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Public Health and Economic Significance of Bovine Cysticercosis in Wolaita Soddo, Southern Ethiopia

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Abstract: A combination of retrospective and cross-sectional study was employed to estimate the economic and public health significance of *Taenia saginata*. A total of 540 carcasses were examined during the study period. Of which, 14 (2.59%) were infected with *T. saginata* cysticerci. Prevalence of *Cysticercus bovis* based on the various anatomical locations was: 2.22% in tongue, 1.66% in masseter muscle, 1.11% in heart, 0.92% in shoulder muscle and 0.32% in the diaphragm. *T. saginata* was found to be a widespread public health problem in the study area with an overall prevalence of 62.5%. *T. saginata* infection rate among the respondents showed significant difference ($p<0.05$) with age groups and different levels of raw meat consumers. Adult individuals had higher odds of acquiring taeniasis (OR=31.8) than lower age groups. However, there was no significant difference ($p>0.05$) in the infection rate of the parasite between sex, religion and educational status groups. Albendazole and menbendazole were the most frequently sold drugs for the treatment of taeniasis. The finding indicates the importance of cysticercosis and taeniasis both in economic and public health aspects. Therefore, due attention should be given for awareness rising in the public and strict routine meat inspection should be undertaken to minimize the impact of this parasite.

Key words: *Cysticercus bovis* · *T. saginata* · Prevalence · Wolaita soddo · Abattoir · Ethiopia

INTRODUCTION

Bovine cysticercosis refers to the infection of cattle with metacestodes of human tapeworm while the adult tapeworms in human small intestine cause taeniasis [1, 2]. The life cycle and transmission of parasite occurs most commonly in environments characterized by poor sanitation, primitive livestock husbandry practices and inadequate meat inspection, management and control policies [3, 4]. Humans are the obligate final host and become infected by ingesting infected meat that has been inadequately cooked or frozen [5]. Most incidents arise in cattle as a result of direct exposure to proglottids shed from humans, but there have been some report of large scale out breaks resulting from sewage-contaminated feed or forage [6]. In cattle, heavy infection by *T. saginata* cysticercosis may cause myocarditis or heart failure [7]. Ingested eggs in cattle develop in to cysticerci, which can often be detected during meat inspection at routinely inspected localization sites of the parasite, including heart, skeletal muscles and diaphragm [8]. Many cases of taeniasis in humans are asymptomatic, except for some anal pruritis due to emerging tapeworm segments but with severe infection humans may experience loss of weight, increased appetite or loss of appetite, abdominal discomfort and digestive upset [8]. In addition to effect on human health, economic loss is high due to condemnation of heavily infected meat, restriction of exports and treatment costs in human for *Taeniasis* [9, 5].

In developed countries, even if the disease has a very low prevalence, the problem with removal and treatment facilities in their sewage system plays a role in the distribution of eggs, since it was recorded that the egg can survive in sewage. In some parts of Ethiopia, due to habit of eating raw meat such as “kurt” and “kitfo” that are served in raw or undercooked are source of *T. saginata* infection in man [10]. Prevalence rate of 64.2% and for Taeniasis reported by [11] and 56.7% by [12] based on questionnaire survey revealed that it is a wide spread disease in Ethiopia. *C. bovis* in cattle reported by individuals were: 3.2% in different agroclimatic zones of country [13], 19.4% in Bahir Dar [14], 13.85% in Debrezeit [15] 26.25% in Hawassa [16] and 9.67% in Gonder [17].

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Although there were some research works carried out in certain parts of country, very little is known about the status of *T. saginata* cysticercosis in cattle, the prevalence of *T. saginata* in humans and the economic and public health impact in the present study area. Hence, the study was conducted with the objectives of estimating the prevalence and economic losses of *C. bovis* and *T. saginata*.

MATERIALS AND METHODS

Study Area: The study was conducted at Wolaita soddo town and its surrounding villages located in southern part of Ethiopia, which is about 390 km away from Addis Ababa. Wolaita soddo is located at latitude of 80° 50' N and longitude of 37°45' E and surrounded by four zones of southern regional states namely Hadya (Northern), Sidama (Eastern), Gamo-goffa (Southwestern) and Dawro (in the Western) directions [18]. The altitude of the area ranges from 1100-2950 m.a.s.l. with 9% highland, 56% midland and 35% lowland. The area has an annual rainfall ranging from 450mm-1446mm which is characterized by bimodal rainfall, long rainy season from June to mid October and short rainy season from March to April [19]. The mean annual temperature of the area is about 19°C. The average maximum monthly temperature (26.6°C) is attained in January while average minimum monthly temperature (11.4°C) is recorded in August. Agriculture is the livelihood for more than 90% the population in the surrounding rural farming community. Livestock is complementary to crop production. The total livestock population of Wolaita zone is estimated to be 685, 886 cattle, 87, 525 sheep, 90, 215 goats, 1951 horses, 20, 137 asses, 2,174 mules, 669,822 poultry and 38,564 bee hives [20].

Study Animals: Animals which were presented to Wolaita Soddo municipal abattoir mainly come from lowland (South Omo, Arbaminch, Gamo Goffa, Humbo, Abala and Bele), highland (Wolaita soddo, Damota Sillassia, Gununo and northern Areka) and midland (Boditti, southern Areka and Dawro) areas. Local zebu cattle presented to the abattoir for slaughter were used as a study population for active abattoir survey.

Study Type: A cross-sectional study was used to study the prevalence of bovine cysticercosis in the abattoir. Whereas, a retrospective type of study was employed to estimate the occurrence of *T. saginata* in humans and associated factors. Additionally, it was also used to estimate the economic losses due to *T. saginata* treatments in humans.

Study Methodology

Active Abattoir Survey: Active abattoir survey was conducted during routine meat inspection on randomly selected 540 cattle slaughtered at the abattoir. During antemortem examination, each study animal was given an identification number and its sex, age and origin was recorded.

During inspection, each predilection sites were inspected according to the guide line by [21] as follows; for Masseter muscle the deep linear incisions were made parallel to the mandible; the tongue was examined from base to top, the hearts were incised from base to apex to open the pericardium and incision was also made in to cardiac muscle for detail examination. Deep, adjacent and parallel incisions were made above the point of elbow in the shoulder muscles. Examination of kidney and liver was also conducted accordingly.

All the positive samples were transported to the parasitology department of Soddo regional veterinary laboratory for confirmation of cyst viability. The cysts were incubated at 37°C for 1-2 hours using 40% ox bile solution diluted in saline solution. After this, the scolex was examined under microscope by pressing between two glass slides. A cyst was regarded as viable if the scolex evaginate during the incubation period [22].

Questionnaire Survey: A semi structured questionnaire was administered to 80 volunteer respondents. In the questionnaire survey, the aim of keeping cattle, presence of and usage of sanitary facilities especially toilet, knowledge of *T. saginata* life cycle, specific questions regarding medical history related to traditional and modern taenicidal drugs were included.

Inventory of Pharmaceutical Shops: An inventory of pharmaceutical shops, rural drug venders and clinics in the study area was conducted by recording a two years (2009-2010) data of taenicidal drug sales to estimate the annual economic loss associated with *T. saginata* treatment in humans.

Data Management and Analysis: The data collected from abattoir, questionnaire and drug sale inventory were stored into Microsoft excel. Logistic regression was employed to analyze the association of *C. bovis* cyst

occurrence with the potential risk factors like origin, sex, age using Stata statistical software [23]. The degree of risk factors association with the disease occurrence was further analyzed using odd ratios. Questionnaire survey data were also summarized using descriptive analysis and important factors were tested with logistic regression for their contribution for the occurrence of taeniasis in human. Pharmaceutical inventory data were also summarized and analyzed using descriptive statistics.

RESULTS

Abattoir Survey

Prevalence: Of the total 540 cattle inspected 14 cattle were positive for bovine cysticercosis with the prevalence of 2.6%. There was no statistically significant difference ($p>0.05$) in the prevalence of bovine cysticercosis among animals from different origins. The prevalence of bovine cysticercosis in cattle from different animal origin is described in Table 1.

Anatomical Distribution of Cysts: Analysis of active abattoir survey showed that there was a variation in the anatomical distribution of cysticerci in organs inspected. Of the organs examined, the highest proportion of the *C. bovis* cysts were observed in the heart (3.8%) followed by tongue (2.22%), massster muscles (1.66%), shoulder (0.94%) and the diaphragm (0.37%) (Table 2).

The Viability Tests: Of the total 124 *C. bovis* cysts randomly collected from the different organs, 49 (39.5%) were found to be alive while the rest 75 (60.5%) were found to be degenerated cysts (Table 3).

Questionnaire Survey: Questionnaire data collected was translated in to categorical variables which were assessed for association with human taeniasis (Table 4). Of the total 80 respondents, 62.5% (50) of them said they were infected with human taeniasis (*T. saginata*) at least once in their life time and had a strong habit of raw meat consumption.

There was statistically significant difference in the prevalence of taeniasis between different age groups ($p<0.05$) and different level of raw meat consumers ($p<0.05$). Accordingly, age groups between 15-30 years ($p=0.001$ OR=8.36) and years above 30 years ($p=0.000$ OR=31.8) had higher taeniasis infection than youngers (>15 years). Medium raw meat consumers ($p=0.002$ OR=6.9) and high raw meat consumers ($p=0.001$ OR=5.5) had higher odds to acquire taeniasis than low (occasional) raw meat consumers. There was no statistically significant difference ($p>0.05$) observed in the prevalence of taeniasis between sex, educational background and religion. In addition, out of 80 volunteer interviewed respondents, 63% of them knows the cause of taeniasis that is raw or under cocked meat and 31% of them replied that cattle are infected with *C. bovis* when they graze on pasture that is contaminated with eggs of *T. saginata* that are excreted with feces of humans.

***Inv*entory of Pharmaceutical Shops:** An inventory of pharmaceutical shops (pharmacies and rural drug vendors) was conducted in Wolaita soddo town. Estimates of annual adult taenicidal drugs dose and its worth collected from recorded data and through personal interviews with pharmacists and their assistants. Descriptive statistics revealed that a total of 29,952 adult

Table 1: Occurrence of *C. bovis* among the different animal origin

Origin	Number of animal examined	Number of animal positive	Prevalence (%)	95% CI	p-value	Odds ratio
Highland	382	9	2.4	[0.83 3.9]		
Midland	55	1	1.8	[0.0 5.3]	0.804	1.3
lowland	103	4	3.9	[0.12 7.6]	0.399	1.7
Total	540	14	2.6	[1.5 3.93]		

Table 2: The prevalence of *C. bovis* in different organs

Organs inspected	Number of positives	Prevalence (%)
Tongue	12	2.22
Masseter muscle	9	1.66
Heart	6	1.11
Shoulder muscle	5	0.92
diaphragm	2	0.37

Table 3: Proportion of viable cysticerci in different organs inspected

	Cysticercus bovis	
Organs inspected	Number of cysts examined	Proportion of viable cysts in each organ
Tongue	38	(21) 55.3%
Masseter	26	(10)38.5%
Heart	33	(10)30.3%
Shoulder	21	(6)28.6%
Diaphragm	6	(2)33.3%
Total	124	(49) 39.5%

Table 4: Logistic regression analysis of risk factors associated with occurrence of human Taeniasis

Risk factors		No of positives (%)	SE	Odds ratio	95% CI	p- value
Sex	Female	12(60.9%)	6.2	-	[48.7-73.2]	-
	Male	38(68.9%)	11.9	1.4	[44.9-92.6]	0.55
Age	<15year	2(16.6%)	0.96		[19.0-40.0]	-
	15-30 year	30(69%)	7.2	8.36	[54.6-83.4]	0.001
	>30 year	17(89.4%)	7.2	31.8	[75.0-100]	0.001
Religion	Christian	39(60.9%)	6.15	-	[48.7-73.2]	-
	Muslim	11(68.7%)	11.9	1.4	[44.9-92.6]	0.565
Educational level	Uneducated	10(52.3%)	11.7	-	[29.2-76.1]	-
	Elementary	15(55.5%)	9.74	1.1	[36.2-74.9]	0.845
	High school or college	20(73.5%)	7.68	2.5	[58.2-88.8]	0.128
Raw meat consumption degree	Low	4(28.6%)	12.5	-	[3.60-53.5]	-
	Medium	11(73.3%)	11.8	6.9	[49.8-96.9]	0.02
	high	33 (68.6%)	6.56	5.5	[55.5-81.7]	0.011

SE= standard error; 95% CI= 95% confidence interval

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.. Relatively high dose of Albendazole (39.1%) was used followed by Mebendazole (37.5%), Niclosamide (20.3%) and Praziquantel (3.12%).

DISCUSSION

The prevalence of *C. bovis* among the carcasses inspected at Wolaita soddo municipal abattoir was 2.59% which is in agreement with the findings of [24] 3.6% at Addis Ababa abattoir, [25] 3.65% at Jimma, [13] 3.11% in different agro climatic zones of Ethiopia, [26] 4.9% at Gondar, [12] 4.4% at Jimma and [27] 5.4% at Konbolcha. However, the prevalence of the present study disagrees with the finding of [28] 11.3% in Wolaita Soddo. The difference in the prevalence rate of bovine cysticercosis between the two studies that were conducted in the same abattoir could be due to differences in the origins of animals that were presented for slaughter. This indicates that studies conducted in abattoirs may not necessarily reflect the situation of the disease under study in the area where the abattoir is located. Higher prevalence value was also reported by many workers including: [29] 18.49% in North West Ethiopia, [16] 26.3% at Hawassa, [30] 17.5% in East Shoa, [31] 21.2% at Nekemte and [32] 9.7% at Debre Zeit. The higher prevalence could be attributed to difference in the prevalence of *C. bovis* from area to area within a country [33], low number of incision made at inspection site in the abattoir, habit or culture of raw meat consumption, level of environmental contamination from where animals were bought, inappropriate use of toilet in the area and dose and viability of eggs consumed by animal probably attributed for this variation [5]. Low infection among the inspected animals in the present study area could be due to limited number of incisions made on the predilections sites. This may in turn lead to missing of infected animals as the sensitivity of detecting the parasite will decline with limited number of incisions [33]. Experimental studies showed a 5-50 times higher prevalence rates by complete slicing of the predilection sites [34]. Generally the method of meat inspection, the ability of meat inspector to identify the cysts, difference in animal management, sample size and sampling method and the number of incisions can contribute for the variation of the prevalence of bovine cysticercosis.

The presence and number of cysts in any given site varied greatly among animals and demonstrate the absence of any true predilection sites for *C. bovis* [5]. The present study showed that tongue, Masseter muscle, heart, shoulder muscle and diaphragm were the predilection sites for the cysts of *C. bovis* which is similar to earlier reports in various endemic areas [34]. The diaphragm was the traditional inspection site that is conveniently accessed during the slaughtering process [5], in this study; however, it was ranked among the least affected sites which is in agreement with the report of [16]. It appears several risk factors, such as activity of the muscles, age, breed and the geographical area concerned and parasite strain determine largely the predilection sites in cattle [5]. The most frequently affected organ with *C. bovis* cysts was tongue and it had highest proportion of viable cysts which harbored 53.3% viable cysts, followed Masseter muscle (38.5%), diaphragm (33.3%), heart (30.3%) and shoulder muscle (28.6%). In spite of the relatively high number of cyst found in the heart (33/124), this study support earlier report which showed heart was not a suitable site for long term parasite survival and the cysts in cardiac muscle degenerate earlier than in skeletal muscle sites and resorption of degenerating cysticerci in the heart occurs more slowly than in other sites which accounted for the higher number of degenerating cysticerci in heart muscles [35].

The prevalence of human taeniasis was recorded based on the questionnaire and indicated an overall infection rate of 62.5% which demonstrates the importance of taeniasis in Wolaita soddo town, surrounding kebeles and in the areas of animal origins. The result of this study agrees with the finding of [11] who reported an overall infection rate of 64. 2% in Hawassa town but the infection rate in the present study was relatively lower than the finding of [30] and [26] who reported 79.5% in East Shoa and 69.2% in Gondar respectively. On the other hand, [28] reported a lower prevalence of 50.6% in Wolaita soddo town. The reason for this variation may be related to the level of environmental contamination and degree of awareness of different societies about taeniasis transmission. Moreover, some individuals in a society may become shy to tell openly about taeniasis infection and that may undermine the true infection rate of the disease.

In this study, higher age groups and higher raw meat consumers had contracted taeniasis infection higher than lower age groups and low (occasional) raw meat consumers respectively which agree with the finding of [12]. This could be explained by the fact that elderly have higher chance to consume *C. bovis* infected raw meat in different occasions including cultural ceremonies where raw meat is served as one of the major food items while younger, in generally, have no such an access. There was no statistically significant difference between the proportion of taeniasis in Muslim and Christian community in this study which is agreement with the finding of [11], [30] and [13] in Ethiopia. The reason behind the similarity of different religion group may be the same culture and habit of raw meat consumption in the study area. However, [28] reported that Christians had more Taeniasis than muslims in the same study area. The conflict between the two studies might be due to differences in the study methodologies; for example in the present study 80 respondents were included whereas in the case of [28] only 40 individuals were sampled which might affect the precision of prevalence estimates. There was also no statistically significance difference between proportion of taeniasis in sex and different educational levels. Similar finding was reported by [12] indicating insignificant infection rate differences among the various educational statuses in Jimma town. This could be due to the long time cultural habit of eating raw meat particularly that of “kurt” and “kitifo” in many social groups including those of the educated and even in the health and veterinary professionals.

Taeniasis has importance both in terms of socio-economic and public health aspects [33]. Inventory of pharmaceutical shops and health center which comprises a two years data (2009-2011) in Wolaita Soddo town during study period revealed a total of 29,952 adult taenicidal drug dose which worths 40,200.8 ETB (2407.2 USD) per annum that resulted from taeniasis treatment in humans. The estimate dose and worth of drug for the disease in this study disagrees with the report of [12] with dose and worth of 111,353 Eth. Birr (11,135.3 USD) per annum. The reason for the differences might be attributed to variation in size of population reside in the two areas, differences in prevalence of *T. saginata* infection from area to area in the country, degree of raw meat consumption habit, variation in cost of individual drugs sold in the pharmacies and variations in the level of traditional herbal medicine usage.

In conculusion, both the abattoir and the questionnaire surveys showed that *T. saginata* was important parasitic disease in the area in terms of its economic and public health implications. Thus, awareness should be created in the public about the zoonotic and economic importance of *T. saginata*.

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