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Original article

The need to optimize deworming interventions: Assessing awareness and practices for *Taenia multiceps* control in dog-owning households within livestock-keeping communities in Northern Tanzania

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Abstract

Taenia spp infections, especially cerebral coenurosis caused by *Taenia multiceps*, pose serious health risks to both livestock and humans. This study examines deworming practices in northern Tanzania, highlighting the disparity between those for dogs and small ruminants amid high coenurosis incidences in small ruminants and undocumented human cases. A cross-sectional survey was conducted with 252 dog-owning households, 248 of which also kept livestock, randomly selected from 18 villages representing pastoral and agro-pastoral communities. The results revealed that only 15% of dog owners dewormed their animals, compared to 85% of small ruminant farmers. Awareness of deworming for dogs revealed that only 24% of respondents were able to identify suitable dewormers for dogs. The median time since the last deworming in dogs was reported as 14 weeks (range: 0 to 100 weeks). Households that were aware of appropriate dewormers for treating and controlling helminths in dogs were over twenty-eight times more likely to deworm their dogs than those that were not aware (OR = 28.1, 95% CI: 11.0 – 79.1). The intervention model projected that increasing the dog deworming rate to 85% could significantly reduce *T. multiceps* transmission. This study reveals a critical gap in dog deworming practices and emphasizes the urgent need for better education on anthelmintics and improved access to appropriate dog helminth preventive treatments, which could significantly enhance small ruminant productivity and public health outcomes in resource-limited rural areas.

Keywords: dogs**,** small ruminants, cerebral coenurosis, deworming, helminths, model intervention

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Introduction

Taenia spp infections are a significant concern for both animal and public health (Kostopoulou et al., 2017). Cerebral coenurosis in small ruminants is caused by metacestode stage (*Coenurus cerebralis*) of the cestodes of dog origin from a taeniid group of flat worms called *T. multiceps* (Varcasia et al., 2022). Like other cestodes of dog origin, such as *Echinococcus, T. multiceps* is known to be zoonotic, with human cases reported in several countries in Africa, Asia and North America (Kulanthaivelu et al., 2020). However, despite high incidence in small ruminants, no human case has been reported in Tanzania and there is limited information on the disease in human. Lack of a specific test for this parasite in clinical settings, coupled with overlapping symptoms with other neurological disorders, poses diagnostic challenges. The disease may manifest as seizures, paralysis, or behavioral changes, which can be mistaken for epilepsy, stroke, or other neuro-infections such as neurocysticercosis (Bern et al., 1999).

Cerebral coenurosis in small ruminants in northern Tanzania remains the major neurologic parasitic disease, significantly impacting the productivity of these animals (Miran et al., 2017). A recent systematic review reported prevalence rates of 3.5% to 45.6% in small ruminants across Africa (Kibona et al., 2022a). Tanzania had the highest recorded prevalence of cerebral coenurosis. Similarly, in northern Tanzania, taeniid infection in dogs ranged from 9.2% to 73.2% (Kibona et al., 2022b; Miran B and Kasuku, 2015). In small ruminants, the disease affects the brain and spinal cord with a range of neurological syndrome including circling, staggering gate, neck tilt, and seizures in affected animals (Hughes et al., 2019). Transmission to dogs and other canids, the definitive hosts, occurs when intermediate stages are consumed by the canids and develop into mature *T. multiceps* worms in the intestines of canids, passing proglottids through faeces. Each mature proglottid of mature *T. multiceps* canids can contain up to 37,000 eggs allowing canid hosts to amplify infection within an ecosystem (Oryan et al., 2015; Sharma and Chauhan, 2006; Willis and Herbert, 1984). In dogs, *T. multiceps* infection is subclinical with typically few health impacts however, under heavy infestation dogs can demonstrate non-specific gastrointestinal syndrome such as abdominal pain, diarrhoea and constipations (TroCCAP, 2018). Although there is limited clinical impact in dogs, treatment of *T. multiceps* and related cestodes such as *Echinococcus granulosus* in dogs is recommended to safeguard ruminant hosts and human population (Moro and Schantz, 2009; TroCCAP, 2018).

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T. multiceps in small ruminants can have severe consequences for flock owner livelihoods. Infected animals are prematurely culled and have low market value as a result (Asefa Deressa, 2012). Despite the high incidence of cerebral coenurosis, veterinary authorities have not given the disease sufficient attention. While deworming is commonly practiced on small ruminants by flock owners, there is limited information on deworming practices in dogs in the same community. This is concerning, given that the transmission cycle of some dog helminths may involve other species. Broadly, the availability of appropriate dewormers for the treatment and control of dog cestodes, such as *T. multiceps*, in agro-pastoral and pastoral communities is not well understood. Using household surveys, this study assessed the current deworming practices, identified the gaps, and model intervention practices used to mitigate *T. multiceps* transmission in agro-pastoral and pastoral communities in northern Tanzania.

Materials and Methods

Study design

A cross-sectional study was conducted to evaluate deworming practices in northern Tanzania between January and December 2019. The study was conducted in Longido, Karatu, Monduli, and Ngorongoro in the Arusha region; and Mbulu and Babati in the Manyara region (Figure 1). These sites were selected because (a) the Manyara region has the highest population of small ruminants in mainland Tanzania, with 2,380,072 goats (9.7 percent of the total), and Arusha has the largest number of sheep, with 1,576,091 heads (18.6 percent), followed by Manyara with 937,541 (11.0 percent) (NBS, 2021), and (b) a previous study by Zoonoses and Emerging Livestock Systems (ZELS) reported a high number of cases of *T. multiceps* coenurosis (up to 44.6%) in small ruminants in these areas. To capture data on helminth intervention practices, the study employed experienced interviewers for the survey. In the study on helminth treatment-seeking practices, local expert knowledge (local field veterinary para-professionals and assistant paraprofessionals) was also utilized to ascertain the availability of veterinary anthelmintic sources. To understand the factors shaping deworming practices for dog-owning and small ruminant-owning households, at least 10 households were randomly selected from each study village. For each village, the village leaders provided a list of sub-villages. At least two sub-villages were then randomly selected using a simple random sampling method. From these selected sub-villages, households were also randomly chosen. In each selected household that owned dogs and/or small ruminants, a questionnaire was administered to gather information on deworming practices. Written consent was obtained from the head of the household. Respondents were either the head of the household or an adult representative (≥18 years old) designated by the head, based on their knowledge of dog and/or small ruminant management, including helminth control in these species. A semi-structured questionnaire was administered by a trained team member to the respondent after obtaining written consent from the head of the household, livestock owner, or dog owner.

The sample size was calculated using the formula $n = Z^2 P(1-P)/d^2$, where n= sample size, using a 95% confidence level with a 5% margin of error (d= 0.05), Z-score statistics (z=1.96), P= expected deworming practices (p=0.1), a sample sizes of 139 was obtained. However, considering the default design effect (DEFF) of 1.5, the final effective sample was 209 households. This study surveyed 252 households to inquire about the extent of deworming practices in selected villages.

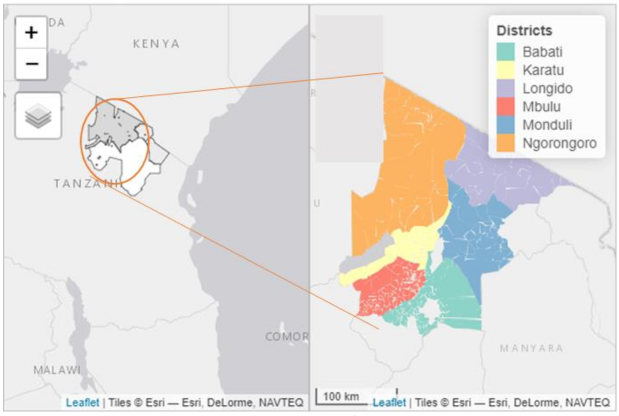

Figure 1. Map showing the position of the Arusha and Manyara regions in northern Tanzania (left) and respective study Districts (right).

Ethical clearance

All individuals whose animals were sampled and who participated in the questionnaire survey provided written informed consent prior to their involvement in the study. The study protocols, including the questionnaires and consent procedures, received ethical approval from the National Institute of Medical Research (NIMR) in Tanzania under approval number NIMR/HQ/R.8c/Vol.I/732. This research was conducted in accordance with ethical guidelines to safeguard participants' rights, confidentiality, and well-being, ensuring compliance with both national and international standards for research involving human subjects.

Household questionnaire survey on deworming practices and its determinants

Dog surveys

Data were initially collected from selected households in chosen sub-villages to determine ownership of dogs and small ruminants, as well as the availability of dewormers and dog deworming practices. Additionally, detailed data on the number of dogs per household were collected from each selected household in the sub-village. Individual dog data included sex and age (owners report), where age was categorized as adult (≥9 months) or juvenile (<9 months). The number of dogs per household was grouped as follows: up to four dogs were considered low (1-4); five to nine dogs were regarded as high (5-9); and more than or equal to ten (≥10) were considered as very high. Source of dewormer was assessed; Agrovet outside village (within the ward), Agrovets within the village, Agrovets at District Headquarter market, Local regular markets (within the village), Local regular markets (outside village).

In addition, several factors were considered as determinants of whether dog owners would deworm their dogs or not, and their influence on the outcome was assessed. The data collected included livestock systems (agropastoral or pastoral), dogs used for grazing (taken for herding), awareness of dog dewormers, deworming practices, the last time deworming occurred in weeks (for those responding "yes" to deworming), the name of dewormers used (for those responding "yes" to deworming), any source of dewormers (for both those responding "yes" or “no” to deworming), the frequency of dog deworming (for those responding "yes" to deworming), and reasons for not deworming (for those responding "no" to deworming).

Small ruminants’ surveys

From selected households in chosen sub-villages data on small ruminants, as well as the availability of dewormers and small ruminants deworming practices were collected. Additionally, detailed data on flock size per household were collected from each selected household in the sub-village. Flock sizes were categorized as: small (≤100); medium (101-300); large (301-600) and very large (≥601). In addition, several factors were considered as determinants of whether small ruminant owners would deworm their animals or not, and their influence on the outcome was assessed. The data collected included livestock systems (agropastoral or pastoral), deworming ("yes" or “no”), the last time deworming occurred in weeks (for those responding "yes" to deworming), the name of dewormers used (for those responding "yes" to deworming), any the source of dewormers (for both those responding "yes" or “no” to deworming).

Data Management and Analysis

Over view on data analysis plan

Data on deworming practices surveys were entered into Microsoft Excel® (Microsoft Corporation, Washington, USA) before analysis using R statistical environment version 4.3.2 by R Core Team (2023) (https://cran.r-project.org). Descriptive statistics on village data were summarised as: percentage of responses on various options related to dog and small ruminants deworming practices across livestock systems in rural northern Tanzania.

Regression analysis for factors for helminth treatment practices.

A mixed effects logistic regression analysis was employed to identify and investigate deworming practices in dogs and small ruminants management practices.

First, univariate analysis of each predictor variable for helminths deworming practices in dogs was performed. The response variable was deworming of a dog (yes/no) determined as either the dog-owning household practiced deworming in last 12-months. The predictor variables were: livestock system (agro-pastoral or pastoral), and whether the dog moved with the herders during grazing (no/yes), awareness of appropriate dewormer (no/yes), number of dogs per household; Low (1-4), High (5-9), and Very high (≥10). Second, univariate analysis for each predictor variable for deworming in small ruminants. Deworming ("yes" or “no”) was a response variable. The predictor variables were: flock sizes were categorized as: small (≤100); medium (101-300); large (301-600) and very large (≥601), livestock systems (agropastoral or pastoral), the name of dewormers used (for those responding "yes" to deworming), source of dewormers if they know any (for both those responding "yes" or “no” to deworming). Further, as described by Kowal (2022), a subset of the dogs' data was created based on the dewormer source for dogs. This sub-setting approach was used to achieve a more balanced and informative dataset, enabling better identification of key patterns, relationships, and predictors. As a result, the interpretability and predictive performance of the model were improved (Kowal, 2022)

Thirdly, variables that were significant at a level of $p \leq 0.25$ in univariate analysis were included in the full multivariate models for response to deworming of dogs. The reason for using $p \leq 0.25$ in univariate analysis as a screening criterion for selecting candidate variables for multivariate logistic regression, ensuring that important predictors are not excluded prematurely. The final models were built by backwards elimination, dropping one variable at time from the full model based on Akaike information criterion (AIC). Likelihood ratio tests (LRT) were used to check the significance of each variable in the final model. A $p \leq 0.05$ of the LRT was considered significant and the variables were retained in the model. Interaction and confounding effects were tested using LRT and the significance of p-values on the presence or absence of the variable with respect to others. Furthermore, due to relatively minimal sample size in this study, Bayesian method was employed as described by Chung et al.; and McNeish (Chung et al., 2013; McNeish, 2016)

Simulated model intervention for coenurosis in small ruminant through dog deworming

Increase the deworming rate in dogs to reduce the prevalence of taeniid infections and subsequently decrease transmission to small ruminants. Utilize the factors identified in the analysis that positively influence deworming practices, and replicate these strategies to enhance helminth-targeted interventions against taeniid infections in dogs. Aim to increase the deworming rate in dogs to 85% of the target population to effectively lower the prevalence of taeniid infection in dogs and reduce the risk of transmission to small ruminants. Below is a step-by-step four-round deworming process, detailing how the proportion of the dewormed dog population (P_d), the transmission rate from dewormed dogs to the susceptible small ruminant population ($T_{d \rightarrow s}$), and the prevalence of the disease (*T. multiceps* cerebral coenurosis) in the susceptible small ruminant population (P_s) come out in each round based on the following disease parameters.

D_d = Proportion of targeted dogs to be dewormed

$P_d(n)$ = Prevalence of *T. multiceps* in dogs after “n” of deworming intervention
$P_s(n)$ = Prevalence of *T. multiceps* (coenurosis) in small ruminants after “n” of deworming intervention in dogs
$T_{d\to s}(n)$ = Rate of parasitic transmission from the dogs to small ruminants for an “n” round of deworming intervention in dogs
R_d = Reduction in transmission due to deworming in dogs
n = number of deworming rounds.
d = dogs
s = small ruminants

Deworming intervention: Round 1

This equation computes the transmission rate of the parasite from dogs to small ruminants after the first round (Equation 1). Similar to the first equation, it reduces the initial transmission rate by the effectiveness of the deworming intervention in dogs. A lower transmission rate indicates reduced risk of the parasite being passed on to the intermediate hosts (small ruminants).

$$T_{d\to s}(1) = T_{d\to s}(0) * (1 - D_d * R_d) \quad (1)$$

This equation calculates the prevalence of the parasite in dogs after the first round of deworming. $P_d(0)$ represents the initial prevalence before deworming, D_d is the deworming coverage rate, and R_d is the effectiveness of the deworming drug. The product $D_d * R_d$ gives the proportion of the parasite population expected to be reduced due to the deworming intervention. The prevalence after the first round is reduced from the initial prevalence proportionally to this reduction factor (Equation 2).

$$P_d(1) = P_d(0) * (1 - D_d * R_d) \quad (2)$$

This equation determines the prevalence of the parasite in small ruminants after the first round of deworming in dogs. The decrease in prevalence in small ruminants is influenced by the reduced transmission rate and the current prevalence in dogs (Equation 3).

$$P_S(1) = P_d(0) + (T_{d\to s}(1) * P_d(1))(1 - P_S(0)) \quad (3)$$

Deworming intervention: Round 2

Similar to the first round, this equation calculates the prevalence of the parasite in dogs after the second round of deworming, further reducing the prevalence based on the coverage and effectiveness of the deworming intervention (Equation 4).

$$P_d(2) = P_d(1) * (1 - D_d * R_d) \quad (4)$$

The transmission rate after the second round is further reduced, reflecting the ongoing deworming interventions (Equation 5).

$$T_{d\to s}(2) = T_{d\to s}(1) * (1 - D_d * R_d) \quad (5)$$

This equation continues to monitor the prevalence in small ruminants, incorporating the reduced transmission rate and dog prevalence after the second round (Equation 6).

$$P_S(2) = P_d(1) + (T_{d\to s}(2) * P_d(1))(1 - P_S(1)) \quad (6)$$

Deworming intervention: Round 3

The prevalence in dogs is further reduced after the third round of deworming (Equation 7).

$$P_d(3) = P_d(2) * (1 - D_d * R_d) \quad (7)$$

The transmission rate is further minimized, reflecting the cumulative effect of multiple deworming rounds (Equation 8).

$$T_{d\to s}(3) = T_{d\to s}(2) * (1 - D_d * R_d) \quad (8)$$

This equation assesses the prevalence in small ruminants after the third round, accounting for the cumulative reduction in transmission and dog prevalence (Equation 9).

$$P_S(3) = P_d(2) + (T_{d\to s}(3) * P_d(3))(1 - P_S(2)) \quad (9)$$

Deworming intervention: Round 4

This equation calculates the prevalence of the parasite in dogs after the fourth round of deworming (Equation 10).

$$P_d(4) = P_d(3) * (1 - D_d * R_d) \quad (10)$$

The transmission rate from dogs to small ruminants is further decreased after the fourth round (Equation 11). This ongoing reduction reflects the continuous impact of deworming on limiting the parasite's ability to spread from the definitive host (dogs) to the intermediate host (small ruminants)

$$T_{d\to s}(4) = T_{d\to s}(3) * (1 - D_d * R_d) \quad (11)$$

This equation calculates the prevalence of the parasite in small ruminants after the fourth round of deworming in dogs (Equation 12). The new prevalence in small ruminants is determined by the reduced transmission rate and the updated prevalence in dogs. The equation also factors in the current prevalence in small ruminants $P_S(3)$, ensuring that the additional cases are only added to the proportion of the population still susceptible to infection.

$$P_S(4) = P_d(3) + (T_{d\rightarrow s}(4) * P_d(4))(1 - P_S(3)) \quad (12)$$

Results

Village demographic data on dogs and small ruminant flock ownership

The median (IQR) number of dogs kept per household was 2 dogs (range: 1 to 14 dogs), and most dogs were less than eight months old. Households in agropastoral and pastoral areas kept slightly more adult males than females. The median (IQR) flock size in small ruminants reported by respondents was 30 animals (range: 1 to 1510 small ruminants), where majority flock owners 74.1% (184/248) owned flock size of ≤100 small ruminants.

Detailed deworming practice survey and exploration of helminth treatment practices

A study was undertaken to examine the deworming practices in livestock-keeping communities. Results indicate that as few as 15% (38/252) deworm dogs, while in the same community, 85% (211/248) deworm their flocks (small ruminants). Of the participants who responded to the questions on awareness and importance of deworming dogs, only 24% could recall the names of deworming drugs. Levamisole and Albendazole were commonly mentioned, whereas Praziquantel was least mentioned at 13% (Table 3). Compared to deworming in small ruminants, of the 211 (85.4%, 211/248) small ruminant livestock farms that responded to having dewormed their animals, 170 (80.6%) recalled the specific drug type they used for deworming. Among the common dewormers used, Albendazole was the major drug of choice at 62.9% (107/170), followed by Levamisole at 35.9% (61/170), and Ivermectin was the least used. All three drugs were used for round gastrointestinal worms. In dogs, the median (IQR) time since last deworming reported by respondents was 14 weeks (range: 0 to 100 weeks), while the median (IQR) time since last deworming in small ruminants reported by respondents was 12 weeks (range: 0 to 56 weeks).

Table 1. Common dewormer mentioned by animal type in rural communities in northern Tanzania

Animal type	Dewormer type	Frequency	Percentages	95% CI
Dogs	Albendazole	6	40.1	22.2-72.6
	Praziquantel	2	13.3	23.4-41.6
	Levamisole	7	46.6	17.4-67.1
Small ruminants	Albendazole	107	62.9	55.2-70.1
	Ivermectin	2	1.2	2.0-4.6
	Levamisole	61	35.9	28.8-43.6

Dewormer source

Mapping for the proportion of the cited dewormer sources for both dogs and small ruminants. The predominant source of dewormers for dogs was agro-vets located outside the villages but within the same ward (local administrative unit consisting of several villages), accounting for the majority at 51.6% (32/62). On the other hand, the predominant source for small ruminants was agro-vets in the district headquarters, accounting for 39.8% (84/170). There is a convergence in sourcing dewormers from all cited points, with the proportion from agro-vets within the village at 23%.

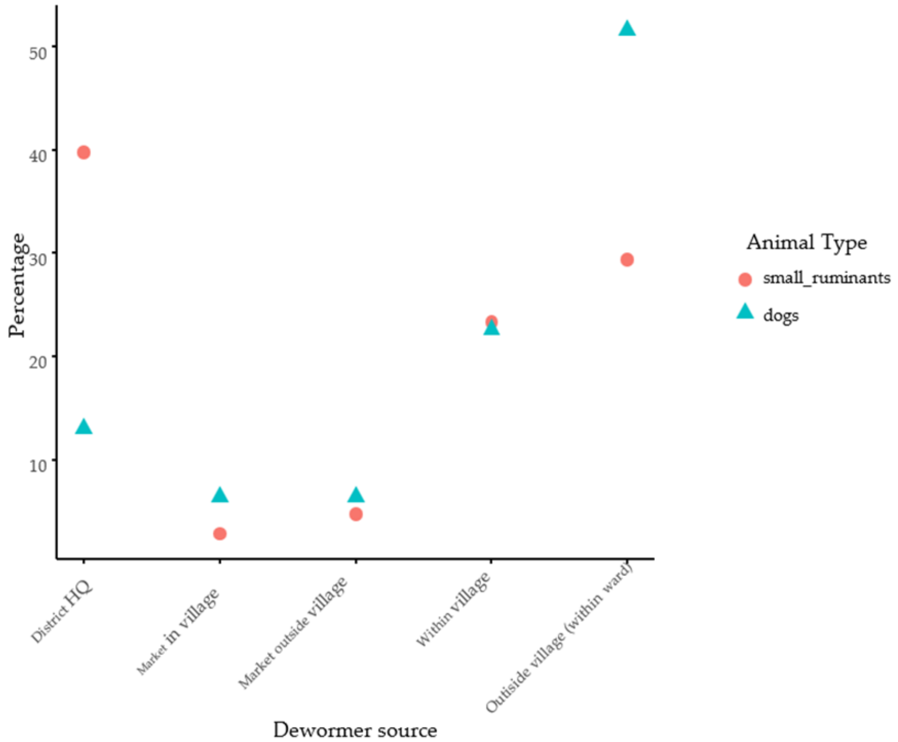

Figure 2. Mapped dewormer source for both dogs and small ruminants livestock keepers communities in northern Tanzania

Univariate analysis

Univariate logistic regression was used to determine how factors are linked to the deworming and what influences deworming practices for helminths infections in dogs and small ruminants (Table 5). We found that awareness of the appropriate dewormer for dogs and all factors for deworming in small ruminants (livestock systems, newly introduced animals, and flock size) significantly impacted household use of dewormers ($p \leq 0.25$). Hence these variables were selected for use in the multivariate analysis.

Table 2. Univariate analysis of household's determinant attributes in relation to deworming practices towards control of taeniids in dogs and coenurosis in small ruminants in rural northern Tanzania

Species	Variable	Variable response	n/N (%)	Univariate regression	
				OR (95% CI)	**P-value**
Dogs	Livestock systems	Agro-pastoral	49/62 (79)	Ref	
		Pastoral	13/62 (21)	1.01 (0.70-1.44)	0.9635
	Involved in herding	No	30/62 (48)	Ref	
		Yes	32/62 (52)	1.02 (0.8-1.3)	0.8212
	Awareness	No	44/62 (38)	Ref	
		Yes	18/62 (62)	1.74 (0.68-1.62)	<0.001
	Dogs per household	High (5-9)	6/62 (10)	Ref	
		Low (1-4)	54/62 (3)	1.05 (0.56-3.01)	
		Very high (≥10)	32/62 (53)	1.00 (0.44-2.26)	0.9595
Small ruminants					
	Livestock systems	Agro-pastoral	137/248 (55)	Ref	
		Pastoral	111/248 (45)	1.17 (1.07-1.27)	<0.001
	Introduced animals	No	183/248 (74)	Ref	
		Yes	65/248 (26)	1.1 (1.00-1.25)	0.06
	Flock size	Large (301-600)	14/248 (5)	Ref	
		medium (101-300)	46/248 (19)	0.92 (0.74-1.13)	
		small (≤100)	184/248 (74)	0.83 (0.69-1.01)	0.118
		Very large (≥600)	4/248 (2)	1.0 0.67-1.48)	

Multivariate analysis

Finally, model for factors influencing deworming in animal type for helminth control was developed. The final model indicated that dog owning households which were aware of appropriate dewormer for treatment and control of helminths in dogs were over twenty-eight times more likely deworm their dogs than those not in the same study area (OR = 28.1, 95% CI 11.0 – 79.10). On the other hand, livestock owners in pastoral communities were over four times likely to worm their flocks (small ruminants) than those in agropastoral communities OR = 4.2, 95% CI 1.88- 10.32)

Table 3. Summary of Bayesian logistic regression model using *stan_glm* for factors driving deworming practices for dogs and ruminants

Animal type	Variable	Variable response	n/N (%)	Regression model analysis
				OR (95% CrI)
Dogs	Awareness to dewormers	No	44/62 (38)	Ref
		Yes	18/62 (62)	28.1 (11.0-79.1)
Small ruminants	Livestock systems	Agro-pastoral	137/248 (55)	Ref
		Pastoral	111/248 (45)	4.2 (1.88-10.32)

Model intervention

Based on the study's baseline information, the high rate of deworming practices in small ruminants was leveraged to promote similar practices in dogs. The following parameters were employed to model the intervention simulation.

Table 4. Parameters used for developing a model deworming intervention

Parameter description	Parameter notation	Value	Comments
Targeted deworming rate in dogs	D_d	0.85	This study dataset
Initial proportion of dewormed dogs	P_d	0.15	This study dataset
Initial prevalence in small ruminants	P_s	0.09	(Kibona et al., 2022b)
Reduction in transmission to ruminants	R_d	0.9	Target 90% reduction
Transmission rates (dogs)	$T_{d \to s}$	0.1	(Borhani et al., 2024)

The intervention model shows that increasing the deworming rate in dogs to 85%, significantly reduces the prevalence of the taeniid in dogs leading to a lower transmission rate to small ruminants

Table 5. Model deworming interventions for against cestodial infection in dogs and its effect on transmission rate from dogs to small ruminants

Round of deworming	Transmission Rate ($T_{d \to s}$)
0	0.1000
1	0.0235
2	0.0055
3	0.0013
4	0.0003

These calculations (Table 5) represent the results of a model deworming practice aimed at reducing the prevalence of *T. multiceps* infections in dogs and subsequently lowering the transmission rate of the parasite from dogs to small ruminants over multiple deworming rounds. The model tracks the impact of each intervention round on infection levels in dogs and the resulting transmission rate to susceptible livestock.

Discussion

Our study investigated current deworming practices, identified gaps, and modelled interventions for controlling *Taenia multiceps* in dogs within pastoral and agro-pastoral communities in northern Tanzania. We found that only 15% of dog owners dewormed their dogs, compared to over 85% of livestock farmers deworming their flocks. This disparity highlights a gap in practices toward integrated helminth control, underscoring both opportunities and challenges in managing helminths in small ruminant-livestock keeping communities. These results indicate that communities understand the importance of deworming livestock, consistent with findings from earlier studies on integrated parasitic control in small ruminants (Waller, 1997). However, this gap in dog deworming may not solely be attributed to a lack of awareness; cultural and economic factors likely also influence dog owners' decisions to prioritize livestock health over dog health due to livestock's direct economic return.

Our modelled intervention assumes a minimal presence of stray dogs in the study area, based on evidence suggesting most free-roaming dogs are owned (Hampson et al., 2009). However, some may argue that stray and semi-stray dogs could significantly contribute to *T. multiceps* transmission. Including stray dogs in intervention models, especially in regions where they are prevalent, could offer a more comprehensive approach to understanding parasite dynamics and transmission. This study's findings contrast with a study on yak herding in Lyana, Bhutan (Southeast Asia), where cerebral coenurosis is endemic in yaks, and most households dewormed their dogs (Wangdi and Wangchuk, 2021). This comparison highlights the need to consider cultural, socioeconomic, and ecological contexts when interpreting results across regions. Bhutanese communities may have higher deworming rates not only due to awareness but also because of community structures and cultural practices unique to the region, which may not be directly transferable to Tanzania.

Our study also identified a therapeutic gap in treating cestode infections, as Praziquantel, effective against taeniids, was the least commonly known dewormer among households. Levamisole and Albendazole, which are more accessible but target roundworms rather than cestodes, were more commonly cited. While an ideal approach would include Praziquantel for holistic helminth control, accessibility and cost may limit its use in resource-poor settings, indicating that regionally available alternatives may need to be prioritized where feasible. Deworming has been shown to be effective for controlling taeniids in dogs in many parts of the world, including Europe and North America (Shiferaw and Abdela, 2016). In Tanzania, rural dog owners in both agro-pastoral and pastoral areas practice deworming to varying extents. However, sustaining mass deworming initiatives poses challenges, including socio-economic constraints and limited availability of suitable anthelmintics. Realistic solutions for resource-poor communities may need to include community-led or integrated control methods rather than depend on ongoing external support for routine mass deworming.

In conclusion, our study reveals a significant gap in deworming practices between dogs and livestock in northern Tanzania's pastoral and agro-pastoral communities, highlighting both opportunities and challenges for integrated helminth control. While livestock deworming is widely practiced, awareness and appropriate dewormer use for dogs, particularly against taeniids, remain limited. Leveraging existing deworming habits for livestock, along with targeted education and outreach, could help increase dog deworming rates, thereby benefiting both animal and public health. Sustaining these interventions, however, will require addressing socio-economic barriers and ensuring access to effective anthelmintics.

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