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Community Based Integrated Animal Health Management to Reduce Impact of Cerebral Coenurosis in Bonga Sheep in Kafa Zone, South Western Ethiopia

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ABSTRACT

Coenurosis, a parasitic and fatal disease, is widespread in the highlands of Ethiopia where 75% of the country's sheep population are found. There is significant prevalence of the disease in the current study area. Therefore, the current study was conducted with the objectives to reduce impact of cerebral coenurosis in sheep production in the study area through integrating different prevention and control options and to raise the community awareness about disease. Questionnaire surveys, coproscopic examination of dog faeces and household level surveillance was used to collect data on reported coenurosis cases and taeniid infections. Awareness creation trainings and regular deworming of dogs were used as an intervention to reduce the prevalence of the disease. A total of 107, 134, 153, and 124 dogs were dewormed during the first, second, third, and fourth rounds during the study period respectively. Eggs were detected in 58.53% (95% CI: 47.4- 68.86) of pre-deworming fecal samples of dogs. Eggs were detected in 24.18% (95% CI: 40.0–49.7) of post-intervention fecal samples, 34.35% less than pre-intervention. At the beginning of the intervention the level of awareness of the farmers in the intervention sites about the cause of the disease was 12.2% which was increased to 51.03% at the end of the intervention. The community-based integrated animal health management approach for the control of coenurosis has the potential to be scaled-up across the country, thereby reducing economic losses of communities where the disease is endemic.

ARTICLE DETAILS

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1. INTRODUCTION

Ethiopia is one of East Africa's developing countries, with 42.91 million sheep and 52.46 million goats primarily raised in the country's lowland and pastoral regions (CSA, 2021). Because of their high proliferation rate and ability to adapt to various environments, small ruminants represent an important export commodity that significantly contributes to the livelihood of rural farmers as a source of food (milk and meat), wool, skins, source of income, and monetary asset, especially in pastoral and lowland areas of Ethiopia (Adams et al., 2021).

In Ethiopia, sheep are the second numerous farm animals with nine diverse breeds and ecotypes distributed across the different agro-ecologies ranging from cool alpine climate of the mountains to the arid pastoral areas of the lowlands (Gizaw et al., 2007). Estimates indicated that about 27.3 million sheep found in Ethiopia, out of which, 99.9% of the total sheep population is indigenous breeds which are owned and managed by resource poor smallholder farmers and pastoralists under traditional systems. Sheep serve as a major means of livelihoods of poor livestock keepers, and thereby contribute to poverty reduction and means of attaining sustainable agriculture and food security (Alvarez et al., 2009). In Ethiopia, sheep and their products provide direct cash income through the sale of live sheep and hides. Sheep are living bank for their owners and insurance against crop failure especially where land productivity is low and erratic rainfall, severe erosion, frost, and water logging problems (Zewdu. 2008).

However, productivity and the levels of foreign exchange earnings from small ruminants are much lower than would be expected, given the size of the population (Berhanu, 2007).

The production system is constrained by several factors such as feed unavailability, both in terms of quality and quantity, disease prevalence, poor productivity of the animal and socio-economic circumstances of farmers/ pastoralists (Zewdu.2012). Helminth parasite is the main diseases that affect sheep and goat productivity in the world (Gadahi et al., 2009). Among helminth parasites larvae of Taenia multiceps known as coenurus cerebralis is the major disease affecting sheep and goat production and causes disease known as cerebral coenurosis in these animals (Sabbatani et al., 2004). Coenurus cerebralis is the metacestode or larval form of the dog tapeworm Taenia multiceps, causes cerebral coenurosis, also known as gid or stagger (Oryan et al., 2015). C. cerebralis causes a serious problem in sheep production (Scala et al., 2007). The larval stage (metacestode) of this cestode, known as C. cerebralis, affects the CNS, particularly the brain of sheep and gives rise to the neurological signs of coenurosis (gid or stagger) (Tavassoli et al., 2011). Domestic and wild canids constitute the definitive hosts, while a wide range of herbivores including sheep, goats, cattle, buffaloes, camels, yak and equines are the intermediate hosts. Coenurosis is quite the commonly occurring disease in sheep compared to the other animals (Acha & Szyfres, 2003; Sharma and Chauhan, 2006). Dog being definitive host of Taenia multiceps plays an important role in spreading the disease (Alemu et al., 2015). Dogs fed on the heads containing cerebral coenuri develops adult tapeworm in the duodenum and jejunum and the life cycle is completed approximately 42-60 days after ingesting the Coenurus cysts (Oryan et al., 2014).

Clinical sign is based on location and size of the Coenurus cyst in the brain and spinal cord (Avcioglu et al., 2012). The resulting neurological signs in affected animals are gid or circling, ataxia, head deviation and blindness. Cerebral coenurosis is worldwide in distribution but most common in developing countries of Africa and south eastern Asia region and it is an endemic disease in Ethiopia (Acha & Szyfres, 2003; Adane et al., 2015). Necropsy finding of cyst, Clinical signs, CT, ultrasound and X-ray are the diagnostic method of coenurosis (Roy et al., 2007). Histopathological findings revealed an extensive area of liquefactive necrosis in the cerebrum related to the evacuated Coenurus cyst also used as diagnostic method (Haridy et al., 2013). Although the surgical removal of the cyst is the treatment of choice (Scott, 2012), mixture of anthelminthic agents (albendazole, praziquantel, fenbendazole) in treating coenurosis is successful in the early stage of infection (Ghazaei, 2007).

Knowledge and awareness on cause, source, and the ways of transmission is very imperative in the control of the disease (Loomu, 2010). Control of coenurosis build on the same methods as those used to prevent other metacestodoses (Varcasia et al., 2009). Cerebral coenurosis can be controlled by routine anthelmintic treatment of dogs at the interval of 6-8 weeks, by using an effective taenicide and appropriate disposal of sheep and goat brain after slaughtering or death of animals to prevent freely rooming by dogs belonging to the general public, which may not receive routine anthelmintic treatment (Scott, 2012). Effective control measures can also be taken by methods such as restriction of backyard slaughtering, disposal of heads and community awareness of the epidemiology of the C. cerebralis (Gicik et al., 2007).

Coenurosis (gid or sturdy), a parasitic and fatal disease, is widespread in the highlands of Amhara, Tigray, Oromia and Southern Regions of Ethiopia where 75% of the country's sheep population are found (Adane et al. 2015). There is significant prevalence of the disease in the current study area, which is part of the southwestern highlands of Ethiopia. Therefore, the current study was conducted with the objectives to reduce impact of cerebral coenurosis in sheep production in the study area through integrating different prevention and control options and to raise the community awareness about the cause, transmission, prevention and control option of the disease.

MATERIALS AND METHODS

Study area

The study was conducted in three community based Bonga sheep breed improvement cooperatives of Adiyo Woreda in Kaffa Zone from Sep 2020 to Dec 2021. Cooperatives included in the study were Boka, Shuta and Shena CBBP`s from Boka cluster. Adiyo district has an altitude ranging from 500 to 3,500 m above sea level. The annual rainfall of the area is about 2,300 mm and the temperature ranges from 3 to 36°C. Mixed crop-livestock production is the dominant farming system in the area (Mamiru et al., 2021).

Sampling and sample collection

A representative number of animals was selected randomly from each intervention village for physical examination and fecal sampling before and after deworming. Pre- and post-treatment samples were not paired, with independent cross-sectional sampling at both pre- and post-treatment. Sampling was done at time of treatment and 14 days later. Deworming and sampling were conducted four times per year every three months.

Fecal samples were collected from dogs for fecal egg count and parasite identification and speciation. The fecal samples were collected directly from the rectum. From each animal 5–10 g of fecal material was collected in a clean polythene bag containing 10% formalin as preservative.

METHODOLOGY

Baseline survey of coenuruses in small ruminants

To assess the presence of disease in the study area, disease burden and community awareness different approaches were followed.

Questionnaire survey on local farmers

A semi-structured questionnaire was administered to those small ruminant owners to reveal information regarding the prevalence, morbidity and mortality of the disease in the last one/two years, the perception and awareness about the cause, risk factors and transmission of the disease, the level of animal-dog interaction, the existence of wild life (foxes and rabbits) their interaction with domestic and socio-economic impact of the disease. The households were selected through random sampling from the households list at the Kebele administration office. Thirty households randomly selected from each study Kebele.

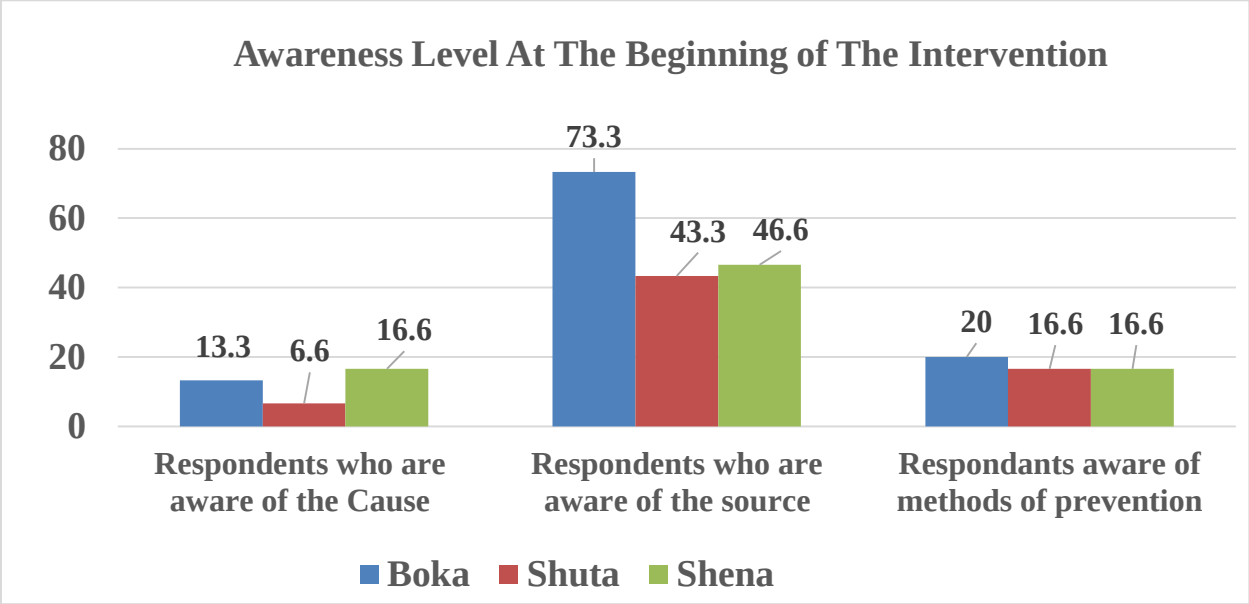

Figure 1. Pre-intervention perception and awareness of farmers about the disease in their locality

Coprological survey of dogs' feces for multiple parasite burden

Fecal samples of dogs were collected with the participation of the owner and if rectal samples cannot be obtained, fresh fecal droppings were collected from the ground around their owners' houses. Fecal samples were also collected from environment (pastures) for laboratory analysis to reveal the degree of parasite contamination in the environment. Each sample was first examined macroscopically for the possible detection of proglottids. Then, examined using fecal floatation, technique as described in the literature (Bowman, 2009; Zajac and Conboy, 2012; Foreyt, 2001; Chauhan et al., 2006) and the result considered as positive when at least one parasite egg, oocyst, cyst or proglottid is present (Lorenzini et al., 2007). The eggs were identified using ova identification keys under 10x magnification of compound microscope to the level of genera or species based on morphological characteristics (shape and structure of shell) and measurements (Hendrix, 2012; Soulsby, 1982).

Table 1. Pre-intervention prevalence

Study Site	No. Examined	No. Positive	Prevalence	95% CI
Boka	36	17	47.2%	31.03- 64.02
Shuta	16	9	56.25%	29.77-79.59
Shena	30	22	73.3%	53.81-86.65
Total	82	48	58.53%	47.40- 68.86

Intervention and impact assessment

Awareness creation about the cause, transmission and control options of the disease

Training was delivered to community members to create awareness about the cause, transmission and control options of the disease, and to stimulate community involvement in programme planning and implementation and facilitate acceptance of the disease control measures. A total of 95 community members had participated in the training from the three study sites (Table 2).

Table 2. Awareness Training Participants

No	Activity	Intervention Sites/villages	Number of participants		
			Male	Female	Total
2	Training on awareness and control options of coenurosis	Boka	20	10	30
		Shuta	17	13	30
		Shena	19	16	35
	Total		56	39	95

Practicing deworming of dogs

Dogs were dewormed at intervals of between three months using praziquantel with dosage of 5 – 10 mg/kg. To make dog sallow tablets are wrapped in locally available dog's food and feed the dog with the help of the dog owners.

Table 3. Dogs dewormed during intervention period

Deworming round and time	Villages	Number of dogs dewormed
First round (December 2020)	Boka	48
	Shuta	32
	Shena	27
	Total	**107**
Second round (March 2021)	Boka	59
	Shuta	45
	Shena	30
	Total	**134**
Third round (June 2021)	Boka	65
	Shuta	50
	Shena	38
	Total	**153**
Fourth round (September 2021)	Boka	47
	Shuta	28
	Shena	49
	Total	**124**

Evaluation of the reduction in incidence of the disease

To assess incidence of the disease intensive surveillance/longitudinal monitoring systems in the sheep flock through collecting monthly household level morbidity and mortality data due to coenurosis was conducted.

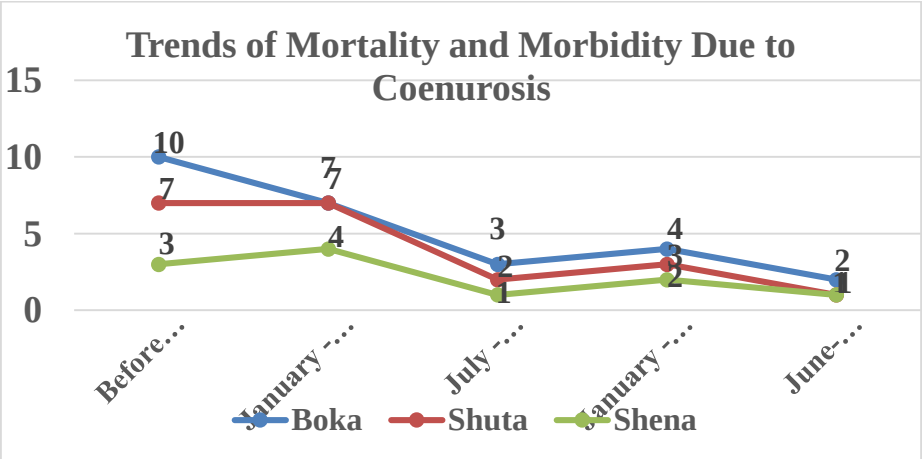

Figure 2. Trend of Morbidity and Mortality in Sheep during intervention Period

Data analysis

The data collected during surveillance/monitoring was entered and stored in MS-excel. Prevalence of GIT parasitism was assessed based on the pre-intervention data. To measure effect of intervention monthly incidence risk (cumulative incidence) was calculated using the formula,

$$\text{Incidence risk} = \frac{\text{Number of incident cases}}{\text{Number of individuals initially at risk}}$$

Data was analyzed using descriptive statistics, i.e., Proportions (percentiles), figures and tables was used to summarize the collected data.

RESULTS

Pre-intervention Coprological Survey of Dogs

A pre-intervention coprological survey of dogs was conducted before deworming dogs in the community-based intervention sites. A total of 82 dogs from were examined for the presence of eggs and metacestodes of Taenia multiceps. Eggs were detected in 58.53% (95% CI: 47.4- 68.86) of pre-deworming fecal samples of dogs. The pre-intervention prevalence of taeniid infection in dogs in the three community-based intervention sites was 47.2, 56.25, and 73.3%, respectively, for Boka, Shuta and Shena (Table 1).

Pre-intervention Survey

A questionnaire survey was conducted at the beginning of the intervention to assess the awareness level of the farmers in the intervention sites. Respondents who were aware of the cause of the disease were 13.3, 6.6, and 16.6% at Boka, Shuta and Shena, respectively. Also, respondents who were aware of the source of the disease were 73.3, 43.3, and 46.6% at Boka, Shuta and Shena, respectively. Awareness level of respondents about the method of prevention of the disease was 20% at Boka and 16.6% at Shuta and Shena sites similarly (Figure 1).

Practicing deworming of dogs

Dogs in the study area were dewormed four times at intervals of between three months using praziquantel with dosage of 5 – 10 mg/kg. A total of 107, 134, 153, and 124 dogs were dewormed during the first, second, third, and fourth rounds during the study period respectively. To make dog sallow tablets are wrapped in locally available dog's food and feed the dog with the help of the dog owners (Table 3).

Post-intervention parasite status and intervention effectiveness

A total of 91 dogs from treated groups were examined after deworming. Eggs were detected in 24.18% (95% CI: 40.0–49.7) of post-intervention fecal samples, 34.35% less than pre-intervention. The pre- and post-deworming percentage of prevalence by year and intervention sites are shown in Table 7. The pre-treatment prevalence had a decreasing trend from 2020 to 2021 in all sites. The prevalence in Boka were 47.2% in 2020, 18.18% in 2021; in Shuta 56.25% in 2020, 30.43% in 2021; and in Shena 73.3% in 2020 and 23.91% in 2021 (Figure 3).

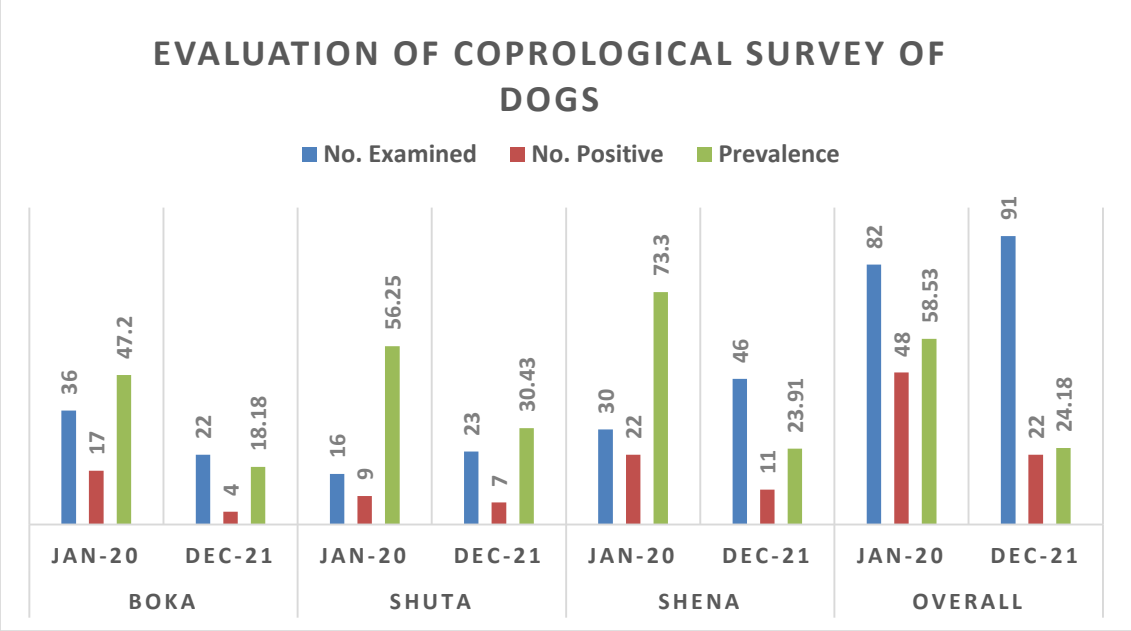

Figure 3. Evaluation of coprological survey of dogs

Evaluation of the reduction in incidence of the disease and the social impact

Monitoring and assessment about the incidence of the disease and survey on the knowledge and attitude of the community After control program of the disease being implemented was conducted. To assess incidence of the disease intensive surveillance/longitudinal monitoring systems in the sheep

flock through collecting monthly household level morbidity and mortality data due to coenurosis was conducted. At the start of the intervention a total of 20 mortality and morbidity cases due to coenurosis were reported, 10 at Boka, 7 at Shuta, and 3 at Shena. The overall incidence risk of the disease was 1:100 (0.0102), where 1 out of 100 sheep were at risk of mortality and morbidity. While, at the end of the intervention 3 cases of mortality and morbidity were reported where the incidence risk was 2:1000 (0.0015), which shows that there was a change in the incidence of mortality and morbidity caused due to the disease (Figure 2).

At the beginning of the intervention the level of awareness of the farmers in the intervention sites about the cause of the disease was 12.2% which was increased to 51.03% at the end of the intervention. At the same time respondents who were aware of the source of the disease were 54.4% in the beginning which increased by 38.7 % and the awareness level was 93.1% in 2021. Also, there was change in the awareness level of respondents about the method of prevention from 17.7% in 2020 to 63.2% in 2021 (Table 4).

Table 4. Awareness level assessment after intervention

Period of Assessment	Villages	Awareness Level		
		Respondents Aware of the Cause	Respondents Aware of the Source	Respondents Aware of the Method of Prevention
At the Beginning (2020)	Boka	13.3	73.3	20
	Shuta	6.6	43.3	16.6
	Shena	16.6	46.6	16.6
	Overall	12.2	54.4	17.7
At the End (2021)	Boka	56.6	100	63.3
	Shuta	44.8	82.75	48.3
	Shena	51.7	96.5	75.9
	Overall	51.03	93.1	63.2

DISCUSSION

The study investigated the prevalence of taeniid infections in dogs and the farmers' knowledge and practices in relation to coenurosis prevention methods established. Based on the current study there was higher prevalence of taeniid eggs in dogs, which adds to earlier studies confirming that cerebral coenurosis is a major disease problem in highland farming systems in Ethiopia. Coenurosis is endemic in Ethiopia, especially in the highland sheep where 75% of the population is found. The presence of freely scavenging dogs on grazing land mostly leads to the continuation of the disease. Dogs are routinely fed on offal including sheep heads and are not dewormed and hence, enduring the cycle of Coenurosis (Achenef et al., 1999).

According to the findings of this study the initial overall prevalence of taeniid infection in dogs was 58.53% (95% CI: 47.4- 68.86) based on the pre-deworming fecal samples of dogs. The current result was greater than the 12.5% overall prevalence in dogs reported in a study conducted in Tanzania (Kibona et al., 2022). Our results indicated that taeniid infections are widespread in our study area and might be due to the lack of deworming practices in area. Although the current study did not identify taeniid eggs to the species level, the high prevalence of coenurosis provides circumstantial evidence that T. multiceps is likely to be present, potentially alongside other taeniids of zoonotic or animal health importance.

The 58.53% pre-intervention overall taeniid parasite prevalence reported in the current study reduced to 24.18% post-deworming. The results suggest that the integrated animal health management strategy incorporating regular deworming of dogs had a positive impact in the intervention sites with reduced contamination of pasture. As expected, the reduced taeniid parasite prevalence in turn reflected on the reduced incidence risk of the disease in sheep. However, the level of worm burden, reflected in taeniid egg counts, is more important than presence/absence of worm eggs, as healthy dogs might still have a low-level worm infection and fecal egg counts reduced over the 2020–2021 course of the community intervention. This reflects room for further improvement with better application as deworming was sometimes missed or erratically applied.

Due to the high prevalence level of taeniid infection in dogs in the study area appropriate deworming agent was used to reduce the level of contamination of pastures with infected dog feces. Dogs in the study area were dewormed four times at intervals of between three months using praziquantel with dosage of 5 – 10 mg/kg. A total of 107, 134, 153, and 124 dogs were dewormed during the first, second, third, and fourth rounds during the study period respectively. Eggs were detected in 24.18% of post-intervention fecal samples, 34.35% less than pre-intervention. There is no effective treatment in sheep and goats to kill the larva and the only solution is prevention in dogs. The life cycle of coenurosis

can be interrupted most effectively by control of tape worm infection in dogs and preventing dogs from having contact to sheep carcasses (Radiostitis et al., 2007). The anthelminthic drugs provided have accumulative co-benefits for the animals. The drugs control not only coenurosis but also scale down or eliminate other diseases common in dog-keeping areas, such as cystic echinococcoisis. Also known as hydatidosis, cystic echinococcoisis is one of the top ten zoonotic diseases in Ethiopia, caused by the metacestode larval stages of the tapeworm E. granulosus sensu lato (s. l.) (Eckert and Deplazes 2004).

A questionnaire survey was conducted at the beginning of the intervention to assess the awareness level of the farmers in the intervention sites. Respondents who were aware of the cause of the disease were 13.3, 6.6, and 16.6% at Boka, Shuta and Shena, respectively. While respondents have slightly higher level of awareness about the source of the disease. Awareness level of respondents about the method of prevention of the disease was 20% at Boka and 16.6% at Shuta and Shena sites similarly. At the end of the intervention the level of awareness of the farmers in the intervention sites about the cause of the disease was increased to 51.03% at the end of the intervention. At the same time respondents who were aware of the source of the disease were 54.4% in the beginning which increased by 38.7 % and the awareness level was 93.1% in 2021. Also, there was change in the awareness level of respondents about the method of prevention from 17.7% in 2020 to 63.2% in 2021.

Control of the disease can occur when farmers and pastoralists are outfitted with knowledge and endorse best practices in animal health. Training was conducted among farmers and dog owners who have limited knowledge and awareness of the disease, in areas where the disease has a high impact on the morbidity and mortality of small ruminants. Focus was given on raising awareness level of participants of the disease, the mode of transmission and how it can be prevented and controlled. The community trainings also helped the participants understand the economic and public health issues associated with coenurosis. Participants were shown how the appropriate disposal of parasite infected heads and regular dog deworming in the community would break off the coenurosis transmission to small ruminants, thereby decreasing the morbidity and mortality of small ruminants.

CONCLUSION

This study proved that coenurosis is a common problem of sheep in the study area. Interventions to prevent and control coenurosis implemented which included awareness creation training and deworming of dogs had significant impact in the study area in reducing the incidence of the disease. The initial questionnaire survey revealed that most of the respondents wrongly understand the cause of the disease and do not know the prevention mechanism. The awareness creation training increased the awareness level of the participants about the cause, source and methods of control and prevention of the disease. Also, the routine deworming of dogs reduced the parasite prevalence in dogs by 34.35%. The community-based integrated animal health management approach for the control of coenurosis has the potential to be scaled-up across the country, thereby where the disease is endemic, decreasing the economic losses of farmers due to the disease. Government should prioritize actions and policies to support livestock farmers in controlling the spread of the disease. To achieve long-term results, small ruminant cooperatives located in areas where coenurosis is prevalent should give focus on the disease and carry out an annual dog deworming calendar. National and international research institutes, together with development organizations, should support regular community-based dog deworming as a good approach to control coenurosis as well as zoonotic helminths of dogs and plan accordingly.

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AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTIONS

NB, AA, and LT collected all the required data. NB, AA, and LT performed the laboratory works. NB, and AA designed the study, and analyzed and interpreted the data. NB drafted the manuscript. NB and AA critically and substantially revised the manuscript. All authors read and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

CONSENT FOR PUBLICATION

Not applicable.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

A local ethics committee ruled that no formal ethics approval was required to conduct this research. Before conducting the research, informed consent was obtained from the owners of animals in this study.

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