

# Prevalence, Control Strategies, and Risk Factors of Major Metacestode Infections in Small Ruminants Across Sub-Saharan Africa

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## SUMMARY

The increasing demand for goat and sheep production in sub-Saharan Africa, due to their resilience to climatic conditions, is hindered by several factors, including metacestode infections. Despite control efforts targeting zoonotic parasitic diseases by international organisations, including the World Health Organisation, cultural practices and the close association between small ruminants and dogs in pastoral communities continue to facilitate transmission. This systematic review assessed the prevalence, control measures, and risk factors of major metacestode infections in goats and sheep across sub-Saharan Africa. A comprehensive search in PubMed, Google Scholar, and AJOL identified 29 relevant studies out of 10,040 publications, revealing significant gaps in reporting. The median (IQR) prevalence of metacestodes in small ruminants has been indicated to be higher with *Cysticercus tenuicollis* at 46.05% (34.52; 13.03–66.00%) followed by, in descending order; *Cysticercus ovis* (16.25; 8.49%- 24%) hydatid cysts (12.13%; 11.26%; 2.20–66.50%) and *Coenurus cerebralis* (8.3%; 24.26%; range: 3.80–44.45%). Moreover, the maximum and minimum prevalence of metacestodes in small ruminants have been recorded for hydatid cysts at 66.5% and 2.2%, respectively. Control strategies recommended in the reviewed studies include improved livestock management, hygiene, and reducing stray dog populations to disrupt the transmission cycle. The high prevalence underscores the critical impact of these infections on small ruminant productivity in the region.

## Keywords

*Cysticercus ovis*, *Cysticercus tenuicollis*, *Coenurus cerebralis*, hydatid cysts, Sub-Saharan African, Prevalence, risk factors, control, goats and sheep.

## INTRODUCTION

Sub-Saharan Africa is known to have a significant number of small ruminants, as keeping these animals aligns well with the financial and labour resource capabilities of low-income rural households (Abassa, 1995). Small ruminants contribute significantly to income generation through the supply of meat and milk in the region. Beyond income, these animals play a crucial role in food security, cultural practices, and

social exchanges, such as dowries and gifts, highlighting their importance in the livelihoods of rural communities. Despite their significance, small ruminants have often been neglected in terms of veterinary care, leading to widespread reports of metacestode cysts invading their organs in various areas of sub-Saharan Africa (Abbas *et al.*, 2009; Oryan *et al.*, 2012; Gessese *et al.*, 2015; Hailu, 2019). Diseases such as coenurosis, caused by

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metacestode infection, pose a serious threat to sheep and goat production, particularly in rural parts of Southeast Asian and African countries, which are home to three-fourths of the world's small ruminant population (Godara *et al.*, 2011). Cestodes of the family Taeniidae infect dogs as definitive hosts and are transmitted to a wide range of intermediate host species, including goats and sheep, where they cause coenurosis, cysticercosis, and hydatidosis, respectively (Hailu, 2019).

Major metacestodes infecting small ruminants include the hydatid cyst, *Cysticercus ovis*, *Coenurus cerebralis*, and *Cysticercus tenuicollis* (Gessese *et al.*, 2015; Hailu, 2019; Aragaw, 2023). The adult tapeworms (*Echinococcus granulosus*, *Taenia ovis*, *Taenia multiceps*, and *Taenia hydatigena*) are found in the small intestines of canids, such as dogs, which excrete the eggs in their feces. Intermediate hosts, such as goats and sheep, including humans (as accidental hosts), become infested by ingesting contaminated pastures, water, vegetables, or through direct contact with dogs (Hailu, 2019).

Infection of hydatid cysts and *Cysticercus tenuicollis* in small ruminants is usually asymptomatic, but these metacestodes in the liver and other tissues can be identified during post-mortem inspection at slaughter. Coenurosis, caused by *Coenurus cerebralis*, can lead to severe neurological symptoms in young lambs (aged 1-2 years), and *Cysticercus ovis* results in cysts in muscle tissue, leading to economic losses due to meat condemnation (Godara *et al.*, 2011).

Existing control strategies, such as those proposed by the World Health Organisation (WHO), include the management of stray dogs, improved hygiene practices, and proper disposal of infected offal. However, these measures are often hampered by cultural practices, religious beliefs, and social norms, particularly in pastoral communities where small ruminants are closely associated with dogs (Erbeto *et al.*, 2010; Gessese *et al.*, 2015; Aragaw, 2023). The public health implications are also significant, as metacestode infections can have zoonotic potential, particularly with *Echinococcus granulosus*, which causes hydatidosis in humans.

Despite numerous reports on the incidence and prevalence of hydatidosis and cysticercosis in small ruminants in sub-Saharan Africa, data on prevalence are affected by various risk factors such as age, sex, geographical location, and the specific species of animals. Additionally, inconsistencies and gaps in research hinder the development of effective control strategies. Therefore, a comprehensive understanding of these risk factors is crucial for developing sustainable control measures.

This systematic review aims to report on the prevalence, possible control measures, and risk factors associated with major metacestode infections in small ruminants in sub-Saharan African countries. By addressing the current knowledge gaps, this review seeks to inform future research and interventions that could mitigate the impact of these infections on small ruminant production in the region.

## MATERIALS AND METHODS

### Review Scope

This review encompasses all studies related to the prevalence, control measures, and risk factors associated with major metacestode infections in goats and sheep in sub-Saharan African countries. Review articles were excluded from consideration. The review was conducted in accordance with the PRISMA guidelines (Moher *et al.*, 2009), focusing on research articles, reports, dissertations, and theses published in English, without any time restrictions.

### Search Strategy

The primary sources for data collection included the PubMed database (<https://pubmed.ncbi.nlm.nih.gov/>), Google Scholar (<https://scholar.google.com/>), and African Journals Online (AJOL) (<https://www.ajol.info/index.php/ajol/>). The search strategy utilised Boolean operators (AND, OR, \*) and was adapted from Saelens *et al.* (2022). The search terms were structured as follows: (*Cysticercus ovis* AND *Cysticercus tenuicollis* AND hydatid cysts AND *Coenurus cerebralis* OR major metacestode infections AND goats and sheep

OR small ruminants AND Prev\*, OR "Risk\*, OR Control\*) AND (Angola OR Benin OR Botswana OR Burkina Faso OR Burundi OR Cameroon OR Central African Republic OR Chad OR Congo OR Zaire OR Côte d'Ivoire OR Ivory Coast OR Djibouti OR Egypt OR Equatorial Guinea OR Eritrea OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Kenya OR Lesotho OR Liberia OR Libya OR Madagascar OR Malawi OR Mali OR Mauritania OR Morocco OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR Senegal OR Sierra Leone OR Somalia OR South Africa OR South Sudan OR Sudan OR Swaziland OR Tanzania OR Togo OR Tunisia OR Uganda OR Zambia OR Zimbabwe).

### Screening and Eligibility

The initial search results from the databases and search engines were screened to remove duplicates. Titles and abstracts were then evaluated for eligibility. Studies were excluded based on the following criteria: (a) Studies published in languages other than English, (b) Studies lacking full-text availability, (c) Review articles, (d) Studies focused on molecular identification of

metacestodes, (e) Studies reporting other cestodes, such as *Taenia solium*, (f) Studies reporting metacestode infections in livestock species other than goats or sheep. Full texts of eligible publications were retrieved and assessed using the same criteria. The reference lists of each eligible publication were also reviewed to identify additional relevant literature. Data from the selected articles were organised and presented in tables using Microsoft Excel.

### Data Analysis

Data on the number of examined and infected species, along with their corresponding prevalences of major metacestodes, were extracted from the selected publications and recorded in Microsoft Excel (Table 1). The average prevalence of each major metacestode was calculated using descriptive statistics, with results reported as means, medians, and interquartile ranges (IQR). Additionally, the risk factors associated with the incidence and prevalence of metacestode infection mentioned in the selected studies were extracted and summarised qualitatively.

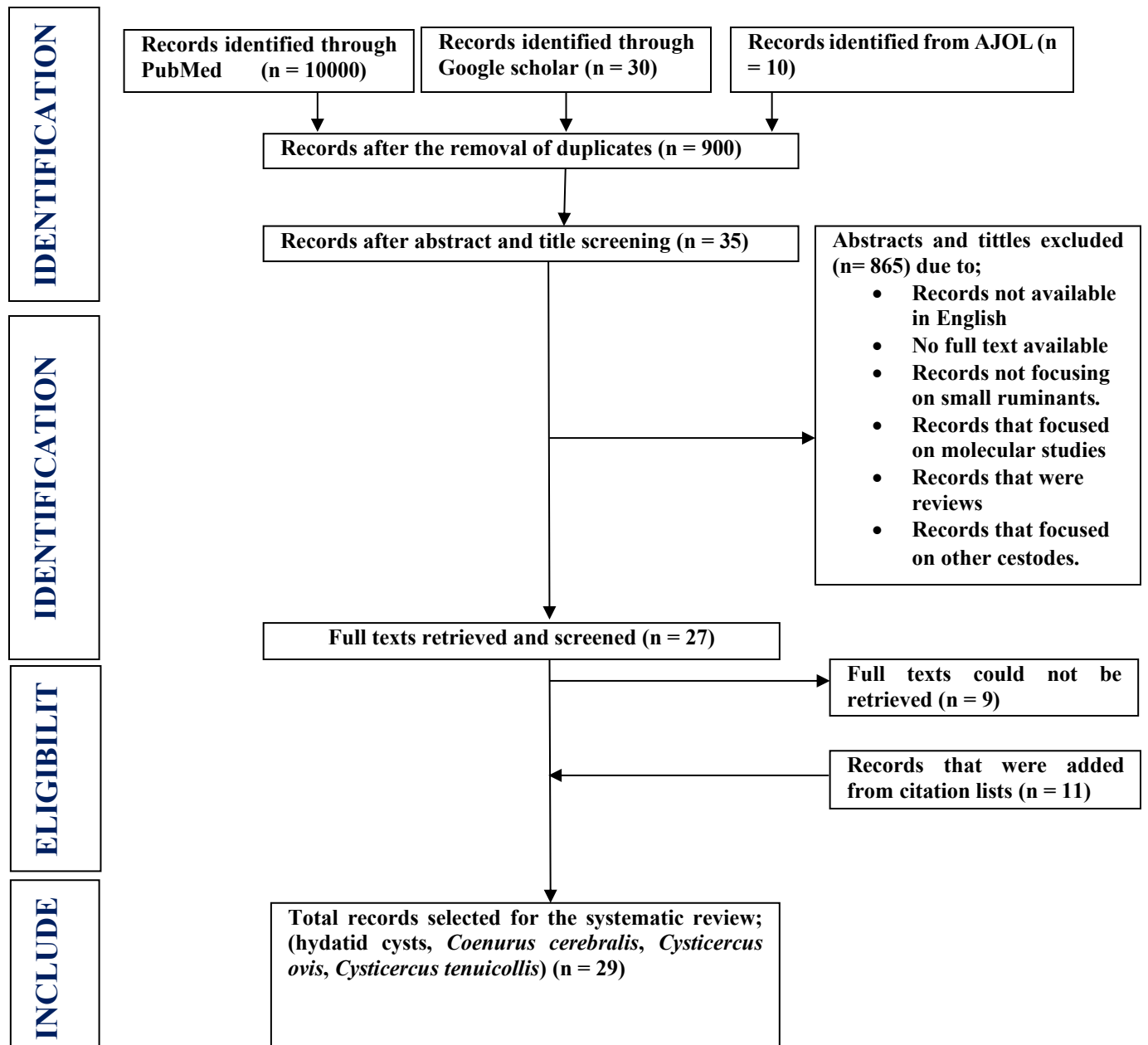
## RESULTS

### Retrieved publications

The initial database searches identified a total of 10,040 publications. Additionally, nine more articles were found through citation and reference list screening of relevant publications. After careful screening and application of the exclusion criteria, a total of 29 studies were included in the systematic review (Figure 1).

Out of the 29 studies included in this review, 22 provided data on the prevalence of metacestodes, 4

articles provided data on both the prevalence of metacestodes and the risk factors associated with metacestode infection, while 6 studies primarily analyzed the control of metacestodes in nomadic or pastoral communities. Among the 22 studies on the prevalence of metacestodes, 13 (59.09%) were from Ethiopia, 5 (22.73%) from Tanzania, 2 (9.09%) from Kenya, and 1 (4.55%) each from Uganda and Nigeria. A detailed description of the prevalence, location (country), and species (small ruminants) is summarized in Figure 2



**Figure 1.** A flow diagram showing database search on prevalence, possible control and risk factors associated with major metacestodes infection in small ruminants in sub-Saharan African countries.

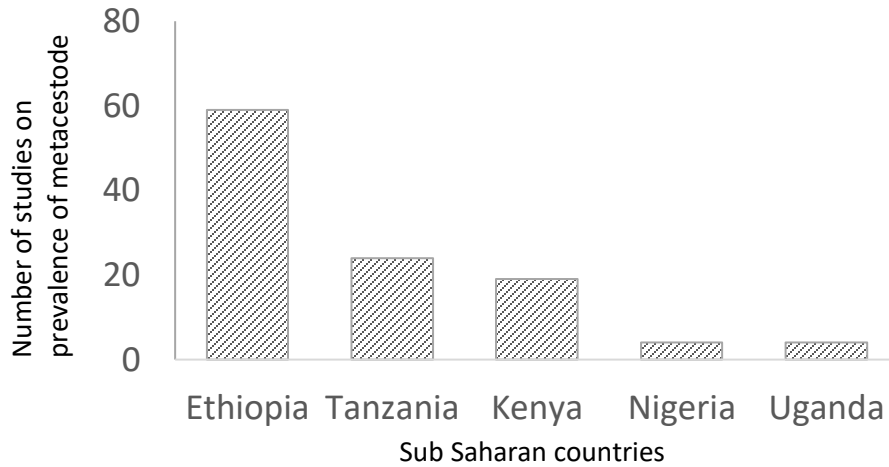
### Prevalence of Metacestodes

Out of the 27 studies included in this review, 22 (81.48%) focused on assessing and reporting the prevalence of metacestode infections in small ruminants across sub-Saharan Africa. The data were collected from five countries: Ethiopia, Tanzania, Kenya, Nigeria, and Uganda. This review presents prevalence data without differentiating the

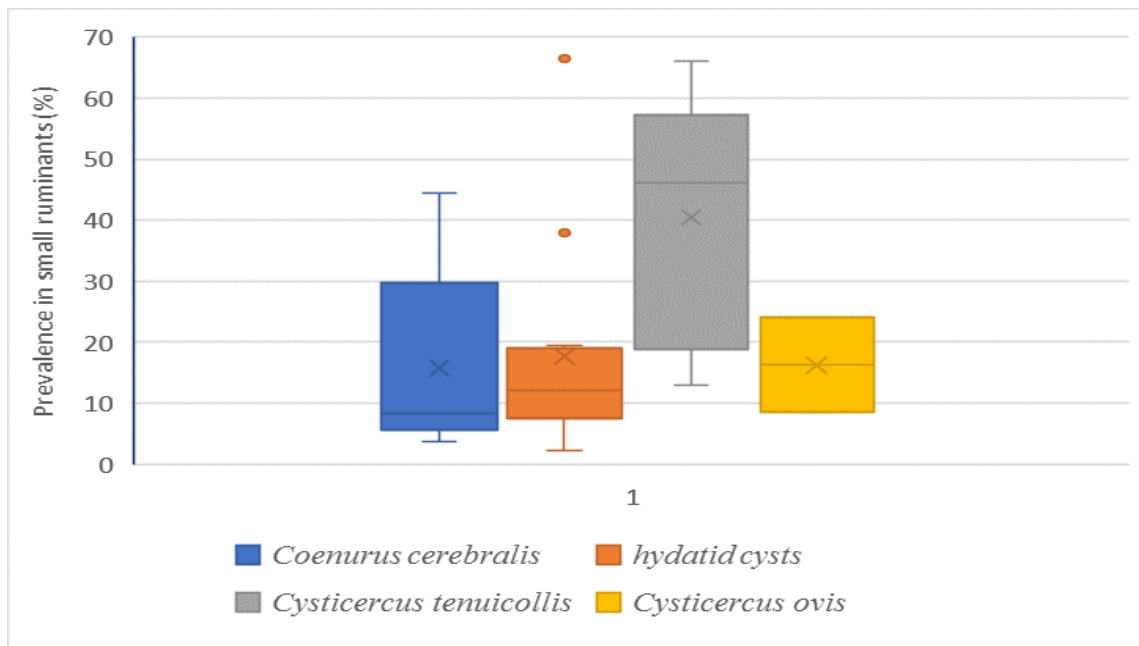
levels of infection between studies, time periods, or specific study areas. The prevalence of major metacestode infections in goats and sheep across these countries ranged from 2.10% to 83.10% in goats and 2.30% to 79.00% in sheep (Sissay *et al.*, 2008; Mosha *et al.*, 2022; Tamarozzi *et al.*, 2022) (Table 1).

Ethiopia reported the highest number of studies, with prevalence rates ranging from 1.90% to 72.38% in goats and 2.60% to 79.00% in sheep (Sissay *et al.*, 2008; Gessese *et al.*, 2015; Hailu, 2019). In contrast, Nigeria and Uganda had fewer studies, with Nigeria reporting a prevalence of 13.03% and Uganda reporting prevalence rates of 3.33% in goats and 42.50% in sheep. The descriptive summary statistics revealed the median

prevalence of each metacestode as follows: *Coenurus cerebralis* at 8.3% with an IQR of 24.26% (range: 3.80–44.45%), *Cysticercus tenuicollis* at 46.05% with an IQR of 34.52 (range: 13.03–66.00%), hydatid cysts at 12.13% with an IQR of 11.26% (range: 2.20–66.50%), and *Cysticercus ovis* at 16.25% with prevalence ranging from 8.49% to 24% (Figure 2).



**Figure 2.** Overall distributions of studies on the prevalence of major metacestode infections in sub-Saharan Africa.



**Figure 3.** Median prevalence of major metacestode infections in small ruminants in sub-Saharan Africa.

**Table 1.** Prevalence of major metacestodes (hydatid cyst, *Cysticercus ovis*, *Coenurus cerebralis* and *Cysticercus tenuicollis*) for sheep and goats in sub-Saharan Africa.

Country (Study Area)	Study settings	Metacestodes	Diagnostic test	Examined species	Infected species		Citations
					Sheep n (% rev)	Goats n (% rev)	
Ethiopia	Abattoir	<i>Coenurus cerebralis</i>	PM	674	14 (8.60)	31 (6.02)	(Sagni and Abebe 2021)
Ethiopia	Slaughter slab	<i>Coenurus cerebralis</i>	AM, PM	412	23 (20.70)	29 (9.63)	(Aliye and Deressa 2017)
Ethiopia	Abattoir	<i>Coenurus cerebralis</i>	PM	785	10 (2.60)	20 (5.00)	(Hailu 2019)
		hydatid cysts	PM	785	31 (8.10)	27 (6.80)	
Ethiopia	Abattoir	hydatid cysts	PM	512	21 (8.02)	17 (6.80)	(Assefa et al. 2015)
Ethiopia	Abattoir	<i>Cysticercus tenuicollis</i>	PM	930	233 (45.70)	303 (72.38)	(Gessese, Mulate, and Nazir 2015)
		<i>Cysticercus ovis</i>	PM	930	43 (8.40)	36 (8.57)	
		hydatid cysts	PM	930	46 (9.00)	8 (1.90)	
Ethiopia	Abattoir	hydatid cysts	PM	1692	206 (19.94)	102 (16.00)	(Erbeto, Zewde, and Kumsa 2010)
Ethiopia	Abattoir	<i>Cysticercus ovis</i>	PM	1287	170 (26.00)	139 (22.00)	(Sissay, Uggla, and Waller 2008)
		<i>Cysticercus tenuicollis</i>	PM	1287	517 (79.00)	335 (53.00)	
		hydatid cysts	PM	1287	445 (68.00)	411 (65.00)	
Ethiopia	Abattoir	hydatid cysts	PM	340	36 (10.60)	N/A	(Kebede et al. 2009)
Ethiopia	Survey	hydatid cysts	PM	8271	768 (11.78)	86 (4.90)	(Fromsa and Jobre 2011)
Ethiopia	Abattoir	<i>Coenurus cerebralis</i>	PM	768	19 (4.90)	45 (11.70)	(Abdo, Tesfaye, and Shibbiru 2017)
Ethiopia	Abattoir	<i>Cysticercus tenuicollis</i>	PM	845	96 (22.80)	112 (26.40)	(Mekuria et al. 2013)
Ethiopia	Abattoir	<i>Cysticercus tenuicollis</i>	PM	1398	252 (40.00)	358 (46.60)	(Samuel and Zewde 2010)
Ethiopia	Abattoir	<i>Cysticercus tenuicollis</i>	AM, PM	545	27 (13.80)	71 (20.30)	(Ahmed et al. 2024)
Tanzania	Slaughter slab	<i>Coenurus cerebralis</i>	PM	180	41 (45.60)	39 (43.30)	(Miran Bushleji Miran et al. 2015)
Tanzania	Slaughter slab	<i>Cysticercus tenuicollis</i>	PM	419	14 (51.90)	172 (45.70)	(Braae et al. 2015)
Tanzania	Survey	<i>Cysticercus tenuicollis</i> and hydatid cysts	PM, PCR	479	22 (26.90)	136 (83.10)	(Tamarozzi et al. 2022)
Tanzania	Slaughter slab	<i>Cysticercus tenuicollis</i>	PM	180	38 (42.20)	55 (61.10)	(M. B. Miran, Kasuku, and Swai 2017)
		hydatid cysts	PM	180	15 (16.60)	10 (22.20)	
Tanzania	Abattoir	hydatid cysts	PM	785	9 (2.30)	8 (2.10)	(Mosha et al. 2022)
Kenya	Abattoir	hydatid cysts	PM, PCR	1100	93 (14.90)	72 (15.20)	(Nungari 2020)
Kenya	Abattoir	hydatid cysts	PM, PCR	624	71 (16.50)	21 (10.80)	(Addy et al. 2012)
Nigeria	Abattoir	<i>Cysticercus tenuicollis</i>	PM	261	34 (13.03)	N/A	(Saulawa et al. 2011)
Uganda	Abattoir	hydatid cysts	PM	455	68 (42.50)	98 (33.33)	(Nyero et al. 2015)

### **Risk factors associated with metacestode infections**

Out of the 29 selected studies, 18 (66.67%) reported on various risk factors associated with major metacestode infections. Age emerged as a significant factor, with studies indicating that the prevalence of metacestode infections increases as animals age, making older animals more susceptible than younger ones (Samuel and Zewde, 2010; Saulawa *et al.*, 2011; Gessese *et al.*, 2015; Abdo *et al.*, 2017; Aliye and Deressa, 2017; Sagni and Abebe, 2021; Ahmed *et al.*, 2024). The origin of the animals, particularly the agro-ecological zones they inhabit, also plays a crucial role in infection rates. Variations in temperature and humidity across different districts, states, or counties significantly influence the prevalence of metacestode infections. Furthermore, the type of grazing grounds, whether highland, midland, or lowland, affects the likelihood of infection, with several studies noting a higher prevalence of metacestode infections in animals from highland areas compared to those from lowland regions (Erbeto *et al.*, 2010; Samuel and Zewde, 2010; Braae *et al.*, 2015; Abdo *et al.*, 2017)

Breed differences are another important factor, with certain breeds showing higher susceptibility to metacestode infections. For instance, the Blackhead Ogaden sheep breed has been reported to have a higher prevalence of metacestode infections compared to other breeds (Erbeto *et al.*, 2010; Mekuria *et al.*, 2013) Specific goat breeds such as Aris, Kaffa, Somali, Afar, and Harar, and sheep breeds such as Blackhead Ogaden, Adal, Afar, and Harar have been highlighted in various studies.

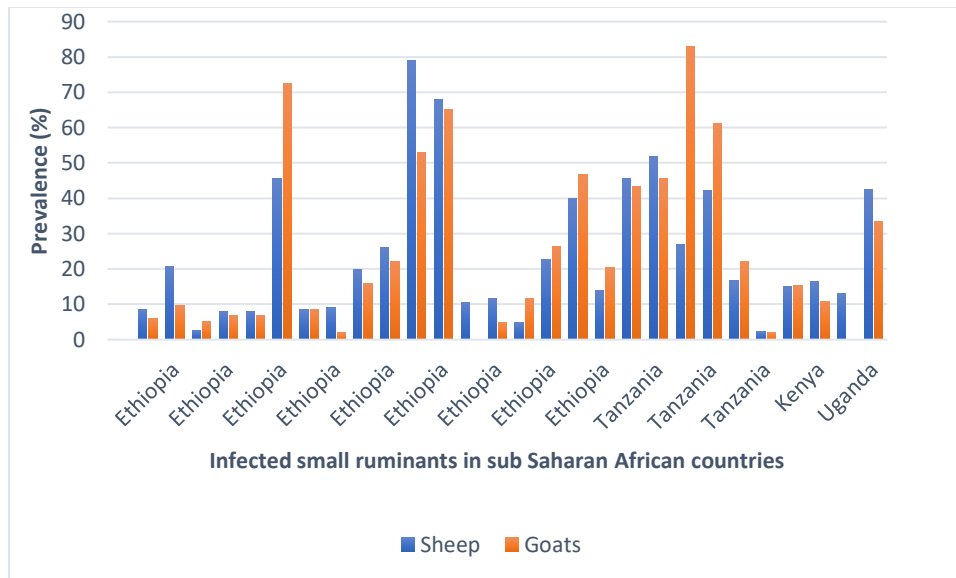
Lastly, the type of species also influences infection rates, with ten out of 22 studies reporting a higher

prevalence of metacestode infections in goats compared to sheep (Samuel and Zewde, 2010; Mekuria *et al.*, 2013; Braae *et al.*, 2015; Nyero *et al.*, 2015; Abdo *et al.*, 2017; Aliye and Deressa, 2017; Miran *et al.*, 2017; Ahmed *et al.*, 2018; Sagni and Abebe, 2021; Tamarozzi *et al.*, 2022). However, this difference is not statistically significant, as both species graze in similar environments, making them equally exposed to infection (Mekuria *et al.*, 2013) (Figure 4).

On the other hand, six studies report a higher prevalence of metacestode infections in sheep compared to goats. This difference is attributed to their feeding habits—sheep are grazers, which increases their probability of picking up taeniid eggs, while goats are browsers and are less likely to encounter the eggs (Sissay *et al.*, 2008; Erbetto *et al.*, 2010; Addy *et al.*, 2012; Miran *et al.*, 2015; Mosha *et al.*, 2022; Nungari, 2020) (Figure 4).

Sex has also been identified as a factor, with several studies showing that male animals are more frequently infected compared to females (Erbeto *et al.*, 2010; Mekuria *et al.*, 2013; Ahmed *et al.*, 2024) Additionally, body condition plays a significant role in infection rates. Animals in poor condition have been reported to have higher rates of metacestode infection compared to those in good condition, with the difference being statistically significant (Mekuria *et al.*, 2013; Ahmed *et al.*, 2024)

Lastly, one study reported that the type of production system is a risk factor. Animals raised in mixed farming systems exhibit higher rates of metacestode infections compared to those raised in pastoral systems (Erbeto *et al.*, 2010).



**Figure 4.** Prevalence of major metacestode infection across species in sub-Saharan Africa.

### Major metacestode control strategies

Out of the 27 selected studies, 12 (44.44%) discussed strategies for controlling metacestode infections and the zoonotic diseases they cause in small ruminants. Diseases such as cysticercosis and echinococcosis, which are caused by metacestode infections, are ranked among the 17 "official" Neglected Tropical Diseases (NTDs) by the World Health Organisation (WHO/HTM/NTD/2015.1 2016). To control these NTDs, several factors must be considered, including disease burden, available interventions, resources (financial and health workforce), and the capacity of local health services (Marchal *et al.*, 2011). Additionally, policy research into the complex multi-sectoral and multi-actor coordination required for zoonoses control, such as detailed case studies on the spread of echinococcosis and cysticercosis, could enhance the implementation of control measures (Okello *et al.*, 2015). A study from Southern Africa also emphasises the significant impact of zoonotic diseases on agriculture, livestock, public health systems, and the national economy. It highlights the need for disease control programs, including surveillance and vaccinations, to reduce public health costs, environmental impacts, and effects on livelihoods (Osofsky, 2019).

Six studies specifically mention the importance of regular deworming of ruminants, vaccination of sheep with the EG95 vaccine, and deworming of owned dogs. The development of a sustained-release formulation of praziquantel, which would provide prolonged protection against reinfection with metacestodes, is also recommended. Controlling the dog population by eliminating stray dogs is urgently needed for effective control (Assefa *et al.*, 2015; Miran *et al.*, 2015; Nyero *et al.*, 2015; Abdo *et al.*, 2017; Tamarozzi *et al.*, 2022) (Figure 4).

Furthermore, five studies support the safe disposal of offal infected with metacestodes, the construction of disposal pits at slaughterhouses, and restrictions on domestic or backyard slaughter of small ruminants. Improving abattoir hygiene, including proper fencing of slaughter slabs and slaughterhouses to prevent access by roaming dogs, is crucial for breaking the cycle of metacestode infections (Kebede *et al.*, 2009; Erbetto *et al.*, 2010; Samuel and Zewde, 2010; Assefa *et al.*, 2015; Nyero *et al.*, 2015; Abdo *et al.*, 2017).

To protect humans, dogs should be kept out of vegetable plots to prevent contamination by eggs from dog faeces, and animals should be kept away from human settlements (Abdo *et al.*, 2017;

Macpherson, 1994). Additionally, four studies emphasize the importance of educating butchers, abattoir workers, meat sellers, dog owners, and the wider community about the factors contributing to the incidence and prevalence of metacestode infections and how they can be prevented to avoid zoonotic outbreaks ( Kebede *et al.*, 2009; Assefa *et al.*, 2015; Miran *et al.*, 2015; Abdo *et al.*, 2017).

A study assessing the improvement of veterinary services in Africa highlighted the critical role of

para-professionals in delivering veterinary services to livestock communities in both intensive and extensive livestock systems. Given the remote and unattractive nature of many pastoral areas, retaining degree-holding veterinarians is challenging. Therefore, the study advocates for the recruitment of para-professionals with diplomas in veterinary science as a viable alternative, as they provide quality services comparable to those of degree-holding veterinarians, including vaccination, meat inspection, and education in pastoral communities (Ilukor, 2017).



**Figure 5.** A stray dog feeding on discarded offal at Mkongeni slaughter slab, Mvomero in Morogoro region (Source: Photograph taken by the authors during field data collection (2025))

## DISCUSSION

This systematic review aimed to integrate the prevalence, risk factors, and possible control measures for major metacestode infections in small ruminants in sub-Saharan Africa, based on published literature. Despite yielding only 27 eligible articles, the findings highlight the evidence and burden of metacestode infections in eastern Africa (Ethiopia, Tanzania, Kenya, and Uganda) and western Africa (Nigeria). The limited number of publications underscores a significant gap in epidemiological studies on metacestode infections in small ruminants, which have become increasingly important in many pastoral communities in Africa due to the adaptability of these animals to various climates (Jansen and Burg, 2004; Kibona *et al.*, 2022). Small ruminants are favoured for their low resource requirements, low initial capital investment, and shorter reproductive

intervals compared to cattle. However, their productivity in Africa is constrained by factors such as poor husbandry practices and diseases (Jansen and Burg, 2004; Kibona *et al.*, 2022).

Ethiopia accounts for 52.17% of the prevalence studies included in this review, likely reflecting the country's large livestock population estimated at 47.5 million cattle, 39.6 million chickens, 7.8 million equines, 26.1 million sheep, and 21.7 million goats (Central Statistical Agency, 2019; Gessese *et al.*, 2015). No significant difference in prevalence was found between goats and sheep, as both species graze in similar environments and are equally exposed to taeniid eggs in contaminated areas. However, the median prevalence of *Cysticercus tenuicollis* was higher compared to other metacestodes, though the maximum

<https://doi.org/10.4314/tvj.v41i1.1>

prevalence (66.5%) was recorded for hydatid cysts. This suggests that in areas where *Cysticercus tenuicollis* is prevalent, hydatid cyst infection is also significant (Sissay *et al.*, 2008; Gessese *et al.*, 2015; Miran *et al.*, 2017; Tamarozzi *et al.*, 2022). The studies reviewed identified origin as a significant determinant for metacestode infections, with animals from highland areas at greater risk compared to those grazing in lowland areas. This difference may be attributed to the limited vegetation in lowland areas, which affects the transmission dynamics of the parasites (Samuel and Zewde, 2010). Age is another critical factor; older animals have a higher prevalence of metacestodes, likely due to prolonged exposure to taeniid or *Echinococcus granulosus* eggs over their lifetimes (Samuel and Zewde, 2010). This underscores the importance of regular deworming, especially since meat and other animal products are primarily derived from older animals.

Body condition also emerged as a significant factor, with poorly conditioned animals showing higher infection rates compared to those in medium or good condition. The weakened immune systems of animals with poor body condition make them more susceptible to gastrointestinal parasites, which in turn exacerbate metacestode infections (Mekuria *et al.*, 2013). Furthermore, a study conducted at the

Addis Ababa abattoir in Ethiopia highlighted the type of production system as a key determinant of metacestode infection. Animals raised in mixed farming systems exhibited higher infection rates than those in pastoral systems. This is likely due to the presence of a large number of owned and stray dogs in mixed farming systems, which act as definitive hosts for the parasites, as well as the cooler temperatures in highland areas that favour the survival and development of parasite eggs. In contrast, the low infection rates observed in pastoral systems are likely due to the smaller number of dogs, coupled with the fact that many Ethiopian pastoralists, who are predominantly Muslim, do not keep dogs due to cultural beliefs (Erbeto *et al.*, 2010). The study also noted differences in infection rates across breeds of goats and sheep, though the reasons for these differences remain unclear.

Overall, the studies reviewed present various strategies for controlling metacestode infections. However, the implementation of these strategies requires significant funding from both governmental and non-governmental organisations to effectively reduce infection rates and safeguard public health. Additionally, there is a need to improve the effectiveness of diagnostic methods for cyst identification in animals to enhance disease control efforts.

#### LIMITATIONS OF THE STUDY

This study faced several limitations. Firstly, there was a lack of sufficient data from some sub-Saharan countries, and in certain regions, no data were available at all. Additionally, access to some relevant articles was restricted, which may have limited the inclusion of all eligible studies and therefore affected the completeness and regional representation of the available evidence in this review. Another limitation was the incomplete coverage of species; for instance, some studies focused exclusively on sheep, omitting data on goats. A number of studies also reported cysts not typically associated with small ruminants, such as *Cysticercus bovis*. Furthermore, some studies examined metacestode infections across various

species, including small ruminants, making it challenging to determine the specific prevalence of metacestodes in small ruminants alone. The small number of publications included in the systematic review introduces potential bias in assessing prevalence rates of metacestode infections in sub-Saharan Africa. Additionally, in some studies, risk factors associated with metacestode infection were merely mentioned without thorough analysis. Lastly, the absence of studies from Central and Southern Africa on the prevalence of major metacestodes in small ruminants is another significant gap, and the reasons for this absence remain unclear.

## CONCLUSION

This review provided descriptive information on the prevalence, risk factors, and possible control measures for major metacestodes in sub-Saharan Africa. The findings highlighted varying levels of infection across different countries, with a significant concentration of studies from Eastern Africa, particularly Ethiopia. This concentration may be attributed to Ethiopia's large population of small ruminants and the documented economic impact of metacestode infections, such as carcass

condemnation in abattoirs and slaughterhouses (Negero and Ferede, 2017). Additionally, regions in Central Ethiopia, such as Oromia and Addis Ababa, have relatively more developed infrastructure, which might explain the higher number of studies conducted there (Shumuye *et al.*, 2021). The results of this systematic review highlight a substantial need for further epidemiological research across sub-Saharan Africa to better understand and address metacestode infections in small ruminants.

## RECOMMENDATIONS

To address the challenges associated with metacestode infections, several actions are recommended. Firstly, improving hygiene practices in abattoirs is essential, particularly through proper disposal methods for infected offal, such as using designated pits to prevent environmental contamination. Regular deworming of livestock should be implemented to inhibit the development and spread of metacestode parasites and cysts. Additionally, raising community awareness through educational campaigns and mass media is

crucial to inform the public about the risk factors and health implications of metacestode infections. Controlling the population of stray or unowned dogs, which act as vectors for these infections, is also important. Regular surveillance systems should be established to monitor infection rates, especially in areas where preventive and control measures are in place. Finally, further research is needed across sub-Saharan Africa to fill existing knowledge gaps and develop targeted, effective control strategies for metacestode infections.

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## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

## REFERENCES:

- Abassa, K. P. (1995). ILCA working document - Reproductive losses in small ruminants in Sub-Saharan Africa: A review. *ILCA*, Ed. (pp. 1–90).
- Abdo, B., Wale, T. and Tilaye, S. (2017). Prevalence of Haemonchosis and Associated Risk Factors in Small Ruminants Slaughtered at Bishoftu ELFORA Export Abattoir, Ethiopia. *J. Nat. Sci. Research* *www.iiste.org ISSN*, 7(7): 48–52. doi:10.5829/idosi.ejbs.2017.101.105.
- Abu-Elwafa, S. A., Al-Araby, M. A. and Abbas, I. E. A. (2009). Metacestodes Among Sheep Slaughtered At Mansoura Abattoir , Metacestodes Among Sheep Slaughtered At Mansoura Abattoir , Dakahlia Province , Egypt. *Mansoura Vet Med J*, 11(1) 1-13, 2009. doi: 10.21608/mvmj.2009.158882.
- Addy, F., Amos, A., Njeri, W., Japhet, M., Cecilia, M., Erastus, M. and Eberhard, Z. (2012). Prevalence and Diversity of Cystic Echinococcosis in Livestock in Maasailand,

- Kenya. *Parasitol. Res*, 111(6): 2289–94. doi:10.1007/s00436-012-3082-8.
- Ahmed, H., Abdullah., Rostam, H. Z., Fatima, M. Ali., Awaz M. S. and Amer, A, H. (2018). Prevalence and Molecular Characterization of *Cysticercus Tenuicollis* Isolated from Some Intermediate Host in Kurdistan-Iraq. *KJAR*, pp. 177–82. doi:10.24017/science.2018.2.30.
- Ahmed, M. A., Abshir, A., Haji, A. H. H. and Samatar, A. M. (2024). Prevalence, Cysts Distributions, Associated Risk Factors and Economic Importance of *Cysticercus Tenuicollis* in Small Ruminant Slaughtered at Jigjiga Municipal Abattoir, Somali Regional State, Ethiopia. *Asian J. Adv. Res*, 18(1): 92–101. doi:10.9734/ajarr/2024/v18i1599.
- Aliye, J. and Feyissa, B. D. (2017). Prevalence and Economic Importance of *Coenurus Cerebralis* in Sheep and Goats in and around ‘Legahida’ District of Bale Zone, South Eastern Ethiopia. *Comp. Clin. Pathol*, 26(2): 483–92. doi:10.1007/s00580-017-2404-8.
- Asmare, K., Kassaye. and Dvm, A. (2023). Ethiopian Veterinary Association Small Ruminant Health Management Continuous Professional Development (CPD) Training Manual
- Assefa, H., Belay, M., Shahid, N. and Alula, A. (2015). Cystic Echinococcosis amongst Small Ruminants and Humans in Central Ethiopia. *Onderstepoort j. vet. res*, 82(1): 1–7. doi:10.4102/OJVR.V82I1.949.
- Braae, U. C., Mwemezi, K., Michelle, E. N., Peter, N., Helena, A. N. and Maria, V. J. (2015). *Taenia Hydatigena* Cysticercosis in Slaughtered Pigs, Goats, and Sheep in Tanzania. *Trop. Anim. Health Prod*, 47(8): 1523–30. doi:10.1007/s11250-015-0892-6.
- Central Statistical Agency. (2019). Report on Livestock and Livestock Characteristics (Private Peasant Holdings): Agricultural Sample Survey 2018/19 [2011 E.C.], Volume II. (May): 98.
- Erbeto, K., Girma, Z. and Bersissa, K. (2010). Hydatidosis of Sheep and Goats Slaughtered at Addis Ababa Abattoir: Prevalence and Risk Factors. *Trop. Anim. Health Prod*, 42(5): 803–5. doi:10.1007/s11250-009-9495-4.
- Fromsa, A. and Jobre, Y. (2011). Infection prevalence of hydatidosis ( *Echinococcus granulosus*, Batsch, 1786) in domestic animals in Ethiopia: A synthesis report of previous surveys. *Ethiop. Vet. J*, 15(2). doi:10.4314/evj.v15i2.67691
- Gessese, A. T., Belay, M. and Shahid, N. (2015). Major Metacestodes in Small Ruminants Slaughtered at Dessie Municipal Abattoir , Eastern Ethiopia : Prevalence , Cyst Viability , Organ Distribution and Economic Implications. *Comp. Clin. Pathol.* (2015), 24(3) 659-668. doi:10.1007/s00580-014-1964-0.
- Godara, R., Katoch, R., Yadav, A., Khajuria, J. K. and Borkataki, S. (2011). Coenurosis in small ruminants: An overview. *Vet. Pract.* 12(1): 102–5.
- Hailu, M. (2019). Prevalence Major Metacestodes of Ruminant Slaughtered at Elfora Export Abattoir and Public Health Importance. *JDVS*, 10(5). doi:10.19080/jdvs.2019.10.555797.
- Ilukor, J. (2017). Improving the Delivery of Veterinary Services in Africa: Insights from the Empirical Application of Transaction Costs Theory in Uganda and Kenya. *Rev. sci. tech*, 36(1): 279–89. doi:10.20506/rst.36.1.2628.
- Jansen, C. and Burg, K. (2004). Goat keeping in the tropics (pp. 1–96). Retrieved from <http://publications.cta.int/media/publications/downloads/371>
- Kebede, W., Hagos, A., Girma, Z. and Lobago, F. (2009). Echinococcosis/Hydatidosis: Its Prevalence, Economic and Public Health Significance in Tigray Region, North Ethiopia. *Trop. Anim. Health Prod*, 41(6): 865–71. doi:10.1007/s11250-008-9264-9.
- Kibona, T., Buza, J., Shirima, G., Lankester, F., Ngongolo, K., Hughes, E., Cleaveland, S. and Kathryn J. A. (2022). The Prevalence and Determinants of *Taenia Multiceps* Infection (Cerebral Coenurosis) in Small Ruminants in Africa: A Systematic Review. *Parasitologia*,

- 2(2): 137–46.  
doi:10.3390/parasitologia2020013.
- Macpherson, C. N.L. (1994). Epidemiology and Control of Parasites in Nomadic Situations. *Vet. Parasitol*, 54(1–3): 87–102. doi:10.1016/0304-4017(94)90085-X.
- Marchal, B., Monique, V. D., Marjan P., Anna, C. G. K. and Katja, P. (2011). Neglected Tropical Disease (NTD) Control in Health Systems: The Interface between Programmes and General Health Services. *Acta Trop*, 120(SUPPL. 1): S177–85. doi:10.1016/j.actatropica.2011.02.017.
- Mekuria, E., Shihun, S., Jemere, B. and Desie, S. (2013). Sheep and Goats Cysticercosis Tenuicollis Prevalence and Associated Risk Factors. *Afr. J. Agric. Res*, 8(24): 3121–25. doi:10.5897/AJAR2012.7361.
- Miran, M. B., Kasuku, A. A. and Swai. E. S. (2017). Prevalence of Echinococcosis and Taenia Hydatigena Cysticercosis in Slaughtered Small Ruminants at the Livestock-Wildlife Interface Areas of Ngorongoro, Tanzania. *Vet. World*, 10(4): 411–17. doi:10.14202/vetworld.2017.411-417.
- Miran, M. B., Nzalawahe, J., Kasuku, A. A. and Swai. E. S. (2015). Prevalence of Coenurosis in Sheep and Goats at Three Slaughter Slabs in Ngorongoro District, Tanzania. *Trop. Anim. Health Prod*, 47(8): 1591–97. doi:10.1007/s11250-015-0903-7.
- Moher, D., Alessandro, L., Jennifer, Tetzlaff and Douglas, G. A. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *J. Clin. Epidemiol*, 62(10): 1006–12. doi:10.1016/j.jclinepi.2009.06.005.
- Mosha, I. H., Mangi, J. E., Miraji, A. M. and Donath, S. T. (2022). Prevalence, Transmission Dynamics of Hydatidosis in Slaughtered Animals in Dodoma Municipality, Tanzania. *IJSRM*, 10(02): 547–57. doi:10.18535/ijssrm/v10i02.mp03.
- Negero, J. and Geremew, F. (2017). A Retrospective Study on the Causes of Carcass and Organ Condemnation and Financial Loss in Debrezeit Helmelex Abattoir. *J. Vet. Sci. Technol*, 8(5). doi:10.4172/2157-7579.1000466.
- Nungari, L. W. (2020). Prevalence and Molecular Characterization of Cystic Echinococcosis in Livestock, Echinococcus Infection and the Risk Factors in Dogs in Kajiado-West Sub-County, Kenya. <http://repository.kemri.go.ke:8080/xmlui/handle/123456789/412>.
- Nyero, D, G., Zirintunda, L. Omandang. and Ekou, J. (2015). Prevalence of Hydatid Cysts in Goats and Sheep Slaughtered in Soroti Municipal Abattoir , Eastern Uganda. *Afr. J. Parasitol. Res*, 2(9): 148–51. <http://www.internationalscholarsjournals.org> © International Scholars Journals
- Okello, A., Susan, W. and James, S. (2015). Crossing Institutional Boundaries: Mapping the Policy Process for Improved Control of Endemic and Neglected Zoonoses in Sub-Saharan Africa. *HPP*, 30(6): 804–12. doi:10.1093/heapol/czu059.
- Oryan, A., S., Goorgipour, M. M. and Shirian, S. (2012). Abattoir Prevalence, Organ Distribution, Public Health and Economic Importance of Major Metacestodes in Sheep, Goats and Cattle in Fars, Southern Iran. *Trop. Biomed*, 29(3): 349–59.
- Osofsky, S. A. (2019). The Global Burden of (How We Manage) Animal Disease: Learning Lessons from Southern Africa. *J. Wildl. Dis*, 55(4): 755–57. doi:10.7589/2019-01-024.
- Saelens, G., Lucy, R. and Sarah, G. (2022). Diagnostic Tools for the Detection of Taeniid Eggs in Different Environmental Matrices: A Systematic Review. *Food Waterborne Parasitol*. 26(December 2021). doi:10.1016/j.fawpar.2022.e00145.
- Sagni, D. and Garoma, A. (2021). Epidemiology and Economic Loss of Coenurosis in Small Ruminants Slaughtered at Mojo Halal Export Abattoir, Oromia Regional State, East Shoa

- Zone, Ethiopia. *Int. J. Vet. Sci. Res*, 7: 127–37. doi:10.17352/ijvsr.000092.
- Samuel, W. and Girma, G. Z. (2010). Prevalence, Risk Factors, and Distribution of *Cysticercus Tenuicollis* in Visceral Organs of Slaughtered Sheep and Goats in Central Ethiopia. *Trop. Anim. Health Prod*, 42(6): 1049–51. doi:10.1007/s11250-010-9537-y.
- Saulawa, M., Magaji, A, Faleke, O., Mohammed, A., Kudi, A., Musawa, A. and Sada, A, et al. (2011). Prevalence of *Cysticercus Tenuicollis* Cysts in Sheep Slaughtered at Sokoto Abattoir, Sokoto State, Nigeria. *Sokoto J. Vet. Sci* (2011), 9(2): 24–27.
- Shumuye, N. A., John, A, O., Mebrahtu, B. G., Hong, B. Y., Li, L., Wen, H. L., Nian, Z. Z., Bao, Q. F. and Wan, Z. J. (2021). A Systematic Review and Meta-Analysis on Prevalence and Distribution of *Taenia* and *Echinococcus* Infections in Ethiopia. *Parasit. Vectors*, 14(1): 1–22. doi:10.1186/s13071-021-04925-w.
- Sissay, M. M., Arvid, U. and Peter, J. W. (2008). Prevalence and Seasonal Incidence of Larval and Adult Cestode Infections of Sheep and Goats in Eastern Ethiopia. *Trop. Anim. Health Prod*, 40(6): 387–94. doi:10.1007/s11250-007-9096-z.
- Tamarozzi, F., Tito, K., William, A. de Glanville., Tauta, M., Elly, A., Anande, S., Kennedy, Misso, et al. (2022). Cystic Echinococcosis in Northern Tanzania: A Pilot Study in Maasai Livestock-Keeping Communities. *Parasit. Vectors*, 15(1): 1–11. doi:10.1186/s13071-022-05518-x.
- WHO/HTM/NTD/2015.1. 2016. Investing to overcome the global impact of neglected tropical diseases. *Alternaria Diseases of Crucifers: Biology, Ecology and Disease Management*, 17–51. doi:10.1007/978-981-10-0021-8\_2.