



Prevalence of Bovine Cysticercosis in three selected areas of Hadiya zone, Southern Ethiopia

Abriham Abera¹ and Melese Gashe²

^{1,2}Southern Nations, Nationalities, and People's Region State, Bureau of Agriculture, Hawassa, Ethiopia.

Corresponding author: abrahamabera1@gmail.com

Abstract

Bovine Cysticercosis is a public health problem and economically important Cestode parasite prevalent in Ethiopia. A cross sectional study was conducted from September 2021 to February 2022 on bovine Cysticercosis of cattle slaughtered at Danema, Wada and Elifata municipal abattoir with the objectives of determining the prevalence and to identify potential risk factors of Bovine Cysticercosis. Out of 384 systematically selected slaughtered cattle, 30 (7.8%) were infected with *Cysticercus bovis*. The anatomical distribution of the cysts showed that the highest proportions of *C. Bovis* cysts were found on shoulder muscle (33.3%) followed by Tongue (30%), Masseter Muscle (16.7%), Triceps Muscle (16.6) and heart (3.3%), in decreasing order of cyst harboring. A statistical analysis of infection rate on the basis of breed of the animal and sex has no significant difference ($p > 0.05$) but age has significant difference ($p < 0.05$). In conclusion, the present study imply that the disease deserves due attention to safeguard the public health and promote beef industry in the study area. Therefore, appropriate control and preventive measures should be taken in order to reduce the disease problem on public health even if it economics significant associated with Cysticercosis is minimal.

Keywords: Bovine, Cysticercosis, Danema, Ethiopia, Municipal abattoir, Prevalence.

1. Introduction

Ethiopia has one of the largest inventories in Africa with livestock currently supporting and sustaining the livelihoods of an estimated 80 % of the rural poor. Animal rearing is an integral part of the agricultural production and estimated livestock population is 70 million cattle, 42.9 million sheep and 52.5 million goats [1].

Livestock sector plays a significant role and has a great potential to assist the economic development and serve as a source of food, income and foreign exchange to the Ethiopian economy and contributes to 15 - 17% of GDP and 35 to 49% of agricultural GDP and 37 to 87% of the household incomes, but its development is hampered by different constraints [2].

Bovine Cysticercosis is a food borne disease caused by *Taenia saginata* with humans as the final host and cattle as the intermediate host. Infection of human by *Taenia saginata* occurs through ingestion of raw or undercooked meat containing *Cysticercus Bovis* while; infection of cattle with *Cysticercus Bovis* occurs through ingestion of *Taenia saginata* eggs. The parasite population of these species consists of three distinct sub populations: adult Tapeworms in the definitive host (man), larvae (*Cysticercus* or metacestodes) in the intermediate host (pigs or cattle), and eggs in the environment [3].

Taenia saginata is global distributed in both developed and developing countries. However, it is high reported incidence cases in Africa when compared with other parts of the world [4]. This parasite epidemiology is ethnically and culturally determined with estimation annually cases and mortality rate around 50-77 million and 50, 000 people respectively [5].

T. saginata which is known as beef tapeworm has two stages of development, intermediate host and final host in cattle and human respectively. Larval stage of this parasite occurs in heart and skeletal muscles of intermediate host and adult worm locates in intestine of final host. Visual inspection of carcass and other organs is the primary detection method of Bovine Cysticercosis because commonly found area of carcass are the external and internal masseter pterygoid muscles, heart, tongue, diaphragm, and esophagus [6].

In discriminate 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 [7]. It is associated with poor hygiene and local factors including cultural background, such as eating meat without proper cooking (raw), economic condition and religious

beliefs, close proximity of humans to cattle kept with little or no distinction between companion or utility functions [8].

Bovine Cysticercosis is a major problem for livestock producers in sub Saharan Africa [9]. *C. Bovis* is small (pea sized) oval in shape [10]. *C. Bovis* is grayish white, about 1cm in diameter and filled with fluid in which the scolex is often clearly visible [11 & 12]. The clinical effect of Cysticercosis on infected animals is generally not significant but it is more important with regard to high economic losses due to the condemnation of heavily infected carcasses and its public health impact [13].

In Ethiopia several authors have been reported the prevalence of taeniasis and cysticercosis with in a wide range of 2.5% to 89.41 % and 3.11 % to 27.6 %, respectively [14, 15, 16]. According to these reports, a prevalence of 2.0% in Gondar by (Ezeddin and Tewodros, 2016) [17], 2.98% in Nekemte by (Abgunna et al., 2011) [18], 5.6% in Bishoftu by Emiru 7.23% in Mekelle by (Getachew and Ashwain, 2013) [19], 19.5% in Bahir Dar by (Mulugeta, 1997) [20] and 3.2% in different agro climatic zones was recorded by (Tembo, 2001) [21]. The cultural habit of eating raw meat in the form of “Kurt” meat cubes and “Kitffo” minced meat in Ethiopia, has favored the spread of this disease [22 & 23]. Live cattle having *C. bovis* show no symptoms and the presence of the cysts in carcasses is observed visually during the routine meat inspection by making different incisions into muscles and organs; however, the adult tape worm in man produced diarrhea, hunger pain, abdominal discomfort, constipation and nausea [24].

One of the prerequisite for implementing control and prevention action is information on prevalence and associated risk factors in Hadiya Zone mirab badawacho woreda especially in Danema, Wada, and Elifeta town there is limited work that indicates the status, risk factors and public health importance of Bovine Cysticercosis. Therefore, the objective of this study is to determine the prevalence of Bovine Cysticercosis and identify potential risk factors of the disease in study area.

2. Literature Review

2.1. Taxonomy

Taenia saginata and its metacestode *Cysticercus bovis*, the unarmed beef tapeworm, belong to the class Cestoda order Cyclophyllidea Family Taeniidae and Genus *Taenia* [11, 12, 25].

2.2. Morphology

2.2.1. Adult worm

Taenia saginata, the beef tapeworm, is a large worm measuring 3-10 meters in length rarely the adult measures up to 15m [11, 25]. *T. saginata* is ribbon-shaped flattened, multisegmented and hermaphrodite. The body is divided into three distinct parts of scolex (head), neck and strobila. *T. saginata* measures 4 -8 meters in length and rarely measured up to 15m [11]. The gravid segments are 10-20 mm long and are usually shaded singly and leave the host spontaneously or crawling about the body, clothes and beds of human beings self and cross-fertilization between proglottids is possible. The gravid proglottids are 15 to 35mm long and 5 to 7mm wide filled with eggs, which detach from the strobila singly and leave the host via anus. Taenid egg passed in the faeces or discharged from ruptured gravid segment are sub-spherical to spherical in shape [26].

2.2.2. Larvae

The cyst is round or oval in shape, and when fully developed, consists of a scolex, invaginated in to a fluid-filled vesicle (tail bladder), which is surrounded by connective tissue capsule formed by the reaction of the tissue of the host [27]. The invaginated scolex is visible in the form of whitish spot at one end of the pole of the cyst [28]. As in the adult tapeworm, it has neither rostellum nor hooks [11, 25]. The larval stages or metacestods are found in striated muscles of the intermediate host [29]. *C. bovis* is small (pea sized) oval in shape [10]. *C. bovis* is grayish white, about 1cm in diameter and filled with fluid

in which the scolex is often clearly visible [11, 12].

2.3. Life Cycle *Taenia Saginata*

The life cycle of *T. saginata* is indirect whereas they 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 (depending on species) after infection of the host (Urquhart et al., 1996). Human is infected by the ingestion of raw or under cooked Parasitized meat [30] and [26]. An infected person can shed as many as 1million eggs each day. Ingesting contaminated pasture infects bovine. The tape worm thrives in the small intestine of humans. As it matures it produces segments that each contains about 100 thousand eggs. In cattle, cysticerci are found predominantly in cardiac and skeletal musculature, and occasionally in other sites including liver, lung, kidneys and lymph nodes [31]. There is evidence that pre-natal infection of calves can occur [32].

2.4. Epidemiological Distribution of the Adult and Cyst Parasite

Taenia saginata is distributed globally but the infection is particularly important in Africa, Latin America, and Asia as well as in some Mediterranean countries [33]. *T. saginata* infections also occur in developed countries, where standards of sanitation are high and meat is carefully inspected and generally thoroughly cooked. Taeniasis/cysticercosis spreads in developed areas of the world through tourists enjoying the consumption of lightly grilled meat, mass migration of labor and the export of meat unreliably passed by "eye or knife" inspection or from live animals imported from endemic areas [34]. The prevalence of *C. Bovis* in cattle population of Africa was 33.02% in Kenya [35], 22.3% in Zaire and 6.67% in Chad [27], 10.2% in Nigeria [36], 10% in Sudan [37], 15% in Rwanda [38].

In Ethiopia, prevalence of *C. Bovis* in cattle population of different regions was conducted by meat inspection survey in abattoirs. It showed that *C. Bovis* was prevalent and widespread

throughout the country with national average of 13.7%. However, the prevalence distribution varied from place to place (Table 1).

Table 1: Prevalence of Bovine Cysticercosis in Ethiopia

Sr. No	Study Area	Species	Prevalence (%)	References
1	Gondor	Bovine	9.7	[39]
2	Jimma	Bovine	2.93	[40]
3	Wolaita Sodo	Bovine	11.3	[41]
4	Kombolcha Elfora	Bovine	16.2	[42]
5	Debraziet Elfora	Bovine	22.75	[43]
6	Tigray	Bovine	21	[44]
7	East Shoa	Bovine	17.5	[15]
8	Hawassa	Bovine	26.25	[23]
9	Addis Ababa	Bovine	7.5	[45]
10	Hawassa	Bovine	30	[46]
11	West Shoa	Bovine	25	[47]

2.5. Public Health Significance

Man is the only final host where the adult *Taenia saginata* resides in the small intestine. The size reached by the adult worm is related to the number of worms present [48]. In a single worm infection, a worm can develop longer and produce large number of proglottids [12]. Multiple infections up to 20 tapeworms in one host are often occurring in developing countries [49]. Oncosphers have been found in finger nails; dirty water transmission is accomplished by the contamination of pasture, fodder and water with egg [26]. Taeniasis causes various symptoms, which probably depend very much on the psychological and physical characteristics of the host. Some patients lose their appetite and thus lose weight while others tolerate the infection [36]. Cyst development takes 3-5 months, and the majority remains viable and infective for about 1-2 years. Man is infected by ingesting raw in adequate cooked beef harboring the viable cyst [[50, 51].

2.6. Economic Impact

The cost implication can be broken down in to those involved in treating human teaniasis and

cattle carcasses (cost of freezing, boiling) or condemnation, as well as the costs involved in the inspection procedures amount to millions of dollars [49]. Annual losses due to treatment in USA were US\$ 100,000 [52], in South Africa US\$ 428 million [53]. In Ethiopia there is a wide usage of both traditional and modern taeniocidal drugs [54], which is an indication of the economic importance of the drugs in each house hold. The total dose of niclosamide and diclorophene production in two drug factories in this country between 1996 and 2000 was 31,814,833. The annual expenditure for the modern drug in three selected areas of Shoa (Akaki, DebreZeit and Nazareth) was estimated to be 1,471,281 Ethiopia birr during the year 2000 [21].

2.7. Clinical Signs

Under natural conditions, the presence of cysticerci in the muscle of cattle is not associated with clinical signs [11]. However, heavy infections, those induced experimentally by 200,000 to 1,000,000 *T. saginata* eggs, may give rise to fever, weakness, profuse salivation, anorexia, increase heart and respiratory rate and a dose of one million or more eggs may cause death between 14 to 16 days due to a degenerative myocarditis [55].

2.8. Diagnosis

Diagnosis of cysticercosis in bovine is usually only made by post-mortem examination i.e. by observation of the cysts [56]. The diagnosis of bovine cysticercosis in many countries is mainly based on carcass inspection through incision of master, tongue, heart, triceps; intercostal muscles and the diaphragm [11]. Many different serological tests have also been introduced in order to replace the current “knife and eye” method of diagnosis at the slaughter house, which detects only a small fraction of cattle infected with cysticerci [57].

2.9. Treatment

The most widely used systemic drugs for the treatment of *T. saginata* in Ethiopia are Niclosamid and praziquantel. The drug of choice in treating Taeniasis is niclosamide (Niclocide, Yomesan). Adult dose rate of 2000 mg is effective in damaging the worm to such an extent that a purge following therapy often produces the scolex. Praziquantel (Biltricide) at a dose rate of 5 to 10 mg per kg also has been reported highly effective [58], but the scolex is partially digested and often not recovered [12]. Other drugs used in the treatment of *T. saginata* are mebendazole [25, 58]. In Ethiopia, the majority of the rural inhabitants use traditional herbal dugs in routine self-deworming as a taenicidal herb, as has been topic for researches in Ethiopia [54].

2.10. Prevention and Control Strategies

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 contamination of raw meat, serological testing of cattle and post – mortem inspection of carcasses for the presence of *Cysticercos bovis* [59, 60]. Generally, *T. saginata* taeniasis and bovine cysticercosis can be easily controlled by cooking meat at 560C or by freezing carcasses at -180C for 5days, or at 100C

for 10 days [11]. Immunity to taeniids is predominantly antibody mediated. It has been reported that highly effective vaccines have been developed against cysticercosis in cattle caused by, *T. saginata* have been developed and are highly effective both under laboratory and field conditions [51].

3. Materials and Methods

3.1 Study Area

The study was conducted from September 2021 to February 2022 on randomly selected cattle at Danema, Wada, and Elifata Municipal abattoir in Hadiya Zone Mirab Badawacho Woreda; Mirab Badawacho Woreda is located in Hadiya zone of SNNP Regional government of Ethiopia. It is 27Km from south of Hosanna and 358Km south of Addis Ababa. Topographically, it is located at an altitude range of 1650-2050 meter above sea level. Geographically, it is located 07 o90 and 8015” North latitude and 350 and 40015” West latitude. The average temperature is 11-270c with lower temperature fluctuation climatically. The Danema has ecological zone of which 100% midline.

3.2. Study Design and Animals

A cross sectional study was conducted on bovine Cysticercosis from in 384 randomly selected cattle from September 2021 to February 2022 cattle slaughtered at Danema, Wada and Elifata municipal abattoir. These animals were brought to slaughter from different livestock market and surrounding of Danema district. Information about breed, sex and age in the study animals were included.

3.3. Sampling and Sample Size Determination

A systematic random sampling technique was used to select 384 cattle slaughter in the study area. The sample size was calculated by using the formula given by Thrusfield (2005) [64] by fixing the confidence level at 95% and assuming expected prevalence of 5% as there was no

previous studies on the Danema, Wada and Elifata municipal abattoir. According to the formula given by Thrustfield (2005) [64] which given below and the total sample size was estimate at 384.

$$N = \frac{1.962 * p^{exp} (1 - p^{exp})}{d^2}$$

Where n=required sample size
Pexp= expected prevalence
d2 =desired absolute precision

3.4. Study Methodology

The cross sectional study was conducted based on active abattoir survey on randomly selected 384 cattle slaughtered at Three municipal abattoir. Furthermore, ante mortem and post mortem examination was performed.

3.4.1. Ante-mortem examination

During ante-mortem examination of the animals detail records about their body condition score, breed, sex, age and origin was recorded. Based on the body condition, animals were grouped as poor, medium and good [65]. The age estimation based on dentition pattern and the age was be categorized in to young (<2 years), adult (2-5 years) and old (>5 years).

3.4.2. Post-mortem examination

During post mortem examination organs namely shoulder, masseter muscle, tongue, heart, liver, lung and diaphragm will systematically inspected for the presence of C.bovis. The routine meat inspection procedures which consists visualization and palpation of the organs and muscle followed by multiple incisions of the organs were made to examine the presence of cysticerci according to the guideline by Ministry of Agriculture (1972) [66]. For masseter muscle, deep linear incisions were made parallel to the mandible. The hearts were incised from base to apex to open the pericardium and incise also made in the cardiac muscle for detailed examination.

3.4.3. Cystic Viability Test

All positive samples were transported to the in Wolayta Sodo regional parasitology laboratory for confirmation of cyst viability. The cysts were incubated in ox bile at 37 °C for 1-2 hours using 40% of ox bile solution diluted in normal saline for 1-2hours. After this, the scolex was examined under microscope by pressing between two glass slides. The cysts were regarded as viable if the scolex envaginates during the incubation period at the same time the scolex was checked whether it is T.saginata metacestode or other based on the size of cysticercus, absence of hook on the rostellum of the envaginated cyst [27].

3.4.4. Visual Examination and Cyst Classification

The suspected cases of C. Bovis were classified as viable or degenerating following macroscopic examination and finger palpation. Translucent, fluid-filled cysts were considered viable, whereas empty cysts and those with cheesy or solid contents were considered degenerating or non-viable [62, 63].

3.5. Data Management and Analysis

The collected data was coded appropriately and entered into Microsoft Excel spread sheet. Statistical analyses was performed using STATA 13 software packages. Descriptive statistics was used to determine frequencies and percentages of the data of cattle slaughtered and displayed by table. Chi-square test was used for determining association between cattle in relation to risk factors. In all cases 95% confidence interval (CI) and p<0.05 was considered for statistically significant difference.

4.Results

Inspection by visual examination: Postmortem visual examination revealed that out of the 384 cattle, 30 (7.8%) cattle were likely infected with C. Bovis cysts. There was no statically significant

different ($p>0.05$) in prevalence of bovine Cysticercosis among sexes and breed. The highest prevalence was observed in the origin from cattle of Danema 16 (4.2%) followed by Wada 8 (2.1%) and Elifata 6 (1.5%) (Figure2). Analysis of the

active abattoir survey showed that there was a significant variation with regard to the anatomical distribution of Cysticercus cysts in the organs inspected, as indicated in (table 2).

Figure 2: Prevalence of bovine Cysticercosis in origin of the animals

Study site	No of animal examined	No of infected	Prevalence (%)
Danema	260	16	4.2
Wada	90	8	2.1
Elifata	34	6	1.5
Total	384	30	

Out of 274 adult animals, 18 animals have been found infected by Cysticercus bovis cyst which consists 6.5% whereas among 71 old animals 9 animals were infected showing a prevalence of 12.7% and out of 39 young animals that are examined 3 (7.7%) of them were infected by C. Bovis and the analysis showed that there is

significant association ($P<0.05$) between age and rate of infection. Of 28 animals were found infected from 380 local breed animals which reveals prevalence of 7.3% and out of 4 cross breed animals 2 of them was infected which consists 50% (Table 3).

Table 3: Prevalence of bovine Cysticercosis by sex, age and breeds of slaughtered cattle

Variables	Animal examined	Animals Infected	Prevalence (%)	Chi-square	P-value
Sex	Male	311	25	7.7	$X^2 = 1.1610$ Pr = 0.478
	Female	73	5	8.2	
Age	Young	39	3	7.7	
	Adult	274	18	6.6	$X^2 = 6.1665$ Pr = 0.046
	Old	71	9	12.6	
Breed	Local	380	28	7.3	$X^2 = 9.989$ Pr = 0.070
	Cross	4	2	50	

The anatomical distribution of the cysts showed that the highest proportions of C. bovis cysts were found on Shoulder muscle (33.3%) followed by

Tongue (30%), Masseter muscle (16.7%) , Triceps muscle (16.6%) and heart (3.3%), no proportion was found in diaphragm (Table 4).

Table 4: Distribution of Cysts among inspected organs of Animals

Organs/Muscle	No of Organs Inspected	No of Organ Infected	Proportions (%)
Shoulder Muscle	30	10	33.3
Masseter	30	5	16.7
Tongue	30	9	30
Heart	30	1	3.3
Triceps muscle	30	5	16.7
Diaphragm	30	0	0
Total	180	30	100

5. Discussion

The present study disclosed that a total of 384 animals examined, 30 animals were identified to be positive for *Cysticercus bovis* with an overall prevalence of 7.8%. The finding was in agreement with previous similar studies (Getachew, 2008) [40] who reported *C.bovis* with prevalence of 6.01% from Mekelle abattoir and Nigatu (2004) [45] who reported 7.5% prevalence of *C. Bovis* infection in Addis Ababa abattoir as well as [67] (Ashenafi, 2013) 8.8% from Wolaitasodo Municipal Abattoir. However, report from this study was lower than the findings of Abuna et al. (2008) [16] in Hawassa abattoir (26.25%); in North West Ethiopia (18.49%) by Kebede (2008) [68]; in east Shoa (27.6%) by Hailu (2005) [15]; 21% at Tigray (Berhe, 2009) [44] and 30% from different abattoirs in the country (Fikire and Adugna, 2012) [46]. However, the recent finding was higher than the result of Tembo (2001) [21] in central Ethiopia (3.2%) and Tekka (1997) [69], in which the prevalence was 2.2%. These differences in prevalence of bovine Cysticercosis might be due to personal and environmental hygiene variation in method and quality of meat infection, management of animals, experience and diligence of inspector and inappropriate use of toilet the area and dose and viability of eggs consumed by animals [70].

Current study revealed that there was no statistically significant difference ($P>0.05$) in the prevalence of *C. bovis* infection between sex and breed. It was coincided with earlier observation of (Hailu, 2005) [15]; Dawit, 2004 and Tembo, 2001) [14, 21] and disagrees with report of (Gomol et al., 2011) [71] and (Jemal and Haileleul, 2011) [72]. In other hand, the prevalence of *C. bovis* was lower (7.7%) in young and adults (6.6%) when compared old age groups (12.6%) and was statistically significant ($P<0.056$) between age groups. This significant variation in prevalence of *C. bovis* might be due to age dependent immunity. However, there was statistically significant difference ($p<0.005$) in the prevalence of bovine Cysticercosis among different age of animals.

As the finding of present study the occurrence of *C. Bovis* based on the origin of cattle had been done and the proportion of *C. Bovis* was observed in the origin from cattle of Danema 16(4.2%) followed by Wada 8 (2.1%) and Elifata 6 (1.5%). This result agrees with report of (Abuna et al., 2008) [16]. The variation in the rate of occurrences in different localities might be related to the less resistance of the egg of the parasite (tape worm ova) to survive in the cold grazing environmental conditions of highlands for longer periods.

The anatomical distribution of the cysts showed that the highest proportions of *C. Bovis* cysts were found on shoulder muscle (33.3%) followed by tongue (30%), masseter muscle (16.7%), triceps muscle (16.6%) and heart (3.3%). The proportion of shoulder muscles affected with *C. bovis* was 33.3% which is in agreement with the reports of [73], Carlos et al. (2002) (46%). However, the present finding was greater than the findings of (Hailu 2005) [15] and [16] who recoded shoulder cyst proportion of 32% and 27%, respectively. This result was disagreeing with the reports of (Feseha, 2009) [54] and (Umber, 2009) [74] who reported that liver to be the most infected organ. Generally, the method of meat inspection, the ability of the meat inspector to identify the cases, difference in the management, sample size and sampling method, and other factors can contribute for the variation of prevalence of bovine Cysticercosis. *Cysticercusbovis* is commonly found in muscle of mastication, particularly masseter muscle, shoulder muscle, heart, tongue, diaphragm and occasionally in fat, liver, lungs and lymph nodes [74].

6. Conclusion and Recommendations

Bovine Cysticercosis is zoonotic parasitic diseases which have great economic importance resulting in losses due to condemnation of infected organs and downgraded carcasses in the study areas. The current finding revealed that prevalence of bovine Cysticercosis was to be

7.8%. Bovine Cysticercosis was an important disease of cattle causing substantial visible and invisible losses. Moreover, environmental sanitation and hygienic conditions are poor and raw beef consumption is common. Therefore, the present study was showed that prevalence of bovine Cysticercosis relatively high in Danema, Wada and Elifata municipal abattoir, Southern Ethiopia and hence, it remains one of the most important diseases warranting serious attention for prevention and control actions.

Based on the above concussion the following recommendations are forwarded:

- Proper meat inspection and disposal of condemned organs are essential to reduce the financial losses and safeguard the public
- Public awareness about the health and economic significance of the disease with special reference to the danger of consumption of either raw or undercooked meat and usage of latrines should be warranted.
- Further studies on prevalence and public health importance of Bovine Cysticercosis should be encouraged to establish clear epidemiological pictures, prevalence and economic importance of the disease.

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