indicus*).

### 3.3. Study Design

A cross sectional study was conducted from Jan 2021 up to Jun 2021 to determine the prevalence of Cysticercosis at study area. Whereas, a retrospective type of study was employed for the determination of treatment costs of human taeniasis.

### 3.4 Sample Size Determination

The total number of cattle required for the study was calculated by using the formula suggested by [18] for systematic random sampling method, by considering 23.17% expected prevalence for cysticercosis from previous studies [19]. The Z value of 1.96 is used at 95% CI and margin of error is 5%. Accordingly, sample size was calculated as follows,

$$n = [1.962 p (1-p)] / d^2$$

Where,

n = Sample size.

p = Expected prevalence

d = Desired level of precision (5%)

The calculated sample size was 274, but to increase precision and tighten the confidence interval a total of 520 animals were inspected.

## 3.5. Sampling Methodology

### 3.5.1 Active abattoir survey

Active abattoir survey was conducted during routine meat inspection for systematically selected 520 cattle slaughtered at the abattoir. Abattoir was visited of twice per week, during ante-mortem inspection each animal was given an identification number and then recorded, followed by post mortem inspection: palpation of Tongue, Triceps muscle, heart, Biceps muscle and Masseter muscle, three times incision of each organ were made.

### 3.5.2 Inventory of pharmaceutical shops

An inventory of Jigjig a hospital based pharmaceutical shops for the purpose of determining the cost of taenicial drugs was conducted, from 20 pharmaceutical drug shops in the study area 6 of them were randomly selected. Four years (2017– 2020) recorded data of taenicial drug sales to determine the annual economic loss associated with *T. saginata* treatment in humans.

## 3.6 Data Management and Analysis

Data collected from ante mortem and post-mortem examination was entered into Microsoft Excel. Descriptive statics was carried out to summarize prevalence of *C. bovis*, the proportion of the positive organs and anatomical distribution of the cysts in each organ. Chi- square was carried out using STATA 11 statistical software. In all cases the difference between different groups were tested for significance at probability level of 0.05 or less.

## 4. RESULTS

### 4.1 Prevalence and Associated Risk Factors

From the 520 animals examined at abattoir, the overall prevalence of *C.bovis* was 2.69% (14/520) with 95% CI of (1.43, 4.29) and. There was no statistically significant difference in sex, age, body condition score and origin of the animal with the occurrence of *C.bovis* (P>0.05); (Table 1).

**Table 1. *Cysticercus bovis* occurrence with various potential risk factors**

Factors	No. of examined animals	No. affected Animals (%)	Pearson chi2	P-Value
<b>Sex</b>				
Male	480	13 (2.7)	0.15	0.70
Female	40	1 (2.5)		
<b>Age</b>				
<6	31	1(3.22)	0.56	0.75
6-8	359	8(2.23)		
>8	130	5(3.84)		
<b>Body condition</b>				
Poor	23	0	0.90	0.64
Medium	346	11(2.89)		
Good	151	3(1.98)		
<b>Origin</b>				
fafam	25	0	7.97	0.54
gursum	42	0		
bambas	161	0		
kebribayah	13	7(53.84)		
Awbarre	75	2(2.7)		
Goljanno	69	1(1.44)		
mulla	11	1(9.09)		
babili	10	1(10)		
ararso	49	1(2.04))		
Degahmadow	65	1(1.53)		

**Table 2. Distribution of *C. bovis* on different organs**

Infected organ	No. of infected animal	Relative percentage (%)
Tongue	5	35.71
Triceps muscle and heart	7	50
Biceps muscle	1	7.14
Masseter muscle	1	7.14
Total	14	100

**Table 3. Annual taeniacidal drug doses sold during 2017-2020 the exact number of shops examined**

Drugs	2017	2018	2019	2020	Total Dose	Total Cost
Niclosomide	360	687	355	1,935	3,337	10,011
Praziquantel	690	512	1,145	1,388	3,735	14,940
Albendazole	3,250	2,963	1,638	2,358	10,209	20,418
Mebendazole	1,383	963	1,839	1,597	5,782	11,564
Total					<b>23,063</b>	<b>56,933ETB</b>

#### 4.2 Proportion of Animal and Organ Affected

From 14 infected cattle with *cysticercus bovis*, 7 (50%) of *Cysticercus bovis* were in the triceps muscle, 5 (35.71%) in tongue, 1 (7.14%) in biceps muscle and 1 (7.14%) in masseter, all of the founded cysts were calcified and none was viable. Muscle (Table 2);

#### 4.3 Inventory of Pharmaceutical Shops

The annual adult taeniacidal medicine dose and its value were gathered through records and personal interviews with pharmacists and their assistants. According to descriptive statistics, a total of 23,063 doses of taeniacidal medications worth 56,933 ETB were used in the town to treat human taeniasis. Albendazole was employed at

a rather high dose, followed by Mebendazole, Praziquantel, and Niclosomide, in that order.

## 5. DISCUSSION

Meat inspection is insensitive and imprecise, therefore the infection's frequency in this city of the country may be underestimated. *C.bovis* was found in 2.69 percent of carcasses inspected at the Jigjiga municipal abattoir, which agrees with the 3.65 percent found at Jimma [16] 3.11% in different agro climatic zones of Ethiopia, [20] 4.9% at Gondar, [14] 4.4% at Jimma and [17] 5.4% at Konbolcha However, the prevalence of the present study disagrees with the finding of [21] 11.3% in Wolaita Soddo. The difference in the prevalence rate of bovine cysticercosis between the two studies could be due to differences in the origins of animals that were presented for slaughter.

Taeniasis has importance both in terms of socio-economic and public health aspects [22]. Inventory of Hospital centered pharmaceutical shops which comprises a four years data (2017-2020) in Jigjiga city during study period revealed a total of 23, 063 taenicial drug dose which worths 56,933ETB from taeniasis treatment in humans. The estimate dose and worth of drug for the disease in this study disagrees from study done at Kombolcha Town, Wollo, Ethiopia which revealed 6998 adult taenicial drug doses for a cost of 19,621.00 Ethiopian Birr (ETB) [23], but agrees for the drugs most commonly sold which were mebendazole and albendazole. The reason for the difference might be attributed to variation of the size of the population resides in the two areas.

Study done in municipality abattoir at Jimma [24] reported that 222,706 Eth, Birr and 72, 190,

21 Eth. Birr, a total of 7,441,727 Eth. Birr was lost due to taeniasis treatment expenditure in

Jimma. In contrast to this study which revealed a total dose of 23,063 doses which worth

56,933ETB for the treatment of human Taeniasis in the town. this difference could indicate so many things like; pharmacies standards and recording ability, difference of prevalence of the disease in the two areas, habit of feeding, people's awareness and demand of the taenicial drugs regardless of the presence of so many traditional medicines.

According to the study done at Adama by Yacob Hailu [17] Niclosamide, Praziquantel, Albendazole and Mebendazole are commonly used for the treatment of *T.saginata* in the area, the cost of taenicial drugs for three years recorded 2011/12-2013/14 was about 378,609.66 Eth Birr which disagrees for the present study. In addition, this study also disagrees in the case of drugs most commonly used (sold) for taenicial purpose. The reasons of this difference may be awareness among the communities, recording errors, health facility.

Study done by Dawit T. at Wolaita Soddo, [25] Southern Ethiopia indicated a total of 29,952 adult doses which worth 40,201.8 ETB (2407.2 USD) per annum on average was spent for the treatment of human Taeniasis in the town. But agrees in this study for the order of the most commonly used taenicial drugs, the number of years included were two years only while this study covers more number of years and the differences shown here agrees for the above discussed studies. Regarding the anatomical distribution of *C.bovis* cyst, some of the previous works [23] mentioned that there were no as such true predilection sites for *C. bovis* as the presence and number of cysts in any predilection sites varied greatly from animal to animal. On the other hand, it was explained that the parasite can migrate via the mesenteric venue to enter systemic circulation and then they filtered out to tongue, heart and masseter muscles as a preferred predilection site [26]. Similarly, the present study reported that relatively higher percentage of these organs was affected by *C. bovis*. It was mentioned that the reason for the preference of these organs by this cyst could be due to the fact that there is relatively higher supply of arterial blood to the muscle in these organs [27]. Moreover, tongue is conveniently more accessed organ during the slaughtering process than the rest of the organs. This result is in agreement with other study conducted at Jimma municipal abattoir, [14].

Unlike other predilection sites of *C. bovis*, tongue and heart had no limitations upon incision for inspection and this could also be the reason for the slightly higher observed frequency of *C.bovis* on tongue and heart [28].

The disease causes financial losses due to the rejection of infected organs and the degradation of carcasses, as well as the high costs of human treatment. As a result, regular meat inspections should be done to ensure that contaminated

carcasses and organs are rejected appropriately. The prevalence of *C.bovis* among the carcasses inspected at Jigjiga municipal abattoir (2.69%) is in agreement with the finding at Nekemte town 2.98%. but disagrees the findings at Awassa municipal abattoir, [29] which was conducted at the western part of the country, However, it is lower than the findings of [21] in Wolaitasoddo, 11.3%, [29].

Human taeniasis is significant from both a socioeconomic and a health standpoint. However, assessing the economic consequences is challenging, especially in impoverished countries such as Ethiopia, where infected individuals treat themselves with traditional herbal medicines. Conducting inventories of pharmaceutical stores is one possible source of information for estimating financial loss, although this may not reflect the true economic burden of the disease. However, inventories of pharmaceutical shops which comprises four years record 2017 up to 2020 in Jigjiga city during the study period indicated that a total of 23,063 taenicial doses which worth 56,933ETB for the treatment of human Taeniasis in the town.

## 6. CONCLUSION AND RECOMMENDATIONS

The present study indicated the prevalence of bovine cysticercosis at Jigjiga city Municipality abattoir which is 2.69% and inventories of pharmaceutical shops which comprises four years record 2017 up to 2020 in Jigjiga city during the study period indicated that a total of 23,063 taenicial doses which worth 56,933ETB for the treatment of human Taeniasis in the town. Moreover, infection in cattle with a huge human treatment loss justifies a program of disease control. In conclusion, both abattoir survey and the retrospective study showed that *C.bovis* and the adult parasite was important parasitic disease in the area, Routine Meat Inspection is the only diagnostic procedure in use in Ethiopia for the diagnosis of bovine cysticercosis.

**Therefore, based on the above conclusion the following recommendations are forwarded:**

- Improved cattle production systems, meat inspection services and public health education are important.
- Meat inspection with proper cooking before consumption could also bring a reduction

of the diseases in human and cattle which reduces the associated economic loss.

- Routine meat inspection should be applied in all slaughter houses.
- Latrines in the rural areas should be encouraged and improved meat inspection procedures.
- Restricting animals from the access of surface drinking water and supplying them fresh water instead.
- Improving the working conditions of meat inspectors and up-grading their meat inspection skill.
- Awareness creation about the health and economic significance of the disease

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

Ethical clearance was obtained from the College of Medicine and health science, Jigjiga University Ethical Committee.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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