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Bovine Cysticercosis and Hospital Based Retrospective Survey of Human Taeniasis in and around Debre Brihan City, Central Ethiopia

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Abstract

A cross-sectional study was conducted in cattle slaughtered at Debre brihan abattoir from December 2016 to April 2017. To assess bovine cysticercosis and to estimate the prevalence of *Taenia saginata* human infection in and around Debre brihan town, central Ethiopia Patients' demographic data and the results of stool examinations conducted by using the formalin ethyl acetate concentration technique were collected from records at Debre brihan referral hospital. The relevant laboratory records from January 2013 to December 2017 were analyzed. Of the total 405 examined carcasses, 22 (5.43%) were found infected with various number of *Cysticercus bovis* in different organs. Organ distribution of the cysts showed highest proportion was observed in tongue, 7(31.81%) followed by heart 6 (27.27%) in shoulder and masseter muscles 4(18.18%) and 1 (4.54%) in liver. Significantly higher (P=0.02) proportion of counted cysts, 19(61.3%) were viable while other 12 (38.7%) were degenerated. The prevalence of *C. bovis* was significantly different (P<0.05) with in age categories and body condition of the slaughtered cattle. Of the total 2484 suspected patients, 97(3.9%) were stool positive for *Taenia saginata* eggs. The highest prevalence was 4.3% (OR=0.82, 95% CI: 0.41-1.84) in the year 2013. The prevalence gradually decreased to 3.6%(95%CI:0.47-2.4) in 2015 and slightly raised without significant difference to 3.9% and 3.7% in 2016 and 2017.The prevalence rate of taeniasis was significantly higher in male patients (4.54%, OR=1.65, 95% CI 1.08-2.53) than in females (3.32%). The results obtained in this study shows the need for integrated community based control strategies such as continuous public education and improved standards of human hygiene together with restriction of backyard slaughtering of cattle are recommended in the study areas.

Keywords: Abattoir; *Cysticercus bovis*; Ethiopia; Public Health; Retrospective Survey; Taeniasis

Introduction

Taeniasis and cysticercosis are meat borne parasitic infection with public health and economic importance globally [1]. Taeniasis is the intestinal infection of humans, by the adult stage of the cestodes of the genus Taenia. The principal cestodes which are important to cause taeniasis in human, who act as the natural final hosts of those tapeworms, are *Taenia solium*, *Taenia saginata* and *Taenia asiatica*. The primary risk factor that sustains the transmission of the disease being unsanitary disposal of human faeces, and eating raw or insufficiently cooked beef or pork [1]. Cysticercosis is tissue infection of the intermediate hosts of tape worms caused by ingestion of Taenia eggs. Cattle serve as intermediate host for *T. saginata* and the cysticerci develop only in beef, while those of *T. solium* and *T. asiatica* in pig visceral organs [2].

The eggs of those tape worms are shed or within the proglottids excreted with the faces of the infected final host to the external environment. Upon ingestion of infective eggs, the intermediate hosts/cattle become infected and develop metacestode larval stages (also called cysticerci), resulting in bovine cysticercosis. People acquire taeniasis following ingestion of undercooked beef meat containing viable cysticerci [3].

Taenia saginata is parasitic infection of human reside in the small intestine of infected human. *T. saginata* is considered to be distributed in the world, it is highly prevalent in developing countries especially in Africa, Latin America, Caucasians, Asia and eastern Mediterranean countries. In these countries where unhygienic conditions are coupled with poor cattle management practice and lack of strict meat inspection due to the common habit of backyard slaughtering [4]. Even though the prevalence of the disease is very low in developed countries, the public health and economic importance of *T. saginata* is considered as a reemerging zoonosis in previously disease free areas due to the migration of infected people and livestock exchange [5].

Bovine Cysticercosis was a food-borne parasitic zoonosis caused by the larval stage of the tapeworm *Taenia saginata* commonly referred to as the beef tapeworm [6]. It was difficult to diagnose in live animals, but if the animal was heavily infested, cysts may be felt on the tongue and face. The majority of cases were identified during visual inspection at slaughter, with samples sent to a laboratory for confirmation. If infection was confirmed, the meat would be destroyed or frozen to inactivate the cysts and prevent transmission to people [7].

Prevention and control methods should be geared towards either to avoid or reduce the risk factors associated with the transmission of taeniasis and cysticercosis. Measures employed in the control of taeniasis and cysticercosis include diagnosis and treatment of Taenia carriers, education of the mass to use latrines, avoid the consumption of raw meat and post –mortem inspection of carcasses for the presence of *Cysticercus bovis* [8]. Cultural aspects of a certain community towards feed cooking and feeding habits are some of the responsible factors for the spread of *T. saginata* infections. This unhygienic practice by the people in the country has a great contribution to the dissemination of bovine cysticercosis in communities [9].

In Ethiopia human taeniasis is common infection related to the common practice of eating raw or undercooked beef in many sections of human population in the country [10]. Indiscriminate defecation, due to lacking latrine facilities, is common practice especially by the rural community in Ethiopia where more than 80% of the populations reside. The common traditional animal husbandry practices in Ethiopia (free grazing in cattle) mainly allow free access of cattle to the contaminated environment and perpetuate transmission of cysticercosis, due to the fact that cattle become infected by ingestion of pasture/feed or water contaminated with *T. saginata* eggs [11].

The prevalence of human taeniasis due to *T. saginata* was reported in different regions of Ethiopia with range of 27.5% [12] to 70% [13] based on questioner survey. *T. saginata*/*C. bovis* prevalence has been recorded from different regions and charted cities of Ethiopia: at Addis Ababa abattoir by Kebede et al. [13]; in Southern Ethiopia by Regassa et al. [14], Northern Ethiopia by Getachew [14,15] and Getachew and Ashiwani [16]; in Awassa municipal abattoir (Southern Nations' Nationalities' Peoples' Region) by Abunna et al. [17], in northwestern Ethiopia by Kebede [18]. The questioner based survey revealed a higher prevalence of *T. saginata* infection than the hospital based studies, however questioner based survey result did not show the actual infection in the community. The hospital based studies are important to estimate the actual prevalence of *T. saginata* infection in the community. Moreover, patients who visited referral hospital came from different districts of north showa zone, in the central region of Ethiopia, our hospital based study may provide insight in to the region-wide distribution of *T. saginata* as well as other epidemiological data. Obtaining epidemiological data of a certain disease is essential before planning and implementation of control programs. Information resulting from hospital records has been taken as useful sources of data for the study of the actual distribution and epidemiological aspect of *T. saginata.*

Therefore, this study was conducted to determine the prevalence of bovine cysticercosis and cyst characterization in view of its public health implication in the study abattoir and another objective was to evaluate the prevalence and possible trends of human *T. saginata* in and around Debre birhan town based on hospital data over a period of 5 years [19].

Materials and Methods

The study area

The study was conducted in Debre Brihan town, Amhara Regional State, which is located at 130 km northeast of Addis Ababa. The study area geographically located at latitude 090 31/ N and longitude 390 28/ E. The area is plateau and found in central Ethiopia at an altitude of 2780 m a.s.l. It has mean annual rain fall of about 956 mm of which 84% falls during the long rainy season that extends from June to September and the remaining is during the short rainy season that extends from October to May. The mean annual minimum and maximum temperatures are 5.3°C-17.8°C; 9°C and 24°C, respectively and the mean relative humidity is about 75% [20]. Extensive management system was dominant, while semi intensive husbandry system of cross breed dairy cattle was rarely practiced.

Study design and study population

A cross sectional study was carried to determine the prevalence of bovine cysticercosis. The breeds of the study animals were the indigenous zebu cattle and cross breeds of zebu with Holstein-Friesian. The study animals were indigenous zebu and exotic cross breed cattle brought at Debre Birhan municipal abattoir in Debre Brihan town for slaughtering, from different localities during the study period. Most of the slaughtered animals were male cattle originated from different localities mainly from market origins of Shewarobit, Jiru, Chacha, Debre Birhan, Ankober and Kotu districts of north Shewa zone, central Ethiopia. During sampling of the study animals in the study time, sex, breed, origin, ages and body conditions of all the sampled animals from the study area was recorded for the assessment of risk factors.

Assessment of taeniasis in human

A retrospective study was performed in patients given stool sample for parasitological examination in Debre Brihan Referral Hospital from January 2013 to December 2017. Laboratory records were reviewed through patient's files, in hospital archives. The suspected patients were both male and female under different age category suffering from gastrointestinal disturbance, who attend medical treatment in the study hospital. The routine stool examination technique employed in the laboratory was formalin ethyl acetate concentration technique. Data considering age, gender and stool examination results was collected.

Sample size determination

The total number of sampled animals required for this study was determined according to the formula given by Thrusfield [20], taking 50% prevalence of bovine cysticercosis in the study abattor, 95% level of confidence and 5% desired level of precision. Accordingly, 384 cattle were the calculated sample size. However, total of 405 cattle were sampled by systematic random sampling technique and examined using the routine meat inspection methods for bovin cysticercosis, according to the guideline by Ministry of Agriculture [21].

Study methodology

Active abattoir survey

Regular visits of the abattoir on two slaughtering days per week were performed to carry out both ante mortem and post mortem inspection of cattle slaughtered at the study abattoir during the study period. Prior to ante mortem examination, each randomly selected cattle were tagged with identification number and data on each animal concerned sex, age, breed, body condition and origin were recorded. During pre-slaughter inspection sampled cattle were examined clinically both at rest and in motion. The age of the animals was determined by dental eruption formula according to De Lahunta and Habel [22] and the animals were categorized into three age groups less than 5 years, 5-10 and greater than 10 years. Body condition score was ranked as good, medium and poor as described by Nicholson and Butterworth [23].

The identified 405 cattle slaughtered at the study abattoir were examined for *Cysticercous bovis* following the routine meat inspection procedures presented by Ministry of Agriculture [21]. According to the guideline, the meat was inspected visually, the tongue was ventrally incised from tip to the root longitudinally, deep liner incisions of the masseter muscle parallel to the mandible were made, and the heart was incised from base to apex. In the shoulder muscles deep, adjacent and parallel incisions were made above the point of elbow. Visual

examination, palpation and incision of liver and kidneys were also conducted.

Cyst viability test

All the cysts from affected organs were carefully trimmed of with surrounding tissues and transported in ice box to Debre birhan agricultural research center veterinary parasitology laboratory for viability tests. For viability test, the cysts were incubated at 37°c in 30% ox bile solution diluted in normal saline for 1-2 hours. A cyst was confirmed as viable *Cysticercus bovis* if the scolex evaginated according to Gracey, et al. [24].

Retrospective hospital data survey

Retrospective survey of hospital data was carried out based on a review of daily laboratory record findings of stool examination report of suspected patients (patients with symptom of abdominal discomfort) in Debre brihan referral hospital. From January 2013 to December 2017, a total of 2405 stool samples from patients with suspicious intestinal parasitic infections were examined for intestinal parasites by using formol-ether concentration technique. The relevant five years data were collected from the hospital, parasitology laboratory record book. Information collected included number of patients examined, sex, age and the stool result of each year. A stool contains egg of *Taenia saginata* in suspected patients that come to the hospital was taken as positive and recorded on the case book.

Data analysis

The abattoir survey and hospital data were recorded and entered in to Microsoft Excel 2013© and analyzed using STATA software version 11.0 (Stata Corp, 2009). Descriptive statistic and Chi-square test was employed. Anatomical distribution of *C. bovis* and cyst viability were tabulated. The retrospective hospital data were also summarized and analysed. Logistic regression was used to determine the level of significance of risk factors and association between prevalence of human taeniasis with the age, sex and years of study. Confidence level was held at 95% and statistical analysis for the difference in prevalence of *C. bovis* and human taeniasis among risk factors were considered significant when the p-value was less than 0.05 ($P<0.05$).

Results

Prevalence of *Cysticercus bovis*

Out of the total 405 selected cattle passed for slaughter and inspected at Debre brihan municipal abattoir, a total of 22 (5.43%) animals were infected with various number of *Cysticercus bovis* in different organs (toung, maseter muscles, heart, liver and shoulder muscles) (Table 1). The current prevalence of *C. bovis* was significantly different with in age categories ($\chi2=18.68$ $P=0.003$) of the animal, higher rate of 6.25% recorded in adult age groups (5-10 years) than in old cattle (5.16%) with age of greater than 10 years. According to this result prevalence also significantly associated ($P<0.05$) with body condition score of the animal ($\chi2=11.1$, $P=0.008$). The higher prevalence was observed in animals with medium body condition (6.73%) than in animals with good body condition score (3.85%) (Table 1).

Variable	Number of examined	Number of positive	Prevalence (%)	X2	P-value
Age				18.68	0.003
Adult(5-10 years)	272	15	6.25		
Old (>10 years)	133	7	5.16		
Sex				3.78	0.52
Male	334	18	5.4		
Female	71	4	5.6		
Body condition score				11.1	0.008
Good	182	7	3.85		
Medium	223	15	6.73		
Breed				5.02	0.051
Local	269	14	5.2		
Exotic	136	8	5.8		
Total	405	22	5.43		

Table 1: Prevalence of *Cysticercus bovis* in relation with age, sex, body condition scores and breed of the animals.

In this result breed of cattle was not significantly associated ($P>0.05$) with *C. bovis* prevalence ($\chi2=5.02$, $P=0.051$). Comparatively, higher prevalence was observed in exotic cross breeds (5.8%) compared with in indigenous zebu cattle (5.2%). Similarly sex of cattle was no

significantly associated (P>0.05) with prevalence rate of *C. bovis* ($\chi 2$=3.78, P=0.52). Comparatively similar prevalence rat of 5.45% and 5.6% was observed in male and female respectively (Table 1).

Prevalence in relation to localities/origin of the animals

According to the data showed in Table 2, the distribution of bovine cysticercosis was not significantly (P>0.05) associated (X2=5.59, P=0.35) with the localities/origin of the slaughtered cattle. Comparable prevalence was observed in cattle originated from Shewarobit (6.6%), followed by Jiru (6.5%), Chacha (6.25%), Debre birhan (5.43%) and 6.25% from Ankober district. However *C. bovis* was not found in cattle from Kotu district (Table 2).

Variables	Number of examined	Number of infected	Prevalence (%)	X2	P value
Localities/Origin					
Shewarobit	106	7	6.6		
Jiru	77	5	6.5		
Chacha	48	3	6.25		
Debre Birhan	92	5	5.43		
Ankober	32	2	6.25		
Kotu	50	-	-		
Total	405	22	5.43	5.59	0.35

Table 2: Prevalence of *Cysticercus bovis* in relation to localities/origin of the animal.

Organ distribution and characterization

Over all distribution of *C. bovis* in different organs of cattle slaughtered at the study abattoir was shown in (Table 3). Of the total 22 infected cattle, 7 (31.81%) had *C. bovis* in the tongue, 6 (27.27%) in heart, 4 (18.18%) in shoulder and masseter muscles while only in 1 animal (4.54%) liver *C. bovis* was observed. A total of 31 cysts was counted from different infected organs, the highest proportion was counted from tongue 13 (41.93), followed by heart 7 (22.58%), 6 (19.35%), 4 (12.9) and 1 (3.22%) counts from shoulder muscle, masseter muscle and liver respectively (Table 3).

Organs Examined (n=450)	No. of infected organ	Prevalence (%)	Proportion from infected organs	No. of cysts counted	Cyst distribution per organ
Tongue	7	1.73	31.81	13	41.93
Heart	6	1.33	27.27	7	22.58
Shoulder muscle	4	0.99	18.18	6	19.35
Masseter muscle	4	0.99	18.18	4	12.9
Liver	1	0.25	4.54	1	3.22
Total	22	5.43	100	31	100

Table 3: Distribution of *Cysticercus bovis* in relation to different organs.

Out of the total 31 *Cysticercus bovis* cysts counted/detected during inspection and subjected to viability test significantly (X2=39.1, P=0.02) higher proportion of cysts, 19 (61.3%) were found viable while other 12 (38.7%) were degenerated cysts. The highest viability rate was observed in cysts of masseter muscle origin (75%) flowed by cysts of tongue (69.23%), 66.7% and 42.86% were cysts from shoulder muscle and heart respectively (Table 4).

Organs affected	No. cysts examined	No. viable cyst	Proportion of viable cyst per organ	X2 (P)
Tongue	13	9	69.23	
Heart	7	3	42.86	
Shoulder muscle	6	4	66.7	

Masseter muscle	4	3	75	
Liver	1	-	-	
Total	31	19	61.3	39.1(0.02)

Table 4: Proportion of viable *Cysticercus bovis* cysts per organ of infected cattle.

Out of the total 31 *Cysticercus bovis* cysts detected during inspection and subjected to viability test significantly higher proportion (P<0.05) (X2=39.1, P=0.02), 19(61.3%) were found viable while other 12 (38.7%) were degenerated cysts. The highest viability rate was observed in *C. bovis* cysts of masseter muscle origin (75%) flowed by, 69.23% cysts of tongue 66.7% and 42.86% were cysts from shoulder muscle and heart respectively (Table 4).

Prevalence of *T. saginata*

A total of 2484 patient records from 2013 to 2017 were collected and computed for the prevalence of *Taenia saginata* based of their age, sex and years of examination. Of these patients, 97(3.9%) were found positive stool result for *T. saginata* egg. The stool examination result showed that the prevalence of the disease was highest in 2013 (4.6%) and decreased insignificantly (P>0.05) with some fluctuation to 3.6 % (OR=1.07, 95%CI: 0.47-2.4) in 2015 (Table 5). However, the prevalence rose insignificantly to 3.9 %(OR=0.96, 95% CI: 0.51-2.04) in 2016 and d slightly decreased to 3.7 % in 2017. According to this result higher diagnostic prevalence of 4.21% was found among patients with age category of >45 years. In terms of gender, significantly higher (P=0.02) proportion of positive stool for *T. saginata* was observed in males patients with diagnostic prevalence of 4.54% (OR= 1.65: 95% CI=1.08-2.53%) compared to female patients (Table 5).

Variable	No. of Stool examined	No. T. saginata positive	OR	95%CI	P-value
Age					
15-30	363	13(3.58)	0.91	0.49-1.67	0.75
31-45	1124	41(3.65)	1.16	0.73-1.85	0.53
>45	997	42(4.21)	-	-	-
Sex					
Male	1189	54(4.54)	1.65	1.08-2.53	0.02
Female	1295	43(3.32)	1	-	-
Year					
2013	852	37(4.3)	0.82	0.41-1.84	0.72
2014	656	24(3.7)	1.04	0.47-2.27	0.93
2015	525	19(3.6)	1.07	0.47-2.4	0.88
2016	232	9(3.9)	0.96	0.51-2.04	0.67
2017	219	8(3.7)	1	-	-
Total	2484	97(3.9)			

Table 5: Proportion of human patients infected with eggs of *Taenia saginata* by age, sex and calendars.

With regard to prevalence of *T. saginata* infection a gradual decline was seen in the number of positive stool result for *T. saginata* egg in both male and female patients. In female the prevalence was high at the first year in 2013 (5%), followed by a remarkable reduction to 2.8% in 2014, but until 2016 the prevalence for *T. saginata* remains without remarkable change. In male patients the prevalence of *T. saginata* infection was lower compared to female in the first year however, from 2013 to 2014 remarkable raise was observed in female than male patients (Figure 1). But until 2016 the prevalence for *T. saginata* remains without remarkable change similar to the case in females, however the prevalence of *T. saginata* considerably rise from 4.6% in 2016 to 5.2% in 2017 in male patients in contrast it was found remarkable reduction from 3.3% to 2.5% in 2017 in female patients (Figure 1).

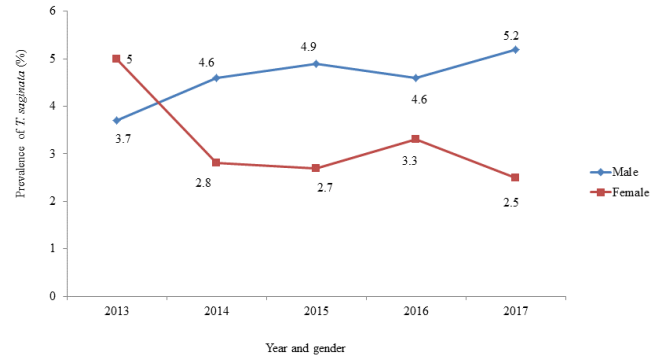

Figure 1: Annual trend of stool examination result for *Taenia saginata* egg relation to patients' sex in Debre brihan referral hospital.

As it is shown in Figure 2, the total annual trend of *Taenia saginata* infection among the patients in Debrebrihan referral hospital showed gradual reduction from 4.3% prevalence rate in 2013 to 3.6% in 2015, but it was slightly increased (P<0.05) to 3.9% in 2016, which was not statistically significant (OR=0.96, 95% CI: 0.51-2.04) (Table 5). Similarly the infection rate was insignificantly reduced to 3.7% in 2017(Figure 2).

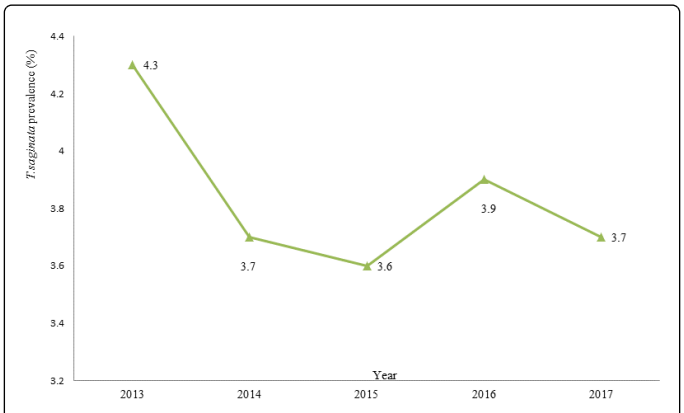

Figure 2: Annual trend of *Taenia saginata* prevalence rate in patients taken stool examination in Debrebrihan referral hospital, central Ethiopia, 2013-2017.

Discussion

The prevalence of bovine cysticercosis among 405 examined cattle in Debre birhan Municipal abattoir during the study period was 5.43% (22/405) which is comparable to the findings of Kifle and Shiret [11] who reported prevalence of 4.46% in the same abattoir. Similarly Dawit [25] reported comparable prevalence rate of 4.9% at Gonder municipal abattoir. In contrast, higher prevalence of *C. bovis* compared to the current finding was reported in different abattoirs of the country by Abuna, et al. [17], 26.25% at Hawassa abattoir; 18.49% by Kebede [18] in northwest Ethiopia; 17.5% by Hailu [26] in east Shoa zone of the country, similar higher prevalence of 26% was reported by Opera, et al. [27] in Nigeria. This finding is considered higher than the previous reports of 2.2% by Teka [28], 3.2% by Tembo [29], 2.93% by Tolosa et al. [30] and 3.6% by Gomol, et al. [31] in different regions of the country.

The variation in prevalence of bovine cysticercosis might be due to the changes in the environmental and epidemiological factors, which could affect the rate of transmission of *Taenia saginata*/bovine cysticercosis. The distribution of *C. bovis* could associated with the breed of cattle involved as intermediate host and their management, body condition score and age of slaughtered animals and other socio-economic related activities such as personal and environmental hygiene, variation in method and quality of meat inspection practices in different localities of a country [32]. Another possible reason for variation in prevalence may be due to difference in sample size, status of the people in the environment especially related to experience and appropriate use of toilet, habit of the community feeding raw and undercooked meat consumption. The number of viable *T. saginata* eggs ingested by cattle was also some of the reasons for variation of *C. bovis* prevalence indifferent localities [33].

Very low prevalence rates of *C. bovis* were reported by different researchers, 0.23% by Haridy, et al. [34], 0.37% by Rodriguez-Hidalog, et al. [35], 0.2% by Blessing, et al. [36] and 0.11% by Zdolec, et al. [37] were reported in Egypt, northern Ecuador south Africa and Croatia respectively. Those very low reports comparing with our result could be mainly related to the control measures and eradication programs of the above countries towards the disease specifically due to strict application of meat inspection practices and difference in public health services and extension rules. Societies in developed and middle income countries have better access for sanitation facilities and services as well as having good awareness towards environmental hygiene could be the possible factors for very low prevalence rate in the above countries compared with developing countries having poor socio-economic status and traditional feeding habits together with their back yard slaughtering practice increase the prevalence and transmission rate of the disease.

The current abattor survey also showed that the most affected organs in order to *C. bovis* cysts encountered and preferred as a predilection sites were tongue, heart, shoulder and masseter muscles, while only one liver was found affected. Similarly high proportion of cyst was observed in tongue (41.93%), in heart (22.58%) followed by 19.35% in shoulder and 12.9% masseter muscles. In agreement with this finding previous report of Belino [38] and Bedu, et al.[12] showed that the most frequently affected organ with the highest number of cyst counts were the tongue flowed by the heart. Dawit, et al. [39] and Haylegebriel and Alembrhan [40] also reported tongue was the most commonly affected organ with bovine cysticercosis. However, Yacob, et al. [41] showed that the highly infected organ was the heart followed by tongue. Moreover, Oryan, et al. [42] reported that the most common preferred sites for the cysts were shoulder muscles followed by masseter muscles.

The variations in anatomical distribution of the cyst depend on a number of factors, such as blood kinetics (mostly found in muscles that have high blood supply due to animals' daily activities and frequently movement of the organs). Any geographical and environmental factors affecting blood kinetics in the animal also affect the distribution of oncospheres [43].

Out of the total 31 *Cysticercus bovis* cysts examined for viability significantly (X2=39.1, P=0.02) higher proportion 19 (61.3%) were viable while, 12(38.7%) were degenerated cysts. Comparable with this result Emiru, et al. [44] found that, 66.6% viable and 33.4% dead cysts

in Elfora Abattoir, Bishoftu Ethiopia. In contrast, Abunnae, et al. [45] reported lower proportion of viable cysts 44.2% and higher proportion of degenerated cysts (65.8%). The variability of *C. bovis* cyst viability rate in different localities might be due to the fact that the difference in immunological response by infected individual cattle to the cyst and also the difference in cattle management activities by owners, especially regular deworming practice of animals by using antihelmintics [46].

The highest viability rate was observed in cysts from masseter muscle (75%) flowed by cysts from tongue (69.23%), from shoulder muscle (66.7%) and from the heart (42.86%) while the cyst in the liver was found degenerated with 0% viability rate. This was in agreement with previous report which manifest that cysts in heart muscles degenerated earlier than in skeletal muscles like the masseter muscles, which accounted for the lower number of degenerated cysticerci in heart muscle [47].

In this study no viable cyst was found in cyst from liver, this could be due to the fact that various metabolic reactions that take place in hepatic cells, compared to muscle cells which could prevent the growth and viability of *C. bovis* cysts found in the liver, consequently the cysts in the liver become calcified [48-50].

In the current result statistically significant difference (P<0.05) in prevalence of bovine cysticercosis was observed between age group. Higher prevalence of 6. 25% was estimated in cattle within 5-10 years age than in age group above 10 years (5.6%) old. In agreement with this result previous researchers reported significantly higher prevalence of *C. bovis* in adult than old animals [32,33,]. However, Nuraddis and Frew [50] found no significant variation in prevalence rate in cattle according to the age difference. This age related variation of *C. bovis* prevalence may be due to age dependent immunity of an animal that had an important role against infestation and re-infestation of cysticerci. The frequent re-stimulation of old animals immunity following continuous exposure to the onchospheres, contribute for old animals (above 10 years) to develop strong immunity which prevent further development of more cysticerci.

According to this study, breed, sex and origin of slaughtered cattle were no significantly associated (P>0.05) with *C. bovis* infection (Table 1). In line with this study, Gomol, et al. [31]; Jemal and Haileluel [32]; Mesfin and Nuradddis [51] and Haylegebriel and Alembrhan [40] reported breed and sex of the animals were not significantly affect the prevalence of *C. bovis*. In contrast, Nuraddis and Frew [50] found significant difference in prevalence between sexes of slaughtered animals. Similarity of cattle management system that is the traditional extensive system in different regions of the Ethiopia may contribute for equal exposure of both breeds of cattle for eggs of *T. saginata*. Other justifications for the insignificant variation of *C. bovis* in origin may be due to the similarity of the main determinant factors for the distribution of the *C. bovis* in certain area such as the socio economic status of the population, animal husbandry practice and awareness about the disease by the community in all localities where the slaughtered animas originated were also similar.

Body condition of slaughtered cattle was significantly associated with bovine cysticercosis (P<0.05), higher prevalence was observed in cattle with medium body condition (6.73%) than with good body condition (3.85%). Our finding was in agreement with previous reports of Mesfin and Nuraddis [51]; Addisu and Wondium [52] from different regions of the country. The possible reason for lower prevalence in animal with good body condition may be because most of the slaughtered cattle with good body condition in the abattoir during the study period were brought from fatting systems of the individual farmers, in which there will be restriction of animal movement for free grazing on pasture land. Thus those cattle were less exposed to *T. saginata* eggs and have low prevalence rate for bovine cysticercosis.

In the current survey of human taeniasis, a five years retrospective data (from January 2013 to March 2017), which was taken from parasitology laboratory case book record in Dere birhan referral hospital, was analyzed to estimate the prevalence of *T. saginata* among the population of in and around Debre birhan town. According to this hospital based retrospective survey, out of 2484 patients taken stool examination (from 2013 to 2017), 97 of those patients were stool positive for *T. saginata* egg with prevalence rate of 3.9% (97/2484) for *T. saginata* infection (Table 5). In agreement with this result, comparative prevalence of 4.3% human taeniasis was reported in Nepal by Sah, et al. [53]. However, Studies of human *T. saginata* in different country showed lower prevalence estimates of 1.2% in Mexico [54], 1.6% in Ecuador without differentiating between *T. saginata and T. solium* [35], 2.3% in Turkey [55] and 2.5% in Kenya [56] were found using fecal concentration diagnostic technique.

The prevalence *T. saginata* infection in relation to gender of patients showed that significantly higher (P=0.02) proportion of males (4.54%) were infected than females (3.32%). In this finding males were 1.65 times more likely to be infected with *T. saginata* infection compared with females (OR=1.65, 95% CI: 1.08-2.53). In agreement with the current results, previous questioner based study in Ethiopia showed that males were at higher risk for *T. saginata* infection compared with females [25,26,57]. The reason for this significantly higher prevalence in males may be due to economical rezones and cultural practices in Ethiopia that adult men groups often enjoy raw beef (kurt) consumption in butchers and restaurants then than women, where as a great proportion of women in Ethiopia are housewives and commonly prepare their dishes at home consequently females have lower probability of getting viable cysticerci infection. Similarly a community based stool egg examination result in Egi showed that the infection rate in males was 1.6% however, *T. saginata* was not detected in females [58]. The findings reported by Usip, et al. [59] in Nigeria showed that higher prevalence of *T. saginata* in males were also in agreement with our report.

In this study prevalence rate of *T. saginata* infection slightly increased with patients' age, relatively the highest prevalence was observed in patients more than 45 years of age (4.21%0) compared with 3.58% in age group of 15-30 years (OR=0.91, 95% CI:0.49-1.67, P=0.75) and 3.65% in 30-45 years of age (OR=1.16, 95% CI:0.73-1.85, P=0.53). However, there was no significant difference between patient's age categories in infection rate of *T. saginata*. This is in agreement with findings of Fufa [60], Hailu [26], Dawit [25] and Mulugeta [57] in Ethiopia, they reported that higher in old age groups compared with young and adults. This finding contradicts that of [61,62] who reported that more young people were infected with taeniasis. This might be related to the habit of raw meat consumption increase with age and the higher age group have better income to consume raw meat and more prone to *C. bovis*. The older peoples also possibly have had more time to be exposed and infected by viable *C. bovis* cysts.

Our findings showed that a gradual reduction of the total *T. saginata* infection rate among the peoples of the study area from 2013 to 2017. In male the infection rate is different, the graph (Figure 1) showed a raising trend of *T. saginata* infection, while in female highly declined

from 5% to 2.8% in 2013and 2014 respectively, however it shows gradual reduction until 2017 (Figure 1) [58-63]. This gradual reduction of the general hospital based prevalence of *T. saginata* in the study area could be related to the implementation of the health extension program (HEP) launched by the Federal Ministry of Health (FMOH) of Ethiopia in 2003. The Program has had a tangible effect on improving the thinking and practices of rural people regarding disease prevention, family health, hygiene and environmental sanitation. Different researchers reported that the socio-economic level of the society, sanitary/hygienic, cultural and feeding habits of the peoples may affect prevalence rate of *T. saginata* [64,65]. Hygienic disposal of human faeces and reduction of close contact between humans and cattle by confinement of cattle have been shown to dramatically reduce the risks for transmission of *T. saginata* infection. Thus the implementation of health extension program (HEP) in our study area, has improved sanitation and personal hygiene nationally with many households currently possessing pit latrines, separated animal sheds, improved kitchens, bedrooms and living rooms, cleanly managed drinking water and household goods. These year to year improvements of personal hygiene, environmental sanitation and people awareness regarding disease prevention in different regions of Ethiopia particularly in the current study area may be contributed to the gradual reduction of the total *T. saginata* infection rate among the peoples of the study area from 2013 to 2017.

Conclusion

The present study showed that bovine cysticercosis was prevalent in Debre brihan and the surrounding areas. Although, the recorded prevalence was lower compared to other studies, the significantly higher prevalence rate of viable *C. bovis* cysts in the slaughtered cattle showed that *Taenia saginata/Cysticercus bovis* is an important zoonotic parasitic disease in the study area. Our five years hospital based stool egg diagnostic data analysis showed that prevalence of *Taenia saginata* human infection gradually decreased in the last five years in Debre drihan town. However, the stool examination result of suspected patients showed that the prevalence of *Taenia saginata* infection was not significantly decreased year after year in the population. Therefore, proper treatment of infected people as well as continues public health education should be provided to avoid consumption of raw meat and improving sanitary conditions including use of latrine has to be encouraged to reduce the public health risk and economic impact of *Taenia saginata/Cysticercus bovis* in the areas.

Competing Interest

Authors declare that they have no competing interests

Authors' Contribution

AY involved in the drafting of the manuscript, statistical analysis and interpretation of data and write up and critical revision of the manuscript. BM contributed in sample collection, laboratory tests, data acquisition. All the two authors read and approved the final version of the manuscript.

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